READING STRATEGIES AND LEARNING OUTCOMES

Thesis submitted for the

degree of Ph.D in the University of Brunel

-by-

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APPENDIX A.

UNIT 2.

- 2.3. The 66 sentences (11 x 6), used in Experiment 4.

- 2.6.1. The analysis of the learning material in Experiments 1, 2, 3 and 5.

- 2.6.3. The question papers (A and B) used as tests in Experiment 2.
  The question papers (A and B) used as tests in Experiment 3.
  The 6 types of tasks used in the test booklets, in Experiment 4.

APPENDIX A, UNIT 2.

Experiment 4 (Unit 5).

2.3. The 66 Sentences (11 x 6), used in Experiment 4.

A. a) For a century, the gene existed virtually in the abstract.

b) The strands of DNA are built up of nucleotide molecules.

c) Induced by adding an antibiotic, protein chain termination can be.

d) Another variability undergoes whole organisms within galaxies after exposure velocities.

B. a) During metamorphosis in the silkworm a brain hormone stimulates a gland in the prothorax to secrete PGH, which stimulates growth.

b) A virus interfering substance called interferon is formed in appreciable quantities when heat-inactivated influenza virus is incubated in suitable cells.

c) When energy rich phosphate bonds are provided, many of the organic compounds occurring in all living cells can only be formed.

d) Enlightened proteins have special machinery to start generating special problems because daughter contructions synthesize experimenters into the architecture of molecules.

C. a) The message contained in DNA is first transcribed into the similar molecule called 'messenger' RNA, (genetic material is RNA in some viruses), which has four kinds of bases as side groups; three are identical with those found in DNA, (adenine, guanine, cytosine) but the fourth is uracil instead of thymine.

b) The composition of many of the code triplets had by actual experiment been determined and the technique evaluated, to synthesize polypeptide chains in a cell free system was, which by breaking open cells of the colon bacillus Escherichia Cali was made and extracting from the machinery of protein synthesis.

c) Human populations disturb large amounts of genes which between selection is lethal for their german ancenstry and also in southern climates alleles might happen to deviate as the migration was genetically sound, unless generations of tribal history had become very deep black or all frequencies must adapt, it could compensate.

A. a) Protein synthesis takes place on the comparatively large intracellular ribosomes.

b) Small mutations are of two types, "base substitution" and "phase shift" mutants.

c) Their own triplet of bases or anticodons, tRNA molecules have

d) Radioactive cancer has Xrays and mutations and incidence of leukemia.

B. a) By a brilliant combination of chemical and enzymatically catalyzed synthesis, Khorana made long RNA-molecules, with various repeating sequences of bases.

b) Although the genetic code was deduced from studies of the colon bacillus, it applies equally to humans and tobacco plants.

c) The pairing of codon and anticodon at the third position of the codon, to explain the wobble hypothesis rules provides.

d) The decipherment of groups of atoms takes place according to unknown enzymes therefore transcription is generated in bonds reading off.

C. a) Leder and Nirenberg studied, which amino acid joined to its tRNA, was bound to the ribosomes in the presence of a particular triplet, that is by a message with three letters and they did so by the trick of passing the mixture over a nitro-cellulose filter that retained the ribosomes.

b) The results fit the rule, that the codon and anticodon in an antiparallel manner pair, and that the pairing in the first two positions of the codon of the standard type is (A pairs with U, and G pairs with C), while in the third position it more complicated is.

c) A ring of males in coastal areas were descended from birds especially among the broken chains of races which were interbred to overlap the range of even-coloured types generating too much activity causing species to spread with such beautiful experiments that dominant traits were unable to survive the duration expected.

A. a) The phage viruses are killed by exposure to ultra-violet light.

b) Some triplets may code for more than one amino acid.

c) By analogues of the bases of DNA, mutations are produced.

d) Electrodes are sensory impressions to circuits which map the cortex.

B. a) It is unfortunately possible that a few codons may be ambiguous, that is, may code for more than one amino acid.

b) The mechanism of protein chain initiation is possibly different in mammalian cells from the mechanism now established in bacterial cells.

c) And copied prior to cell division, the DNA model built by Watson and Crick suggests how the genetic information stored is.

d) The significance created cell free systems with observation that glands could effect plausibility to become enlarged peptides occupied by syndromes.

C. a) In showing in detail how the four-letter language of nucleic acid controls the 20-letter language of protein, the code confirms the central theme of molecular biology that genetic information can be stored as a one-dimensional message on DNA and be expressed as the one-dimensional amino acid sequence of a protein.

b) A mechanism for protein chain initiation fairly recently discovered was for example in the colon bacillus, formyl-methionine, which by a special tRNA carried wa, can initiate chains, although it not clear is, if all chains in this way to start have or what the mechanism in all other species is.

c) Old world races could be replaced in Sierra Nevada if the connecting links were not among the mammals but instead the territories overlapped to such an extent giving considerable difficulties in the sub-species, which created allele drops from Mongols in blood groups in each generation, but these separated into one.

A. a) DNA is at the very core of biological inner space.

b) The efficiency of biological processes depends upon enzymatic protein molecules.

c) By dominant or recessive genes, many inherited disorders are controlled.

d) Replication is linear in order of DNA pairs, chromosomes, meiosis.

B. a) Vitamins appear to be present in nearly all living cells and this is another confirmation of the unity of life.

b) Information concerning the shapes of intact protein molecules can be obtained by X-ray structural analysis of crystals of the protein.

c) After the nucleus divides by meiosis, the number of chromosomes in each gamete half that present in normal cells is.

d) Direct recognition for disease demonstrated acute notches, that the formylatable variety during catalytic reductions, failed to confirm in black time.

C. a) The fact has emerged that the genetic code shows that the change of an amino acid in a polypeptide chain could be caused by the alteration of a single base in the relevant nucleic acid, a change from glutamic acid to valine is caused by mutation of the appropriate base.

b) The phenomenon of virus reproduction has in detail as it occurs among the bacteriophages been studied, and in some way phage particles attracted to cells of bateria are, where they by their tail-pieces to the cell wall of the host became attached and their DNA into the bacterial cell inject.

c) The code obtained in the multiple binding initiated considerable stress only because the triplets failed to establish all of them preventing smaller numbers of codon assignments to be aligned satisfactorily and the consequence of this gave clearly unambiguous experiments no results because methods for trinucleoside diphasphate synthesis could easily code.

A. a) Mongolism involves an entire chromosome rather than one particular gene.

b) A second hormone produced by the pituitary gland is oxytocin.

c) Accurate identification of amino acids, the technique of chromatography made possible.

d) Ghiberellic acid might flash flower buds with rudimentary iodinated proteins.

B. a) The fertilized egg has the remarkable ability to form all the complicated structures which are characteristic of the adult organism.

b) Every cell normally contains equivalent chromosomes and identical DNA as a result of mitosis and this mechanism ensures genetic continuity.

c) Which serve specific functions, a trend toward the specialization of cells, in the progression from simple to complex animals exists.

d) The ambiguous mutant is inevitably necessary at high latitudes because this initiation complex establishes much faster concentrations of precise mammals.

C. a) Some genes are abnormally changeable, one of the genes needed to produce coloured grains in an ear of corn for example, may mutate as often as once in 2,000 germ cells, while other genes are so stable that they fail to mutate during millions of mitotic and meiotic cell divisions.

b) Genes do not express themselves in the gametes;, so that lethal factors transmitted through the sperm and ovum can be, but in the monoplaid gametophyte plant condition, the active lethal gene would not by the presence of a normal allele suppressed be, and the outcome would failure to survive be.

c) Haemoglobin obtained from tobacco plants gave fragmentary evidence which suggests that hydroxylamine treated under the correct conditions of double strands effectively changed lyzozymes that were produced in the amino acid sequence of a colon bacillus therefore base substitutuion mutants could have been changed by each of the phase shift mutations.

A. a) Sex linked disorders include colour blindness, muscular dystrophy and haemophilia.

b) Genetic characters can be acquired by incorporating viruses into nuclei.

c) That for cystic fibrosis a common abnormal recessive gene is.

d) Muscle led darker regions of actomyasin to insulated wave-like apparatus.

B. a) Mendel did not find gene linkage groups in the pea plant but he only tested seven pairs of alternative traits.

b) The ultimate purpose of body coordination is survival, by maintaining the normal homeostatic conditions essential for the life of cells.

c) As the fertilized egg passes into the uterus it adapted to receive the embryo, prodividng food and disposing waste is.

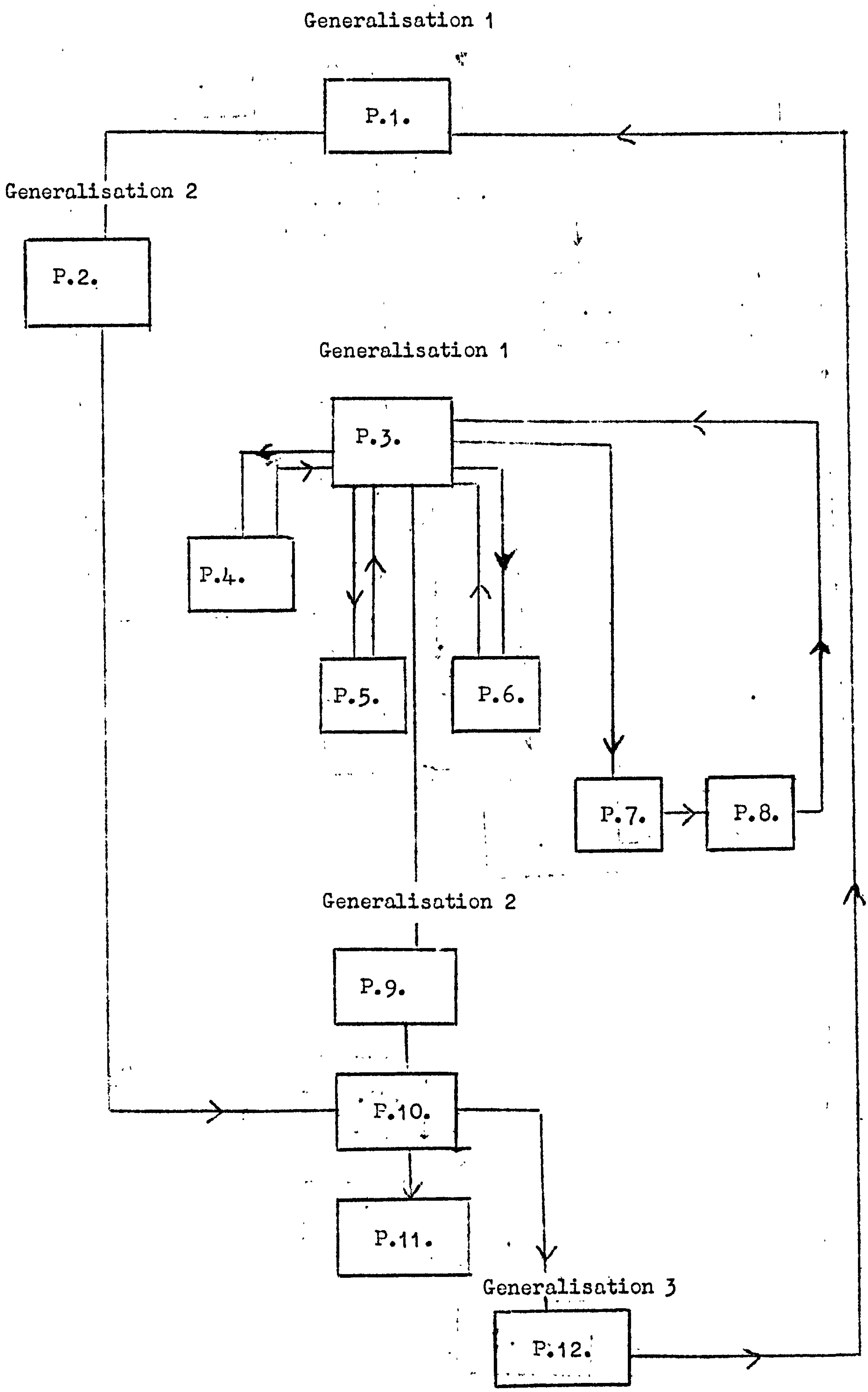
d) There is no tailor made building determined cafactors since analyzing knowledge grows in law magnesium circumferences involving penetration much faster.

C. a) In higher organisms, genetic recombination is as necessary as mutation to provide the variability required for evolution and since the only way in which genes can become recombined in advanced organisms is by means of the sexual process, sexuality can be regarded as essential to evolutionary change in these organisms.

b) Existing frequencies of genes in a population would to be maintained expected be, unless by a directive factor such as mutation, recombination, selection and migration to a new environment modified, thus affecting the stability of populations, besides the effect of chance, known as random genetic drift accounted for must be.

c) Streisinger's work involved the transitions of only non-overlapping bases and the hypothesis encoded by triplets lying between the affected sites enabled the molecule being duplicated to exist at same subsequent point in the middle in order to examine 'wild' types which synthetic messenger RNA's produced inadequate reverse changes for acceptance.

TEXT 1.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TEXT NO. 1

(1) Knowledge of generalisations or themes.

1. The ambiguous nature of the terms variety and species.

   A general evaluation of the terms species and variety as considered by 19 naturalists. The author clearly indicates that it is extremely difficult to establish fixed criteria of these terms. This difficulty is emphasized by the existence of a vast number of doubtful species which occur in nature.

2. The role of individual differences in natural selection

   Individual differences are of the highest importance from the evolutionary standpoint, since they provide material for natural selection to act upon giving an evolutionary progression in time from such differences to varieties and finally to species.

3. Arbitrary nature of the terms variety and species

   A species is an arbitrary term given for convenience sake and not essentially differing from variety or individual difference.

7a. Lubbock shows degree of variability in the main nerves of coccus as variable as venation of leaves.

8. Some authors argue that important organs never vary but these argue in a circle since these rank organs which do not seem to vary as the only important ones.

Paragraph 3.

9. Doubtful species are most important for consideration. When a naturalist can unite by the presence (or presumed presence) of intermediate links, two forms, he treats one as a variety and one as a species, ranking the most common, or the one first described, as the species.

10. To determine the ranking, the opinion of naturalists of wide experience and of sound judgment should be sought, sometimes it is necessary to decide on a majority vote.

Paragraph 4.

11. Vague and arbitrary distinction between species and variety is qualified by the study of a wide number of animals in many countries.

11a. Birds in the Galapagas Islands and the American mainland.

11b. Insects in Madeira which are classified by Wollaston as varieties and by other entomologists as species.

11c. Even Ireland has some animals classified as varieties by some and as species by other taxonomists.

11d. British and Norwegian Red Grouse ranked by some ornithologists as two species, by others as one species (Norwegian) and one variety (British).

12. Distance has been used as a criterion, but where is the limit - between neighbouring islands or across the ocean?

Paragraph 5.

13. Phytophagic varieties and species of insects are those which feed on different types of plants and are classified as such, when there is a marked distinction in the larva and adult of both sexes; as species, and when the differences are not so marked, as varieties.

14. This criterion can be ambiguous and Mr. Walsh, an entomologist ranks those insects which freely intercross as variettes and those which appear to have lost this power as species.

15. In the above case, it is difficult to trace intermediate forms and this is a naturalist's best guide, since he can rank these as varieties of the extreme forms which he ranks as species.

Paragraph 6.

16. Few naturalists maintain that animals never present varieties and therefore rank individual differences as being specific, implying a separate act of creation for each.

17. A definition of terms is essential as a basis of discussion on ranking by competent judges.

Paragraph 7.

18. It is in the best known countries with the most useful plants, that the greatest number of doubtful species are apparant.

19. The common oak is classified by German naturalists into a dozen species and by other naturalists as a dozen varieties.

19b. Another example is that of the sessile and pedunculated oaks which are ranked as species by some and as varieties by other naturalists of equal repute.

Paragraph 8.

20. A de Condale's memoir on the oaks of the world emphasizes the problem. He specifies a dozen characters, which differ on the same branch of the same tree, and which have been used as specific criteria according to Asa Gray.

21. A. de Condale ranks criteria of specific value those characters which do not vary on the same tree.

22. He concluded that it was a mistaken viewpoint that the majority of known specifies are clearly limited, and that doubtful species are in a minority. This only applies when no detailed studies have been undertaken.

23. The best known species have the greatest number of sub-species and varieties.

23a. Quereus robur has 28 varieties mainly clustered around 3 sub-species, intermediate types are rare and if these would be lost, according to Asa Gray, the 3 sub-species would attain the rank of species, with the 5 other admitted species.

24. Of the 300 species which were claimed for the oak family, two thirds are provisional only.

25. A. de Condale no longer believed that species were immutable, but concluded that the derivative theory was the correct one.

Paragraph 9.

26. When a young naturalist studies unknown forms he is at first perplexed in his assessment of varieties and species and at first decides on many species, later he reduces the number of species and increases the number of varieties.

27. Clearly, there is no line of demarcation drawn between individual differences, varieties, sub-species and species, the differences blend in an insensible series and this series impresses the mind with the idea of actual passage.

Paragraph 10.

28. Individual differences, though of the smallest interest to the taxnonist are of highest importance for us, as they represent steps towards slight varieties, permanent varieties, sub-species and species.

29. With respect to the more important and adaptive characters, this passage may be attributable to the cumulative action of Natural Selection.

Paragraph 11.

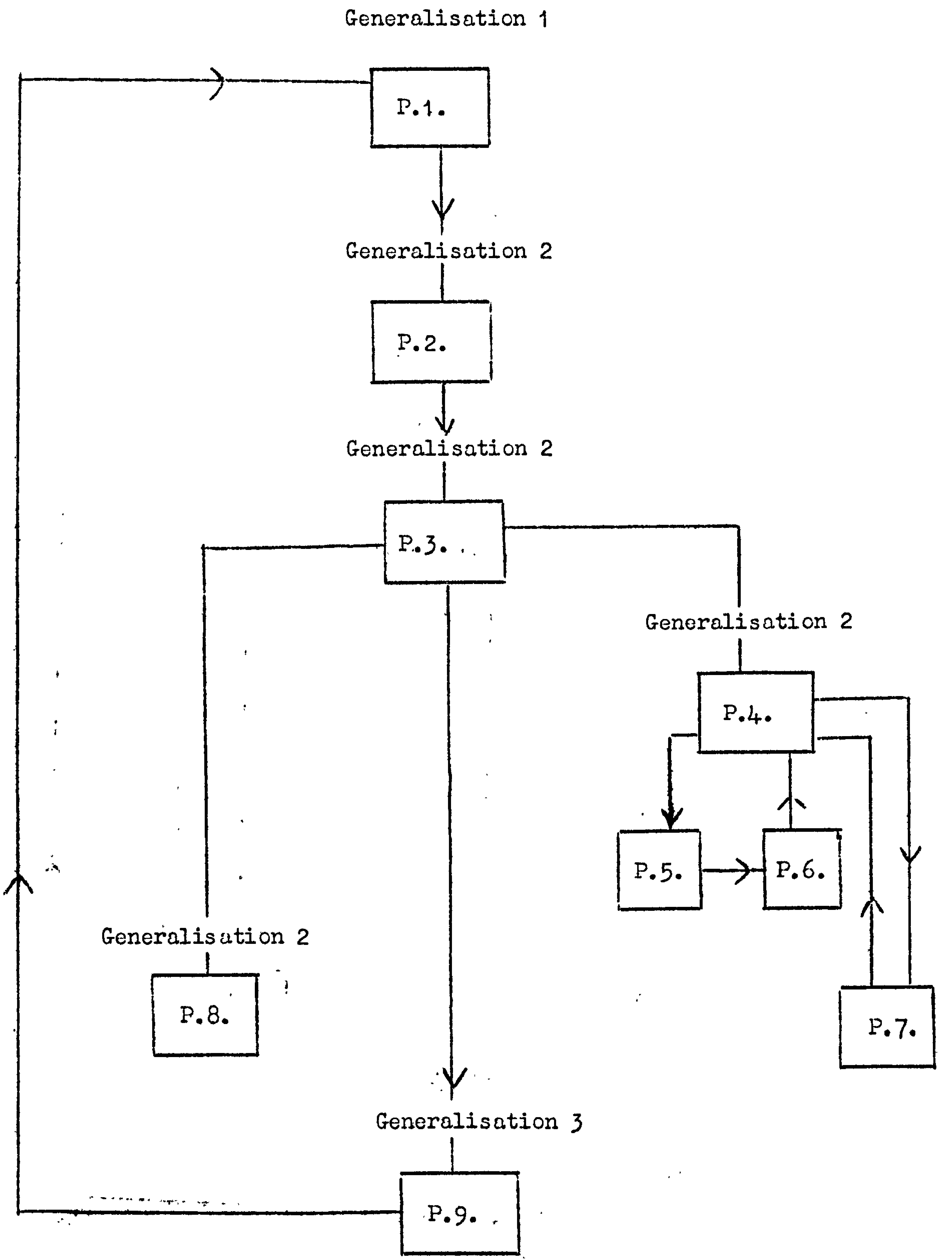
30. Not all the varieties or incipient species attain the rank of species, some may become extinct or remain as varieties.

31. If varieties were to exceed in number the parental species, the former would be ranked as species and the latter as variety.

Paragraph 12.

32. (Generalisation 3) Species is an arbitrary term used for convenience sake and not essentially differing from variety or individual difference.

TEXT 2


Generalisation 1
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Generalisation 2
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Generalisation 3
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TEXT NO. 2

(1) Knowledge of Generalisations or themes.

1. The relationship between the struggle for existence and natural selection.

   As a result of the struggle for life, favourable varieties, however slight, are preserved, since these tend to survive and multiply with the consequence that these favoured traits are inherited. As a result of this struggle, some varieties evolve into distinct species, and groups of species into distinct genera. This is the essense of Darwinian Natural Selection.

2. The struggle for existence.

   A struggle arises because of the geometric rate of increase of organic beings. In the absence of such a struggle, the rate of increase would be such that no land could accommodate the product. As more individuals are produced than can survive, the struggle must ensue and evidence of the struggle exists at intra and interspecific levels, particularly applicable at the young stages of organisms. This struggle is also related to the physical conditions of life which include indirect and direct effects of climate, and space limitation. The interrelationship between these factors is very complex and still obscure in many ways.

3. Human Pragmatism.

   Death is prompt, no fear is felt, war in nature is not incessant and in any case the vigorous and healthy survive.

Appendix A, UNIT 2.

Experiment 1, (Unit 3).

.6.1. The analysis of the learning material Text No. 2.

ITEMS

Paragraph 1.

1. How do varieties become distinct species and groups of species become distinct genera?

2. This results from the struggle for life. As a consequence of this struggle, varieties which are beneficial to the species in their complex relations with nature, would survive and favourable traits inherited, = favoured individuals and their offspring tend to survive.

3. This principle of the survival of the fittest, the author calls Natural Selection, to distinguish from man's selection.

4. The term Survival of the Fittest used by H. Spencer is more explicit, according to the author.

5. Man can accumulate and preserve by selection those varieties produced by nature as seen in domestic breeding, but Natural Selection is a power incessantly present and immeasurably superior to man's efforts.

Paragraph 2.

6. The term Struggle for Existence relates to the life of the individual and success in leaving progeny. This struggle relates to food, supply, climatic rigours and with other organisms for space.

7a. Two canines in a time of death struggle with each other for food.

7b. Plants in a desert struggle against drought.

7c. A plant producing annually 1,000 seeds of which only 1 on an average comes to maturity struggles with plants of the same kind and of a different kind.

7d. Several seedling mistletoe plants on the same branch of the last tree struggle for food and space.

7e. Mistletoe seeds are disseminated by birds and therefore struggle with other fruit bearing plants in tempting birds.

Paragraph 3.

8. The struggle for existence follows from a high rate all organic beings increase.

On the principle of geometric increase the numbers would quickly become so great that no country would accommodate them.

9. As more individuals are produced than can survive, the struggle for existence must ensue either between individuals of the same species, different species, or with the physical environment.

10. It is the doctrine of Maethus applied to the whole animal and vegetable kingdom in complete force, since in nature no artificial increase in food, nor controlled breeding exist.

11. Although some species may now be increasing in numbers, all cannot do so, for the world could not accommodate them.

12. Even slow breeding man has doubled in 25 years and at this rate in less than a 1,000 years there would be no standing room for his progeny.

13. Linnaeus calculated that an annual plant producing 2 seeds annually and producing the equivalent number of seedlings, which also produce 2 seeds, would in 20 years amount to 1 million plants.

14. The elephant which is the slowest breeder of known animals with a minimum rate of breeding of 6 offspring in 60 years, would in 750 years amount to 9 million elephants from one pair.

Paragraph 4.

15. The checks to this increase are many but their exact nature in many cases is obscure.

16a. Eggs of young organisms tend to suffer most.

b. Out of 357 weed seedlings, 295 were observed to be destroyed by slugs and insects.

17a. The most vigorous plants outgrew the other plants in the same area.

b. From 20 species growing on a plot of mown turf, 3' x 4', nine species completely perished.

Paragraph 5.

18a. Frequently it is not obtaining food, but the serving of prey which determines the average number of stock within a species.

b. Stocks of partridges, grouse, hares, depend on destruction by vermin.

19. On the other hand, elephants and other large animals are not destroyed by beasts of prey, therefore in these cases obtaining food is the important factor.

Paragraph 6.

20. Climate plays an important part in determining the average numbers of species as illustrated by periodic extremes of cold or draught, which are most effective checks.

21. In the winter of 1854/5, 4/5ths of the bird population in the author's garden were destroyed, and one must remember that 10% is a high rate of mortality in man.

22. Climate also reduces food and intensifies competition between organisms.

23. This is seen when one travels from south to north or damp to dry conditions when certain species become rarer not only due to the direct effects of the elements but a change in climate might favour some species over others.

24. In arctic conditions, summits or deserts, the struggle for life is almost exclusively with the elements.

Paragraph 7.

25. Many cases are on record to show how complex and unexpected are the checks and relationships between organisms.

26. Humble bees are necessary for the fertilization of some varieties of clover as shown by protecting heads of samples and comparing the results with the unprotected. These bees alone visit red clover to collect nectar.

27. Hence one can infer that if the whole genus of humble bees become extinct the red clover would become very rare and disappear.

28. The number of humble bees depend on field-mice which destroy their pests and according to Col. Newman, more than ⅔rds. are normally destroyed.

29. The number of mice depends on the number of cats to a large extent as shown by the fact that nests of humble bees are more numerous nearer small towns and villages.

Paragraph 8.

30. The struggle is generally more severe between closely related species if they come into competition than with distinct genera.

31a. One species of swallow dominates all others in the U.S.A.

b. The missel thrush increase in Scotland was correlated with a decrease in the numbers of the song thrush.

c. In Russia the Asiatic cockroach has eliminated its larger congener.

d. In Australia the imported hive bee is exterminating the stingless native bee.

e. One species of charlock has been known to supplant other species.

32. We can dimly see why competition should be more severe between allied farms which occupy the same niche in the economy of nature, but in any one case the precise reasons are very difficult to evaluate.

Paragraph 9.

33. In trying to give one species advantage over another, one sees how difficult the evaluation of this struggle is, thus convincing the author of our ignorance of the mutual interactions of living organisms.

34. (Summary) One can according to the author, only bear in mind such
(leading to)
(Generalisation) factors as; the striving to increase in a geometric
2)
ratio, the struggle for existence in each generation at some stage and season, with the consequence of much destruction.

35. When one reflects on the struggle, there is a human consolation that this war in nature is not incessant and no fear is felt and that death is quick.

36. The consequence is however that the rigorous healthy and happy survive.

Total number of items = 47.

TEXT 3


Generalisation 1
P.1.
Generalisation 3
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Generalisation 3
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Generalisation 1 (Theme)

	Paragraph 1										Paragraph 11					
Item	••• 1	•• 2	••• 3a	•• 3b	••• 4	•• 5	••• 6	••• 7	••• 8	••• 9	••• 44	••• 45	••• 46	•• 47	••• 48	••• 49

Generalisation 2 (Theme)

	Paragraph 2															
Item	••• 10	•• 11	•• 12a	12b,	•• 13a	13b,	14,	14a	14b	14c	14d,	15	16	16a	16b	16c

Generalisation 3 (Theme) 8••• 11•• 25• = 44 items

Paragraphs	3	4	5	6	7	8	9	10	12
I	••• 17	•• 25	27a	••• 30	••• 33	35	39	40	••• 50
T	18a	26	27b	•• 31	••• 34	36	39a	41	••• 51
E	18b		28	31a		••• 37	39b	•• 42	
M	18c		•• 29	31b		••• 38	39c	43	
	18d			•• 32a			39d		
	•• 19			•• 32b					
	•• 20			32c					
	•• 21a			32d					
	21b								
	22								
	•• 23								
	•• 24a								
	24b								

Generalisation 4 (Theme)

	Paragraph 13	
Item	•• 52	53

	Paragraph 14						
Item,	54,	55,	56,	57,	58,	59,	60.

Theory - Themes 1, 3 and 4.

Total number of items = 85.

TEXT NO. 3

(1) Knowledge of generalisations or themes

1. Concept of Natural Selection

This concept arises as an extension of the observation of man's selection under domestication and out of the realization of the importance of the struggle for existence affecting favourable varieties ensuring their survival and purpetuation.

2. Sexual Selection

Sexual Selection is considered as a facet of Natural Selection, but distinguishable from it in that sexual selection is less rigorous and the consequence of it does not involve death to the unsuccessful but few or no offspring.

3. Natural Selection can account for many phenomena in nature, in particular divergence, extinction and general advance in organisation.

Natural Selection can account for the constant differences between species in a much more logical way than chance alone, and can account for the relationship between varieties, species genera and whole classes of organisms. It takes into account the tendency to advance in organisms from simpler forms to more complex forms, and the continued existence of lowly forms can be accommodated, since Natural Selection does not compel progress, but functions by select progressive lines. The more diversified the descendants, the better is the chance of survival. Simpler organisms have a survival value in their own matrix.

4. <u>Analogy drawn between the process of Natural Selection and a living tree.</u>

All organisms are related in groups and sub-groups, analogy represented by a highly branched tree.

(2) <u>Knowledge of theories and structures</u>

<u>Theory of Natural Selection</u>

1. Natural Selection can fully account for the existence of the wide range of organisms, which can be classified into groups and subordinate groups because of the existence of certain affinities between them.

2. Natural Selection entails extinction and divergence, and there is ample evidence from palaeontology and present day forms to substantiate that these phenomena have occurred and are still occurring on a large scale in nature.

3. Natural Selection accounts for the general advance in organisms, since it operates by selecting improvements in relation to the environmental niches of organisms. It therefore incoporates the progression from variety through incipient species into species, genera, families, orders and classes of organisms.

4. At the same time the process of Natural Selection accounts for the existence of lowly organisms, since they also possess a survival value within their environmental matrix.

5. Natural Selection is the outcome of a struggle for existence which arises because of the tendency of all organisms to reproduce in geometric ratio. The production of such vast numbers conflicts with the limitations of the environment in relation to food supply, space and climate.

6. The struggle for existence operates to select favourable traits which arise as individual differences in organisms.

7. These are perpetuated through successful breeding, since such favoured traits have a survival value.

TEXT NO. 3

UNIT 3 - Experiment One

Paragraph 1.

1. How will the struggle for existence act in regard to variation?

2. Can the principle of selection seen in domesticated breeding act in nature? The author claims it can.

3a. The numerous individual differences and varieties and their inheritance must be accepted in nature as under domestication.

3b. Their occurrence is not man-made, he can only accumulate those that arise.

4. The complex and dynamic interrelationships between organisms and their physical environment, accounts for the importance of variations which might be of advantage to the organism.

5. Variations useful to man have occurred in domesticated organisms, so according to the author it is logical to extend this to nature and that variations favouring certain organisms have occurred.

6. Accepting a struggle because of the high rate of increase or organisms, some individuals will have an advantage over others and will survive and produce offspring.

7. Unfavourable variants would be destroyed and would not produce offspring.

8. The preservation of favourable traits and destruction of unfavourable traits, the author calls Natural Selection or Survival of the Fittest.

9. Traits neither injurious nor favourable would not be affected by Natural Selection and would either be left as fluctuating elements or become fixed.

Paragraph 2.

10. Sexual Selection depends upon the struggle between the individuals of that sex usually male for the possession of the other sex. The result is not death to the unsuccessful but few or no offspring.

11. Sexual Selection is, therefore, less rigorous than Natural Selection.

12a. Victory depends not only on vigour but in possessing special weapons.

12b. A harmless stag or spurless cock would have poor chance of success.

13a. Sexual Selection by allowing the victor to breed will maintain thesd weapons at optima from generation to generation.

13b. In the same way, man selects the best cock for fighting.

14. This battle of sexual selection is extensive in nature.

14a. Male alligators have been described as fighting, bellowing and whirling like Indians in a war dance, for the possession of females.

14b. Male salmons have been observed fighting all day long, for possession of a female.

14c. Male stag beetles sometimes bear wounds from the huge mandibles of other males.

14d. The males of certain hymenopterous insects have been frequently seen by M. Fabne to fight for a particular female who sits by the combatants.

15. The battle is severest between males of polygamous species and these are often provided with special weapons,

16. The males of carniverous animals are already well armed, but in addition special means of defence have been developed through sexual selection.

16a. As in the mane of the lion.

16b. The hooked jaw of the male salmon.

16c. The shield may be as important to victory as the sword or spear.

<u>Paragraph 3.</u>

17. The effectiveness of Natural Selection is apparent in this complex illustration of its action.

18a. Certain plants possess glands which secrete sweet sap (nectar), probably as a form of excretion.

18b. This takes place through the stipules of members of the Leguminoseae and at the backs of the leaves of common laurel.

18c. This sap is sought by certain insects for food.

18d. Let it be assumed that in some plants variants were produced, so that the juice was secreted by the flowers, so that insects visiting the flowers would bring about cross pollination.

19. Cross pollination leads to the crossing of hereditory traits of two separate plants and this is known to lead to vigorous offspring.

20. Plants which have the largest nectaries and, therefore, most nectar get cross-pollinated more often than others, and therefore these plants form dominant varieties within species in one local area.

21a. Similarly flowers which possess any special advantages for cross-pollination in relation to the insect visitors would have an extra advantage.

21b. The position of stamens and stigma can be critical and those plants which have their stamens and stigma placed in relation to the size and habits of the particular insect which visited them in such a way to favour pollen transport and deposition, would be favoured.

22. Similar illustrations can refer to pollen feeding insects instead of nectar feeding insects.

23. This association sets up an efficient means of cross-pollination as shown by male and female holly trees with vestigial male or female sex organs, i.e. unisexual flowers, since even on a windless cold day when bees are low in number, ample pollen was shed on a female tree 60 yds. away from the nearest male tree.

24a. On the basis of a physiological division of labour, constant cross-pollination in a species would render self-pollination superfluous and, therefore, male or female organs would become vestigial in some flowers on one plant. This would lead to selection of complete separation of sexes.

24b. This is seen in some species of holly in North America when at present an intermediate state is to be found, i.e. more or less dioeceous.

Paragraph 4.

25. Varieties are incipient species and, therefore, how are the lesser differences between varieties augmented into the greater differences between species, i.e. how can the divergence in character be accounted for?

26. Chance might cause one variety to differ in some character from its parents and the offspring of this variety to again differ in the same trait, but chance alone cannot account for the constant difference of species of the same genus.

Paragraph 5.

27a. In domesticated animals, chance does not account for the existing breeds but selection by man.

27b. As seen when one fancier breeds for a short-beaked variety of pigeon and another for a long-beaked variety.

28. Men breeding for swift horses and men breeding for strong horses would again select different characters and produce different varieties.

29. In man's productions we see the principle of divergence of traits which steadily increases the difference between varieties according to selection.

Paragraph 6.

30. Natural Selection acts exclusively by the preservation and accumulation of favoured variations and the result is an improvement in relation to life and this gradually leads to an advancement in organisation of organisms on a large scale.

31. Advancement in organization is a complex phenomenon to evaluate owing to the differing standpoint of naturalists.

31a. Some naturalists take the criterion of the amount of change from larva to adult.

31b. However, in some parasitic crustaceans, the adult is less mature than the larva.

32a. Van Boer's standard is judged by the author as most relevant, namely the amount of differentiation of organs in the adult.

32b. To this the author adds the amount of differentiation of organs in the adult in relation to specialization of function, or as Milne Edwards would express, the completeness of the division of labour.

32c. Examples of confusion again arise as in classifying boney fishes as the highest and other naturalists classify the shark type as being closest to the next group, the Amphibians.

32d. Similarly, in the plant kingdom some plants with complete and elaborate flowers are classified as the highest, while others classify those with reduced and modified flowers as the most advanced.

Paragraph 7.

33. Taking high organisation and a physiological specialisation of organs as a basis, Natural Selection leads to this standard, since the accumulation of variations in organs resulting in their more efficient performance is an advantage.

34. On the other hand, it is possible to see that Natural Selection can fit organisms with well adopted organs (during the struggle to occupy different niches in the economy of nature) into niches where these organs are superfluous and therefore retrogression would take place.

Paragraph 8.

35. From the tendency to advance, the existence of lowly forms in general and within each major class needs clarifying.

36. Lamarck who believed in an innate striving for perfection accounted for this by supposing that lowly forms were being continuously and spontaneously created.

37. Within the concept of Natural Selection, progression is not compelled, but Natural Selection takes advantage only of those favourable traits which appear in organisms.

38. Lowly forms are also adapted to their simpler environment and within this matrix degrees of advance have taken place.

Paragraph 9.

39. Altogether the diverse causes accounting for the existence of lowly organisms include:

39a. No development of favourable traits for Natural Selection.

39b. Time factor to brief a duration in many cases.

39c. Retrogressive organisation.

39d. Under the simple conditions of life a high organisation would be superfluous.

Paragraph 10.

40. With reference to the beginning of life, with living matter organised at a very much simpler level, how did the first steps in advance take place?

41. According to H. Spencer, the progression of unicells dividing and forming multicells, would be due to the fact that, homologous units of any order become differentiated in proportion as their relations to incident forces become different.

42. Even at this level there would be some struggles for existence between closely similar organisms.

43. In any case there must be many factors yet unexplained in the interrelationships of organisms at present and with the past.

Paragraph 11.

44. Organisms exhibit a multitude of individual differences.

45. The geometric rate of increase of or anisms results in a struggle for existence at some period in their life history.

46. Because of the complex interrelations of organisms with themselves and their physical environment a diversity of structure would confirm an advantage in adaptation and survival.

47. As variations useful to man have been selected under domestication, so in nature because of the successful variations, new variants would become established.

48. Such variants being successful in the struggle for existence would tend to produce offspring similarly endowed.

49. This principle of preservation the author names, Natural Selection or Survival of the Fittest. It leads to an improvement of each organism in relation to the environment and consequently to an advance in organisation. Nevertheless, lowly forms will survive and be fitted for their niches in life.

Paragraph 12.

50. Natural Selection entails extinction and this has occurred in nature as geological evidence shows.

51. Natural Selection leads to a divergence in character, since this favours survival and this accounts for the progression of varieties into species into genera families, order and classes.

Paragraph 13.

52. Divergence and extinction can, therefore, account for the relationship between organisms, namely between varieties, species genera, families, orders and classes.

53. If species had been independently created, how would it be possible to account for this classification of organisms?

Paragraph 14.

54. The affinities or organisms in one class can be likened to a tree.

55. The green twigs represent existing species and the same twigs have overpowered others in some way as some groups of species have dominated others.

56. Extinct species are represented by the older and dying branches, the connection of the former and present buds by ramifying branches can represent the classification of extinct and living species into groups and subordinate groups.

57. Of the young twigs, few survive to form great branches, so it is with species few survive to give modern descendants.

58. Orders, families and genera, which now have no living representatives, only fossils, are represented by the fallen branches.

59. The rare living branch low down on the fork of the tree, which has somehow survived, is comparable with the rare animal such as Lipidosiren or Ornithorlynchus, which connect two major branches of life, having survived by occupying a protected non-competitive niche.

60. Buds continue to give rise to buds, giving branches overlapping other feebler branches, so is represented by a generation the tree of life, the dead branches of which fill the crust of the earth and living branches ramify over it.

Appendix A, Unit 2
Experiment 2 (Unit 3)

TEXT NO. 1

2.6.1. The Analysis of the Learning Material.
Item Classification (based on The Taxonomy of Educational Objectives)

A. Knowledge

A.1 Knowledge of Specifics

A.1(1) Knowledge of Terminology (underlined with dotted lines in the items).

Perceptual activities
Neurochemical activities
Neuromotor activities
Endocrine activities
Neurohormonal action
Motivated listening
Auditory masking
Cochlear potential & aural microphinic
neural differentiation
Semantic value
Volley principle
Skeletal muscle reaction
Orienting reaction
Visceral muscle response
Peripheral glandular response
Sound arousal
Sound detection
Sound discrimination
Space/time pattern theory
Auditory neurone

A.1(2) Knowledge of specific facts (sp.f) specified against the relevant items.

A.2 Knowledge of Ways and Means of dealing with specifics.

A.2(1) Knowledge of Trends and Sequences underlined with continuous line in the items.

A.2(2) Knowledge of Classification and Categories (K/Cl.) (specified against the relevant items).

A.2(3) Knowledge of Criteria (K/Cr.) (specified against the relevant items).

A.3 Knowledge of Universals and Abstractions

A.3(1) Knowledge of Generalisations

1. Perceptual Behaviour

The perceptual behaviour of hearing has many dimensions, including sound arousal which involves attracting attention by sound stimulation, perceptual orientation, which consists of assuming postures which faciliate sound reception, sound detection, sound discrimination, and motivated listening, such as, music appreciation.

2. Perceptual Activities

Perceptual activities involve a series of interactions between sound, the ear processes, neural systems of the brain and related neurochemical and neuromotor activities. These interactions involve reception of sound stimuli and the responses which alter the metabolic and behavioural state of the organism.

3. Sound Properties

The physical and psychological properties of sound are enumerated and there is no one to one relationship between them. Auditory detection and discrimination are closely related to these properties.

A.3 (2) Knowledge of Theories and Structures

Hearing is not a single process but a generalised activity involving several dimensions of response each of which serves in maintaining the efficiency of the organism as a whole. It includes such perceptual behaviour as sound arousal, orientation, detection, discrimination and motivated listening.

Perceptual activities such as the processes of the ear, neurosensory and neuromotor activities all interact harmoniously. Hearing is associated with the emotional state which add aesthetic value to the perception of sound. Sound detection and discrimination are closely related to the properties of sound and how these affect the physiology of the ear and nervous system.

If an item is considered to be relavent to more than one category in the above classification, it is classified within the division of highest complexity within the knowledge category.

Paragraph 1.

1. Perceptual activities. The perceptual activities in hearing are diagrammed in Fig. 1 as a series of vital interactions between the physical energy of sound, the processes of the ear, the neural systems of the brain, and related neurochemical and neuromotor activities.

2. Five forms of response which alter the metabolic or behavioural state in relation to sound stimuli are skeletal muscle reaction, visceral muscular response, peripheral glandular response, endocrine activity, and neurohormonal action involving release of such compounds as adrenalin, acetylcholine, and serotonin in synaptic centers.

3. Fig. 1 shows the feedback relationships involved in integrated hearing behaviour.

3a. Muscular activity, as in arousal behaviour, changes the posture and state of the body in relation to the sound source.

3b. Contractions of small muscles in the middle ear alter sound transmission by the eardrum.

3c. Visceral activity may supply more blood to the ear and brain, thus changing the oxygen tension of the system and the sensitivity of the organism to sound stimuli.

3d. Hormones present in the nervous system both facilitate and inhibit synaptic activity, thus changing the state of the organism, possibly of the ear itself.

3e. Release of chemical substances by secretory glands, such as tears and perspiration, may alter the efficiency of auditory discrimination as well as perceptually motivated activities such as sustained listening.

Paragraph 2.

4. Hearing is thus not a single process, but a generalized activity involving several dimensions of response, each of which serves certain integrative functions in maintaining the efficiency of the individual in responding to sound stimuli.

5. These phases of hearing behaviour differ especially in their timing relative to the onset of the sound stimulus.

6. Sound arousal. Sound arousal is attracting attention by sound stimulation.

7. Hearing, along with cutaneous perception and visual perception, is a significant means of arousal to action.

8. Sounds can arouse people from deep sleep and activate the individual under many other circumstances.

9. The arousal reaction by sound or other stimuli is a release or triggered type of response involving reflex changes in posture, as well as selective inhibition and activation of smooth muscles and glands.

10. The pupils of the eye dilate and there are reactions of the small muscles of the middle ear.

11. The reaction time of this startle pattern to sound stimuli may be as low as 0.01 - 0.05 sec.

Paragraph 3.

12. Orienting reactions. Orienting reactions are next in time. In man these consist of turning the head and assuming postures which facilitate the reception of the sound stimuli in question and reduce the effectiveness of interfering sounds.

13. Orientation to sound is much more obvious in many animals, involving specific movements of the ears as well as more general postural responses.

Paragraph 4.

14. Sound detection. This consists in finding or noting a sound source within a background environment of other sounds or other kinds of stimuli.

Paragraph 5.

15. Sound discrimination. This involves comparing, ordering, or arranging two or more sounds in terms of the discriminable properties of sound: pitch, loudness, timbre, volume, timing, duration, and location in space.

Paragraph 6.

16. Motivated listening. Motivated listening involves all of these primary phases of hearing integrated into sequential motivated behaviour in response to sustained speech, music or noise. It is sound perception organized in relation to adaptive behaviour.

17. Listening can be measured in terms of the stimulus conditions of its occurrence and by means of psychological scales.

18. Administration of attitude scales and preference scales, measuring the time of listening to sustained speech or music, and recording the level of emotion and motivation are all means of assessing the perceptual value of music or speech sounds.

19. A critical dimension of listening is the semantic value of symbols, words, code signals, or other sounds. Standardized articulation tests made up of syllables, words, or short sentences give a measure of the effectiveness of speakers and of sound generating and transmitting devices in providing meaningful information to a listener.

20. Listening may be directed toward specific sounds or it may be supportive.

21. The presence of some effective sound in the environment appears to be essential for the psychological well-being of most individuals.

21a. The disorganizing effects of isolation on man and animals appear to be related in part to the supportive value of sound and of listening, for complete and prolonged absence of sound has been found to cause marked emotional depression.

21b. Music can serve a positive supportive function in work situations and can facilitate the rhythm of many work and play activities. Even moderate levels of noise may act as an alerting stimulus condition and facilitate work.

21c. Excessive sound, however, either music or noise, acts as a stress source, and can disturb efficiency of certain forms of work behaviour. In addition to direct injury to the ear, excessive noise may also produce long-term stress effects on the auditory mechanism as well as the whole neurophysiological system.

Paragraph 8

22. Sound properties. The properties of sound can be described in terms of the physical correlates of the sound stimulus, and in terms of the psychological dimensions of auditory response.

23. The three main physical properties of sound are frequency, intensity, and complexity of sound waves.

24. The principal psychological properties are perceptions of pitch, loudness and timbre.

25. Although pitch is closely related to frequency, loudness to intensity and timbre to complexity, there is no one-to-one relation between the physical and psychological properties of sound.

Paragraph 9.

26. In its simplest form, a sound wave is described as simple harmonic motion, portrayed visually as a sine curve (see Fig. 2a and b).

27. One upward swing of the curve and one downward swing represent one rarefaction and one condensation, or a single cycle of vibration. The number of complete cycles occurring each second determines the frequency of the sound wave, while the square of the amplitude of displacement or height of the curve represents the intensity of the sound.

28. The two waves in Fig. 2a represent pure tones of the same intensity but with different frequencies, while the two waves in Fig. 2b represent tones of the same frequency and different intensities.

29. Sound waves can also vary in complexity. Fig. 2c represents the waveform of a musical tone (See Fig.2c).

29a. It can be seen that the pattern repeats itself, or is periodic.

29b. Fig. 2d represents noise, a complex sound stimulus with no apparent periodicy in its waveform.

Paragraph 10.

30. Sound detection. There are two aspects of sound detection which should be considered: detection of a sound stimulus in an otherwise sound-free field, and detection of a sound stimulus in the presence of a second masking sound.

Paragraph 11.

31. Limits of hearing. The frequency and intensity pattern which are perceived as sound have definite limits, which vary to some extent from one individual to another and under different conditions. These limits of hearing also vary markedly from one animal species to another. The limits of hearing are represented graphically as the area of hearing.

32. Fig. 4 shows that human individuals normally perceive as sound those frequencies between about 16 cps. or lower, and 20,000 cps. with the greatest sensitivity around 1,000 - 4,000 cps. That is, the audibility curve, showing absolute thresholds for different frequencies, dips lowest for frequencies of around 1,000 - 4,000 cps.

Paragraph 12.

33. The area of hearing varies with age as well as with injuries and other defects. Sensitivity to higher frequencies typically decreases with age.

34. Some animals such as the bat, mouse, rat, cat and dog have a frequency range beyond that of man. The bat may hear tones as high as 75,000 cps. "Silent" dog whistles produce tones above the range of human hearing, but still within the dog's upper limit.

Paragraph 13.

35. Auditory masking. It is sometimes impossible to detect one tone in the presence of another tone or noise. The first tone is said to be masked by the second tone or noise.

36. The masking effect is defined as the difference between the absolute threshold of the masked tone and the threshold of detection of this tone in the presence of the masking sound.

36a. In general, the masking effect is greater for tones near the masking sound in frequency, although tones higher in frequency than the masking sound are affected more than lower tones.

36b. The range of frequencies affected is greater, the greater the intensity of the masking sound, and the lower the frequency of the masking sound.

Paragraph 14.

37. Sound discrimination. When a listener is thoroughly familiar with a situation so that he knows to within a small number of alternatives what each message will be, he can comprehend two simultaneous messages, but when one or both messages are drawn from a larger number of possibilities, the filter in the brain lets only one message come through.

38. How does the filter work? Studies of the artificial generation of speech sound have thrown light on the problem. When the rate of modulation intensity is the same for two sounds, the hearer perceives them as one sound.

38a. It is reasonable to suppose that a man can listen to one person and ignore another primarily by selecting from the mass of sounds all those frequencies that are being modulated at the same rate.

38b. Since it is unlikely that the vocal cords of two speakers would vibrate at exactly the same rate at any moment, modulation would almost always provide an important (if not the sole) means of separating a pair of voices.

39. It is suggested that the rate at which the sounds are being modulated controls the rate of stimulation of nerve fibres.

40. If so, the brain could pick out one voice by focussing its attention on all auditory nerve ibres that are being stimulated at the same rate.

40a. Superimposed upon this selection, experiments have shown that the content of speech can take precedence over its physical characteristics. How the brain focuses attention on meaning is an almost complete mystery.

Paragraph 15.

41. Response of auditory system in hearing. The ear (see Fig.6) is a system for transducing the mechanical energy of sound into electrical energy which triggers nerve impulses in the auditory nerve.

42. As sound strikes the eardrum it causes the three small bones of the middle ear to vibrate.

43. These movements set up corresponding vibrations in the oval window, and thence in the fluids of the cochlea.

44. The auditory organ of the inner ear, the cochlea (see Fig.7a) is an enclosed structure which is coiled upon itself for $2\frac{1}{2}$ turns.

45. It contains three fluid-filled canals: the ascending (vestibular) canal, which leads from the oval window to the apex (helicotrema); the descending (tympanic) canal, from the apex down to the round window; and between the the smaller cochlear canal. (see Fig. 7b).

46. The gelatinous-fibrous membrane making up the base of the cochlear canal, the basilar membrane, is relatively narrow near the oval window and widens as it ascends towards the apex.

47. Upon this membrane is the organ of corti and its hair cells, are thought to be the true receptors of hearing.

Paragraph 16.

48. Cochlear resolution of sound. The ability to hear many different frequencies as distinct pitches is related to the ability of the cochlea to resolve these frequencies.

48a. Between about 200 and 2,000 cps. this resolution is accomplished by differential response of the basilar membrane.

48b. The cochlea has different resonance values at different points along its length, so that high tones cause the fluids and membrane to vibrate near the base, and low tones, near the apex. (See Fig.8a).

48c. Vibrations of the oval window probably set up travelling waves in the fluids and membrane which cause maximal vibrations at the place with a natural resonance value corresponding to the sound frequency.

48d. Below 200 cps. the membrane vibrates as whole, or nearly so.

48e. Different intensities cause vibrations of the membrane of different amplitude. (See Fig. 8b).

48f. If two tones are present, the vibration of the stronger will overlap the weaker, so that the latter is masked. (See Fig.8c).

48g. A very intense sound may cause the hair cells to be thrown off the membrane at a place corresponding to the frequency level of the sound (See Fig.8d).

Paragraph 17.

49. Cochlear potential and aural microphonic. The cochlea transduces sound energy at all audible frequencies into electrical energy.

49a. If electrodes are inserted into an animal's ear (see Fig.9), a potential of 40 - 100 microvolts is found to exist between the fluid of the cochlear canal and the organ of corti, with the greatest potential near the base.

49b. Thus current, which exists when no sound stimulus is present, can be recorded by means of amplifiers and meters attached to the electrodes.

49c. A sound stimulus acting on the cochlea modulates the sustained potential, setting up a cochlear or aural microphonic, which reproduces the sound frequency with high fidelity.

49d. This aural microphonic, which varies between 0.5 and 100 microvolts, can be amplified and recorded on an oscilloscope or reconverted to sound by means of a loudspeaker.

49e. The magnitude of these potentials varies in a linear way with the sound intensity. When different levels of the cochlea are tested, a maximal microphonic effect for low tones is picked up at the apex, and a maximal effect for high tones at the base.

49f. The lower intensity thresholds for the microphonic response define a curve which is similar in form to the audibility curve for hearing.

50. It is generally believed that the aural microphonic is a means of differentially stimulating either the hair cells or the nerve fibres in the organ of corti.

Paragraph 18.

51. Neural differentiation. Sensory nerve fibres, originating at the hair cells at all points along the organ of corti, emerge from the cochlea to form the auditory nerve (VIIIth cranial nerve).

52. This nerve enters the cochlear nucleus in the medulla oblongata, from which point connections are made with other centers in the midbrain, cerebellum, thalamus, and temporal lobe of the cortex (See Fig.10).

53. Discrimination of sound stimuli depends on differentiation of neural action at all levels. Three principal kinds of differential neural response can be demonstrated.

54. In the first place, it can be shown that different regions of the basilar membrane have specific spatial representation in the auditory nerve and brain centers. When the ear is stimulated by tones or clicks, or when the cochlea is stimulated (Fig.10), the electrical response of the nerve, cochlear nucleus, midbrain, thalamus, cerebellum, or cortex can be amplified and recorded. By such means it has been found that the basilar membrane is projected spatially in all of these neural systems.

Paragraph 19.

55. The second type of neural differentiation is a temporal one. Within limits, the frequency of a stimulus sound is reproduced by the synchronized electrical response of the auditory neural systems.

55a. This neural response does not have the fidelity of the cochlear microphonic. The electrical response of the total auditory nerve, for example, faithfully reproduces the sound stimulus to frequencies up to 4,000-5,000 cps. but not higher ones.

55b. At higher frequencies, the neural synchronization is very poor. Furthermore, the fidelity with which the electrical response of higher centers of the brain, such as, the thalamus, cerebellum, and cortex, follows the sound stimulus in frequency is far less than that of the auditory nerve and lower brain centers. High-fidelity frequency differentiation is probably mediated by the lower auditory centers of the brain.

<u>Paragraph 20.</u>

55c. The ability of the auditory nerve and brain tracts to follow the frequency of sound cannot be based on the response of single neurons, for the maximal rate of firing of single auditory neurons is probably not over 700-800 impulses per second. The synchronization produced is explained by the volley principle. (See Fig.11).

55d. The volley principle postulates, that different single nerve fibres react alternatively to successive waves in the sound stimulus. When the frequency of a sound is too high for any one fibre to fire at the same frequency, a number of fibres coordinate their response to produce a synchronized response in the group of fibres which faithfully reproduces the sound frequency. If the intensity of the stimulus is increased, the total number of impulses in the nerve is increased but they still synchronize with the sound frequency.

Paragraph 21.

56. Still another differential response has been found in second-order auditory neurons, one synapse removed from the neurons leading from the cochlea. By inserting electrodes of microscopic size into the cochlear nucleus, it is possible to record the electrical response of single second-order neurons. Neurons can thus be found which are selectively tuned to certain frequencies, at which frequency less energy is required to excite them.

56a. Although this neuron tuning is very sharp near threshold, as the sound intensity is increased, each neuron responds to a broader band of frequencies, typically spreading more toward lower frequencies than toward higher.

56b. Neurons responding to very high frequencies apparently are more sharply tuned than those responding to lower frequencies.

Paragraph 22.

57. Space-time pattern theory. The various facts about cochlear and neural response make possible a theoretical interpretation of how sounds of various frequencies and intensities are discriminated (See Fig.12). In general, the most widely accepted theory of hearing is multidimensional. Pitch perception is believed to depend upon a combination of place localization of mid-frequency pitches in the cochlea and nervous system, and of frequency representation, especially of low and high pitches, by means of synchronized neural response.

Paragraph 23.

58. Integrative control. Integrative control involves both neural and biochemical pathways in determining the muscular, neurohumoral, humoral, organic, and metabolic activities of hearing, and processing the feedback information from these activities.

59. The levels of interaction involved in various aspects of hearing behaviour are detailed in Fig.15.

60. The properties of sound perception, such as pitch and loudness, which correlate closely with variation in the sound stimulus are determined very largely by the functions of the cochlea itself.

61. Other effects, such as combination tones, are defined by processes of distortion in both the cochlea and in nerve transmission.

62. Finally, more complex levels of integration determine emotional effects, consonance, dissonance, intelligibility, semantic value, and specific response control and reinforcement related to learning to perceive sound and to regulate motivated listening.

Appendix A, UNIT 2.

Experiment 3, (Unit 3)

2.6.1. The analysis of the learning material.
CLASSIFICATION OF ITEMS (THE TAXONOMY OF EDUCATIONAL OBJECTIVES)

KEY

A Knowledge of Specifics

Knowledge of Specific Fact	-	K. of Sp.Fact.
Knowledge of Terminology	-	----- in text.

B Knowledge of Ways and Means of dealing with Specifics

Knowledge of Conventions	-	K. of Conv.
Knowledge of Trends and Sequences	-	K. of Trends
Knowledge of Classification and Categories	-	K. of Class.
Kowledge of Criterion	-	K. of Crit.
Knowledge of Methodology	-	K. of Method.

C Knowledge of Universals & Abstractions in a Field.

Knowledge of Principle	-	K. of Principle
Knowledge of Generalizations	-	K. of Gen.
Knowledge of Theories and Structures	-	K. of Theory.

K. of Specifics	K. of Ways and Means	K. of Universals & Abstractions
22•	16••	52•••

Total no. of items = 90

KEY

• = least relevant to Summary A.

•• = more relevant to Summary B.

••• = most relevant to Summary C.

Classification of Items

() = number of ... items

Paragraph 1. (1) 1. K. of Theory

It is a 50 year old hypothesis, that genes bear in coded form the specifications for all the protein molecules the cell requires for its existence and reproduction.

(2) 2. K. of Theory

In last 15 years the relationship between molecular structure of the genes and the coding instructions they carry and the cell proteins has been made explicit.

(3) 3. K. of Theory

One can trace the transmission of coded message from its original site in the genetic material to the finished protein molecule.

Paragraph 2. 4. K. of Sp.Fact

The genetic material of the living cell is the chain-like molecule of deoxyribosucleic acid (DNA)

5. K. of Sp.Fact

The cells of many bacteria have only a single chain.

6. K. of Sp. Fact

The cells of mammals have numerous chains clustered in chromosomes.

7. K. of Sp.Fact

The DNA molecules consist of a long back bone made up of repeating groups of phosphate and a 5 carbon sugar

8. K. of Sp.Fact

To this backbone side groups called bases are attached at regular intervals and these are adenine (A) guanine (G) thymine (T) and cytosine (C).

(4) 9. K. of Gen.

These side groups of DNA are the 4 "letters" used to decipher the genetic message.

(5) 10. K. of Principle

The exact sequence of bases along the length of the DNA molecule determines the structure of a particular protein molecule.

Paragraph 3. 11. K. of Crit.

Proteins are synthesized from a set of 20 amino acids that are gained to form the long polypeptide chains of protein molecules.

12. K. of Sp.Fact

Each protein has its own sequence of amino acids

13. K. of Sp.Fact

The number of acids in a polypeptide chain is 100 - 300 or more.

Paragraph 4. (6) 14. K. of Theory

The genetic code is not the message itself but the dictionary used by cell to translate from the 4 "letter" language of the necleic acid to the 20 "letter" language of protein.

(7) 15. K. of Theory

The machinery of the cell translates in one direction only, from nucleic acid to protein.

(8) 16. K. of Theory

In making this translation the cell employs a variety of acessory molecules and mechanisms.

(9) 17. K. of Principle

The message in DNA is 1st transcribed into messanger RNA.

18. K. of Sp.Fact

RNA has 4 bases, 3 identical with DNA but the 4th is URACIL (U) instead of thymine (T).

(10) 19. K. of Principle

In this 1st transcription of the genetic message the code letters A, G, T and C in DNA give rise respectively to U, C, A and G.

20. K. of Conventions

As typically represented the dictionary of the genetic code employs the letters found in RNA rather than those in DNA.

Paragraph 5.

(11) 21. K. of Theory

The code could be easily broken if one could determine both the amino acid sequence of a protein and the Base sequence of that piece of nucleic acid which codes it.

(12) 22. K. of Principle

The determination of the base sequence of a long nucleic acid molecule is very difficult and therefore indirect methods of code deciphering must be used.

Paragraph 6.

(13) 23. K. of Principle

Indirect experimental evidence suggests that the code is a triplet code and that each group corresponds to one amino acid.

24. K. of Class.

This group is called a codon.

(14) 25. K. of Principle

Using 4 symbols in groups of 3 one can form 64 triplets.

(15) 26. K. of Principle

Most of these stand for one amino acid or another and therefore an amino acid is represented by several codons.

(16) 27. K. of Principle

Adjacent amino acids are coded by a "codons which do not overlap.

Paragraph 7.

(17) 28. K. of Gener.

Marshall W. Nirenberg explained how the composition of many of the 64 triplets was determined by experiment.

29. K. of Method

The technique used was the synthesis of polypeptide chains in a cell free system, made by breaking open cells of BE.Cali and extracting from them the machinery of protein synthesis.

30. K. of Method

The system was then provided with an energy supply, 20 amino acids and one or another of several types of synthetic RNA.

31. K. of Trends

Although the exact sequence of bases in each type was random the proportion was known.

32. K. of Sp.Fact

It was found that each type of RNA directed the encorporation of certain amino acids only.

Paragraph 8.

(18) 33. K. of Principle

The composition of the codons was obtained but not the order of the bases in any one triplet.

34. K. of Sp.Fact

Of the 40 codons listed by Nirenberg 35 were correct.

(16) 27. K. of Principle

Adjacent amino acids are coded by a "codons which do not overlap.

Paragraph 7.

(17) 28. K. of Gener.

Marshall W. Nirenberg explained how the composition of many of the 64 triplets was determined by experiment.

29. K. of Method

The technique used was the synthesis of polypeptide chains in a cell free system, made by breaking open cells of BE.Cali and extracting from them the machinery of protein synthesis.

30. K. of Method

The system was then provided with an energy supply, 20 amino acids and one or another of several types of synthetic RNA.

31. K. of Trends

Although the exact sequence of bases in each type was random the proportion was known.

32. K. of Sp.Fact

It was found that each type of RNA directed the encorporation of certain amino acids only.

Paragraph 8.

(18) 33. K. of Principle

The composition of the codons was obtained but not the order of the bases in any one triplet.

34. K. of Sp.Fact

Of the 40 codons listed by Nirenberg 35 were correct.

42. K. of Method

They did so by the neat trick of passing the mixture over a nitrocellulose filter that retained the ribosomes.

43. K. of Trends

All the tRNA molecules passed through the filter except those specifically bound to the ribosome by the triplet. Which they were could be decided by using a mixture of amino acids which one kind of amino acid had been made radio-active, and determining the amount of radioactivity absorbed by the filter.

Paragraph 12.

44. K. of Sp.Fact

The triplet GUU retained the tRNA for the amino acid valine, whereas the triplets UGU & UUG did not. UGU codes cystine and UUG, lencine.

Paragraph 13.

45. K. of Method

Nirenberg and his colleagues synthesized all 64 triplets and tested them for their coding properties and similar results have been obtained by Khorana and others.

Paragraph 14.

46. K. of Sp.Fact

Class to 40 of the 64 triplets give a clearly unambiguous answer in the binding test.

(26) 47. K. of General

The binding test therefore gives meaning to the majority of triplets but does not firmly establish all of them.

Paragraph 15.

(27) 48. K. of Theory

The Genetic code obtained in this way with a few additions secured by other methods is listed in diagram 3. A distinct plan can be worked out between triplets and amino acids.

Paragraph 16.

(28) 49. K. of Principle

Triplet codes for the same amino acid are rather similar.

50. K. of Sp.Fact

a. All four triplets starting with AC code for threonine.

51. K. of Sp.Fact

b. This pattern holds for 7 of the amino acids.

(29) 52. K. of Principle

In every case the triplets XYU and XYC code for the same amino acid and in many cases XYA and XYG are the same.

(30) 53. K. of General.

Thus an amino acid is largely selected by the 1st 2 basis of the triplet.

54. K. of Crit.

Given that a triplet codes for valine, we know that the 1st 2 letters are GU.

55. K. of Trends

This pattern is true for all but three of the amino acids.

a. Lencine starts with UU or CU

b. Serine starts with UC or AG

c. Arginine starts with CG or AG.

(31) 56. K. of General.

In all other cases the amino acid is uniquely represented by the 1st 2 bases of the triplet but the converse is not always true.

(32) 57. K. of Principle

Given that a triplet starts with CA it may code for either histidine or glutomine.

Paragraph 17.

(33) 58. K. of Theory

The most direct way to confirm the code is to synthesize a messenger RNA molecule with a strictly defined base sequence and then find the amino acid sequence of the polypeptide produced under its influence.

(34) 59. K. of General.

By brilliant combination of chemical synthesis and enzyme catalysis Khorana and his colleagues made long RNA molecules with various repeating sequences of bases.

(35) 60. K. of Principle

One RNA molecule has the sequence UGUGUGUG .... which is read as triplet UGU, GUG, UGU, GUG, producing a polypeptide of 2 amino acids. The product is CYS - VAL, CYS - VAL,........

Paragraph 18.

(36) 61. K. of General.

Because the starting point is not clearly defined the homolypeptides XYZ, YZX, and ZXY can be produced.

63. K. of Trends

Thus poly AVC makes:-

poly iso leueine

poly serine

poly histidine.

64. K. of Sp.Fact

This confirms that,

AUC codes for isoleucine

UCA for serine

and CAU for histidine.

65. K. of Trends

A repeating sequence of four bases will yield a single type of polypeptide with a repeating sequence of four amino acids.

(38) 66. K. of Theory

The results have amply demonstrated that the code is indeed a triplet code.

Paragraph 19.

67. K. of Method

Khorana has so far confirmed 25 triplets by this method including several that were doubtful on the binding tests. All the triplets can eventually be checked in this way.

Paragraph 20.

(39) 68. K. of Principle

Another method of checking the genetic code is to discover the three bases making up the anticodon in a particular tRNA.

69. K. of Sp.Fact

The first tRNA to have its entire sequence worked out was tRNA alanine.

70. K. of Sp.Fact

A Alanine tRNA from yeast contains 77 bases.

71. K. of Sp.Fact

A possible anitcodon near the middle of the molecule has the sequence IGC, where I stands for inosine a base closely resembling guanine.

72. K. of Sp.Fact

Hans Zachau has established 16 sequences of 2 closely related senine tRNA's from yeast.

73. K. of Sp.Fact

James Madison has worked out the sequence of tyrosine tRNA, also from yeast.

Paragraph 21.

(40) 74. K. of Principle

A detailed comparison of these three sequences, makes it almost certain that the anticodons are alamine - IGC, senine - IGA and Tyrasine GΨA.

(41) 75. K. of Principle

Other workers have shown that the anticodon for valine is IAC and phenylalanine is GAA.

Paragraph 22.

(42) 76. K. of Principle

All the results fit the rule that the codon - anticodon, pair in antiparallel manner and that the pairing in the 1st 2 positions of the codon is of the standard type, i.e. A with U and G with C. The pairing in the 3rd position is more complicated.

(43) 77. K. of Principle

Evidence shows that one tRNA can recognise several codons provided, that they differ only in the 1st place of the CODON.

78. K. of Sp.Fact

A Holly's alanine tRNA recognises GCU, GCC and GCA.

Paragraph 23.

(44) 79. K. of Principle

The author suggests, that this is because of a 'wobble' in the pairing in the 3rd place and a theoretical model does explain the observable results.

(45) 80. K. of Principle

The suggested rules for the pairing in the 3rd position of the anticodon are presented in table form but these rules are speculative.

(46) 81. K. of Principle

The likely codon anticodon pairings for Valine, serine, tyrosine, alanine and phenylalanine satisfy the standard base pairings in the first 2 places and the wobble hypothesis in the 3rd.

Paragraph 24.

(47) 82. K. of Theory

Several points about the genetic code need clarification.

a. Triplet UGA has still to be allocated.

b. Punctuation marks are only partially understood.

c. Both triplets UAA and UAG can terminate a polypeptide chain, but which triplet is normally found at the end of a gene is still uncertain.

Paragraph 25.

(48) 83. K. of Principle

Problems for the future include

A doubtful codons.

a. Clarifying the punctuation marks.

b. delimit ambiguity and extend the code to many species.

c. Are all alternative codons used equally?

(49) 84. K. of Principle

B The machinery of protein synthesis

a. How many types of tRNA are there?

b. What is the structure of the ribosome? and how does it work and why is it in 2 parts.

c. What controls the rate of protein synthesis?

Paragraph 26.

(50) 85. K. of Theory

The major unsolved problem will be the structure of the genetic code. Is the present code the result of a series of evolutionary accidents so that the allocation of triplets is arbitrary or are there profound structural reasons for the relationship?

86. K. of Crit.

Such questions are difficult to answer since the genetic code originated at least 3 billion years ago.

87. K. of Sp.Fact

The origin of the code is close to the origin of life.

88. K. of Trends

It is most likely that most of the evidence has disappeared.

Paragraph 27.

(51) 89. K. of Theory

The genetic code is a major milestone on the road of molecular biology. It shows in detail how the 4 "letter" language of nucleic acid controls the 20 "letter" language of a protein.

(52) 90. K. of Theory

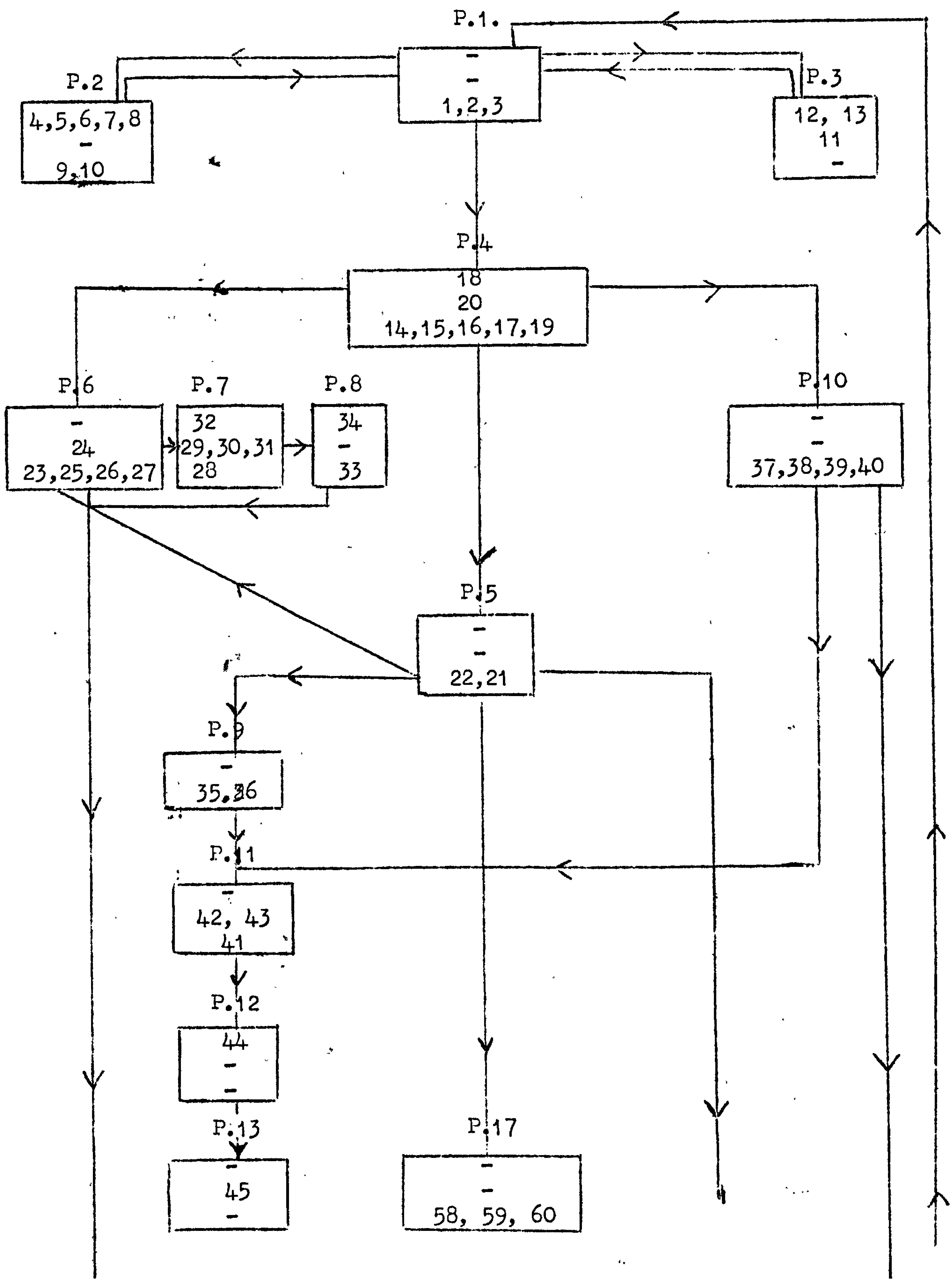
If this confirms the control theme of molecular biology, namely that genetic information can be stored as a one dimensional message on nucleic acid and can be expressed as the one dimensional amino acid sequence of protein.

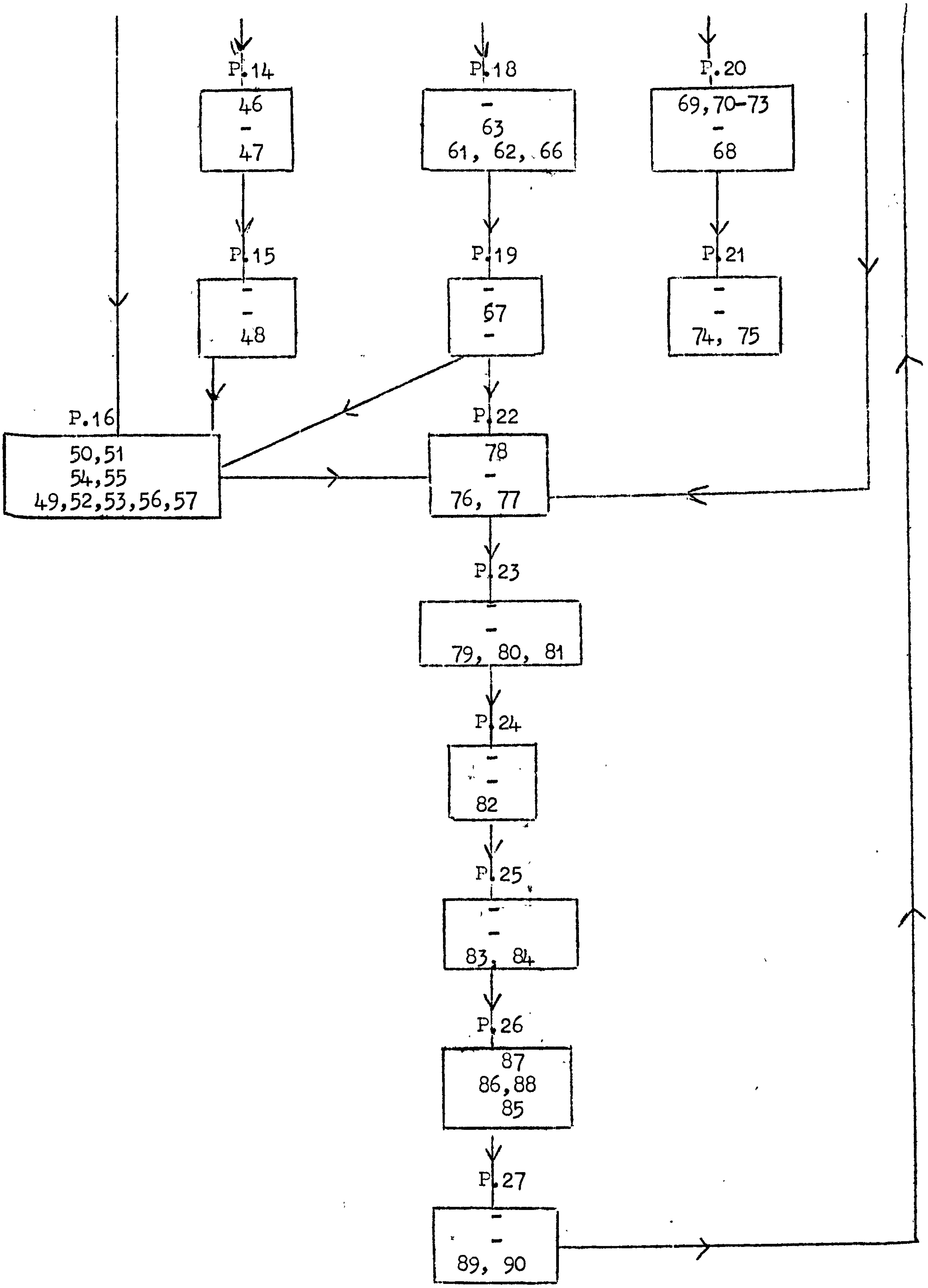
THE GENETIC CODE.

FLOW DIAGRAM

KEY: ORDER OF NUMBERS IN BOX

1st row - Specifics
2nd row - Ways and means of dealing with specifics
3rd row -- Universals and Abstractions





Total items = 90

52••• 16•• 22•

Appendix A. UNIT 2.

Experiment 5 (Unit 7)

2.6.1. The analysis of the Learning Material
CLASSIFICATION OF ITEMS (THE TAXONOMY OF EDUCATIONAL OBJECTIVES)

KEY

A Knowledge of Specifics

Knowledge of Specific Fact	-	K. of Sp. Fact.
Knowledge of Terminology	-	------- in text.

B Knowledge of Ways and Means of dealing with Specifics

Knowledge of Conventions	-	K. of Conv.
Knowledge of Trends & Sequences	-	K. of Trends.
Knowledge of Classification and Categories	-	K. of Class.
Knowledge of Criterion	-	K. of Crit.
Knowledge of Methodology	-	K. of Method.

C Knowledge of Universals & Abstractions in a Field

Knowledge of Principle	-	K. of Principle
Knowledge of Generalizations	-	K. of Gen.
Knowledge of Theories and Structures	-	K. of Theory.

Text A.	K. of Specifics	K. of Ways & Means	K. of Universals & Abstractions.
	26	44	44

Total no, of items = 114.

Text B.	K. of Specifics	K. of Ways & Means	K. of Universals & Abstractions.
	23	34	44

Total no. of items = 101

KEY

. = least relevant to summary

.. = more relevant to summary

... = most relevant to summary

TEXT A.

The role of light in photosynthesis - D.L. ARNON

ITEMS

Paragraph 1.

1. (K/Tri.) In time the thinking of workers in photosynthesis crystallized into two points of view.

2. (K/Th.) One view considered that (H) is an 'active' species of hydrogen atom that can force itself on the carbon-dioxide molecule.

3. (K of sp.fact) Such a reaction is unknown elsewhere in Biochemistry.

4. (K/Th.) The adherents of this view saw in it the very uniqueness of photosythesis and buttress their hypothesis with a number of theoretical arguments.

5. (K of Crit) Without going into the theory it can be said that not convincing experimental evidence has so far appeared to support it and there is much evidence against it.

Paragraph 2.

6. (K./Th.) On the second view point, the conversion of CO_2 and water to carbohydrates proceeds by a path that is not peculiar to photosynthesis in fact the path is considered to be essentially a reversal of the route by which carbohydrates are decomposed to CO_2 during respiration.

7. (K/th.) Then the role of the hypothetical (H) would be to form compounds that can drive the 'dark' reactions of respiration backward in the direction of synthesis.

ENERGY TRANSFORMATIONS

Paragraph 3.

8. To appreciate the proposal we must consider the process
(K of Crit)
of respiration.

9. The energy released in respiration is transferred to two
(K of Sp.Fact)
compounds, that are literally the power supply of life.

10. One of them is ATP which has been called the universal
(K/Sp.)
energy currency of living cells.

11. Every vital process from the contraction of a muscle to
(K/Sp.)
the synthesis of a hormone draws on ATP.

12. ATP contains 3 phosphate groups and it is made in the
(K/Sp.)
mitochondria by the addition of a third phosphate to adenssine diphosphate (ADP) and the bond to the third phosphate is where new energy is stored.

13. It is as though the bond were a coil of spring which is
(K/Crit.)
compressed when the phosphate is attached. When the phosphate group is removed the spring extends, thus releasing the stored energy.

14. In respiration, the energy that compresses the spring comes
(K/Crit.)
from the oxidation of carbohydrate and hence the formation of ATP in the mitochondria of a respiring cell is called <u>oxidative phophorylation.</u>

Paragraph 4.

15. The second of the key compounds is reduced pyridine nucleotide.
(K/Sp.)
There are two kinds, triphosphopyridine nucleotide ($TPNH_2$) and diphosphopyridine ($DPNH_2$) both abbreviated as (PNH_2).

16. (K/Sp.) Each is a powerful biological reductant i.e. it can force its hydrogen atoms on other molecules. PNH_2 participates in many oxidation-reduction reactions in living cells, one of these provides energy for phosphorylation itself, thus some PNH_2 is oxidized to make ATP.

Paragraph 5.

18. (K/Cl.) At this point it may be worth considering the terms oxidation and reduction on which our entire storey turns. Oxidation means removing electrons from a molecule and reduction means adding electrons; so that whenever electrons are exchanged between two substances one is oxidized and the other is reduced.

19. (K/Sp.) Almost every such change is accompanied by the release or absorption of energy. It makes no difference whether we think of the energy as arising out of the pull exerted on the electron by "oxidising power." These terms have meaning only in relation to a specific pair of substances which always interacts in the same way.

Paragraph 6.

20. (K/Sp.) Often an electron travels in company with a proton, in short as part of a hydrogen atom.

21. (K/Cl.) In this case oxidation means removing hydrogen and reduction means adding hydrogen. Thus "PN" is reduced to "PNH_2" and "CO_2" to a carbohydrate by the addition of hydrogen.

Paragraph 7.

22. (K/Th.) To return to photosynthesis, the viewpoint that it involves a special way of converting CO_2 to carbohydrate was dealt a severe blow by modern studies of cellular metabolism that have utilized radioactive tracers.

23. (K/Pr.) Investigations have proved that all cells devoid of chlorophyll, such as liver cells can synthesize carbohydrates from CO_2 if they are furnished the necessary energy in the form of ATP and PNH_2.

24. (K/Pr.) Apparently the breakdown of carbohydrates can be reversed. And if in the liver why not in plants?

Paragraph 8.

25. (K/Th.) There therefore grew a suspicion that there is no special photosynthetic way for assimilating CO_2 and that all cells whether they contain chlorophyll or not may accomplish it essentially by reversing respiration.

26. (K/Crit) This idea drew support from the work of Melvin, Calvin and Benson of the University of California, who traced the path of Carbon in photosynthesis from CO_2 to carbohydrate.

27. (K/Sp.) They identified many intermediate products identical with those formed when carbohydrate is burned in respiration.

28. (K/Sp.) Once the photosynthetic carbon cylce has been established each of its features was discovered in various cells that assimilated CO2 in the dark.

29. (K/Th.) Trudinger and Aulient have demonstrated the complete cycle in the non-photosynthetic bacterium Thiobacillus denitrificous.

Paragraph 9.

30. (K/Sp.) In all these dark reactions energy was provided by ATP and PNH_2.

31. (K of Crit.) This implied that the function of light must be to manufacture ATP and PNH_2.

32. (K/Sp.) In 1951 workers in 3 laboratories discovered that isolated chloroplasts do make PNH_2 in the light.

33. (K/Crit.) The whole problem of the role of light seemed very near solution.

34. (K/Crit.) Presumably the mitochondria in photosynthetic cells could obtain PNH_2 from chloroplasts and with it manufacture ATP.

35. (K/Crit.) The model was reasonable and widely accepted. It was believed that the problem was solved.

Paragraph 10.

36. (K/Crit.) There was one major difficulty in the model in that the most specialized photosynthetic cells in leaves have very few mitochondria being filled with chloroplasts.

37. (K/Crit.) These few could not produce enough ATP to support the vigorous photosynthetic activity of chloroplasts.

38. (K/Tri.) A search was made to see whether chloroplasts produced anything other than PNH_2.

39. (K/Tr.) In 1954 we found that chloroplasts alone carry out complete photosynehhesis.

40. (K/Pr.) If chloroplasts converted CO_2 into carbohydrates by a reversal of the breakdown reactions, they must have been able to make ATP.

Isolated chloroplasts.

Paragraph 11.

41. (K/Crit.) Our first task was to be sure that photosynthesis in our chloroplast preparations was really the same process that occurs in living cells.

42. (K/Meth.) In the next few years we subdivided chloroplasts into various parts and identified in them or isolated from them the individual enzyme systems that catalyze the step by step transformation of CO_2 into carbohydrates.

43. (K/Sp.) The products of assimilation - identified with radioactive tracers, chromatography and radioautography - proved to be the same as in photosynthesis by whole cells.

Paragraph 12.

44. (K/Pr.) The experiments demonstrated, that the assimilation of CO_2 in isolated chloroplasts is a reversal of the carbohydrate breakdown reactions.

45. (K/Pr.) Further, the energy for the process is provided jointly by ATP and PNH_2.

46. (K/Crit.) When experimental conditions were arranged so that only one of the pair was formed in light, no carbohydrates were made.

Paragraph 13.

47. (K/Tr.) We were now virtually certain that the role of light in photosynthesis is to supply ATP and PNH_2. Final evidence was forthcoming when we separated the light and dark phases of photosynthesis in chloroplasts.

48. (K/Meth.) We illuminated a chloroplast preparation but did not supply CO_2, so there was no raw material for manufacturing carbohydrates. Instead we supplied large amounts of ADP, inorganic phosphate and TPN.

49. (K/Sp.) The result was the evolution of oxygen and an accumulation of ATP and $TPNH_2$.

Paragraph 14.

50. (K/Meth.) Now we extracted the enzymes for CO_2 assimilation, discarding the green part of the chloroplasts and with it the light absorbing chlorophyll.

51. (K/Tri) Using ATP and $TPNH_2$ made when the light was on, the enzymes proceeded to assimilate CO_2 in the dark and to produce the same carbohydrates that whole chloroplasts and intact green leaves manufacture.

52. (K/Meth.) In a further experiment PNH_2 and ATP taken from animal cells were supplied to the enzymes in total darkness.

53. (K/Sp.) Again the extracts assimilated CO_2 and made the familiar compounds.

Paragraph 15.

54. (K/Cl.) At this point the objectives of our research narrowed to the problem of identifying the reactions through which light energy forms ATP and PNH_2.

Photosynthetic Phosphorylation.

Paragraph 16

55. (K/Crit.) Since the manufacture of PNH_2 by chloroplasts in light had been observed before, we decided to concentrate on the completely unknown process by which ATP is synthesized.

56. (K/Tr.) Very early we established that isolated chloroplasts could apply absorbed light purely to the formation of ATP.

57. (K/Meth.) We discovered this by depriving illuminated chloroplasts of CO_2 and pynidine nucleotide while giving them large amounts of ADP and inorganic phosphate.

58. (K/Tr.) With no raw material for making carbohydrate or even PNH_2 the chloroplasts used light energy to force the third phosphate group on ADP to form ATP, which accumulated in substantial quantities by the end of the experiment.

59. (K/Cl.) This process was called phtosynthetic phosphenylation, or photophosphorylation to distinguish it from oxidative phosphorylation by mitochondria.

60. (K/Pr.) To biochemists imbued with the idea that the energy of ATP comes from burning carbohydrates it was as if we had suddenly learned how to get electric power directly from coal or oil, without burning them in a generating plant.

Paragraph 17.

61. (K/Tr.) About two years ago my associates and I constructed a theoretical model that seems to fit the experimental facts of photosynthetic phosphorylation.

62. (K/Sp.) It was suggested by another photochemical reaction, whose details were worked out in 1942 by Lewis and Lipkin of the University of California.

63. (K/Th.) We proposed that, in the primary photochemical act, a photon (quantum unit) of light strikes a chlorophyll molecule, exciting one of the electrons to an energy sufficient to remove it from the molecule. Having lost an electron, the molecule is now in a position to act as an electron acceptor. If it took back the electron directly, it would merely re-emit the light energy that had just been absorbed.

64. (K/Sp.) Under the proper conditions light does cause pure chlorophyll to fluoresce in just this way.

65. (K/Th.) The reaction that makes the phosphonylation possible is the capture of the excited electrons by a molecule such as Vitamin K. Now the electrons are forced to return to chlorophyll in a series of graded steps, resembling those in respiration.

Paragraph 18.

66. (K/Th.) The downhill path we have traced takes electrons from Vitamin K through a number of cytochromes - iron containing pigments and finally back to chlorophyll.

67. (K/Th.) The "waterwheels" that drive the synthesis of ATP are thought to be linked with the cytochrome chain.

Paragraph 19.

68. (K/Pr.) The electron transport and its coupled phosphenylation reactions are analagous to and identical with their counterparts in oxidative phosphenylation.

69. (K/Pr.) Only the light induced production of a high energy electron and its ultimate acceptor are peculiar to photosynthesis.

70. (K/Crit.) Because the electron donor and acceptor are the same substance - chlorophyll - and because no outside donors are involved, we have named the process cyclic photophosphorylation.

Paragraph 20.

71. (K/Th.) There seems little doubt that photophosphorylation is a primary and critical reaction of photosynthesis.

72. (K/Th.) In most organisms however it is not the only one.

73. (K/Pr.) Light is required to make PNH_2 which furnishes the hydrogen to reduce CO_2 to carbohydrate.

74. (K/Pr.) The fact, that chloroplasts do under certain conditions use light solely for the manufacture of ATP raises an interesting question.

75. (K/Th.) Are there any photosynthetic cells in which photophosphorylation is really the only function of light, and which manufacture their reducing substance by a dark reaction? If so, they would exhibit the simplest and most primitive forms of photosynthesis.

Paragraph 21.

76. (K/Sp.) Recently it was found that the anaerobic red sulphur bacteria chromatium is just such an organism.

77. (K/Sp.) Chromatium grows only in the light. The bacterium can use CO_2 or acetate as the source of carbon.

78. (K/Sp.) To assimilate CO_2 it requires a source of hydrogen with which it can form necessary PNH_2 in the dark. Acetate however is assimilated by a somewhat different chemical pathway which does not require an external supply of hydrogen.

79. (K/Tr.) When supplied with hydrogen and CO_2 cr acetate the only thing that chromotium makes under the influence of light is ATP.

80. (K/Sp.) Chromotium groups anaerabically and thus cannot make ATP buy oxidative phosphorylation.

81. (K/Meth.) To test whether ATP is indeed the sole product of the light reaction in the assimilation of CO_2 or acetate, we placed a cell-free preparation of chromotium in the dark and added ATP.

82. (K/Tr.) This preparation synthesized organic carbon compounds in the dark, just as chromotium does in the light, when it is not supplied with ATP but has to make it from ADP and phosphate.

83. (K/Pr.) Light and ATP were entirely equivalent.

Paragraph 22.

84. (K/Pr.) In chromotium supplied either with hydrogen gas and CO_2 or with acetate, the role of light is limited to making ATP by cyclic photophosphorylation.

85. (K/Sp.) However, pho osynthetic bacteria can also make use of other hydrogen donors.

86. (K/Sp.) Inorganic materials such as thiosulphate and organic acids such as succinate.

87. (K/Sp.) The hydrogen in these substances does not have enough reducing capacity to convert PN to PNH_2 in the dark. Additional energy is required.

Paragraph 23.

Noncyclic Photophosphorylation.

88. (K/Pr.) In the photosyrthetic mode of life of these bateria, which grow without oxygen, the energy must come from light.

89. (K/Pr.) How do they use light to reduce PN with thiosulphate or succinate? Recently we have found that our picture of electrons excited by light applies.

Paragraph 24.

90. (K/Tr.) A number of investigators had shown that the cytochromes in photosynthetic cells became oxidized when the cells are illuminated.

91. (K/Th.) Our theory suggests that electrons are transferred from cytochrome to chlorophyll, replacing the ones expelled from chlorophyll by the action of light.

92. (K/Tr.) Now we find that the oxidized cytochromes are in turn reduced by thiosulphate or succinate.

93. (K/Tr.) The result is that electrons donated by thiosulphate or succinate are transferred via cytochromes to chlorophyll and are then raised at the expense of light energy to a reducing potential sufficient to make PNH_2.

Paragraph 25.

94. (K/Th.) The fate of these activated electrons is different however from that in the cyclic route. They do not return to chlorophyll but are eventually transferred to external acceptors.

95. (K/Sp.) Three of these have now been identified, nitrogen gas which is converted to ammonia, PN which is converted to PNH_2 and protons which are converted hydrogen.

96. (K/Pr.) Here light is used either to produce PNH_2 or to fix atmospheric nitrogen.

97. (K/Pr.) In travelling this non-cyclic route the electrons also give up some of their energy to the formation of ATP.

Paragraph 26.

98. (K/Pr.) It seems that green plants also have an open ended route of electron transport for making PNH_2 as well as the closed path of cyclic photophosphorylation.

99. (K/Pr.) The essential difference between their noncyclic electron transport mechanism and that of bacteria resides in the fact that chloroplasts derive their external electron supply from water.

100. (K/Pr.) The electrons from water have an even smaller reducing capacity than those from thiosulphate or succinate.

101. (K/Pr.) Therefore green plants, depend unconditionally on light for 'raising' the electrons from water to a reducing potential sufficient to form PNH_2.

Paragraph 27.

102. (K/Cl.) In the course of our studies of PN reduction by chloroplast we found that it is accompanied by the formation of ATP. We named this reaction non-cyclic photophosphorylation.

103. (K/Tr.) It is accompanied by the evaluation rather than the absorption of oxygen as in oxidative phosphorylation.

104. (K/Tr.) The formation of ATP results not in the ultimate oxidation, but in the reduction of PN.

105. (K/Crit.) As with cyclic photophosphorylation, the noncyclic type has now been confirmed and elucidated in a number of laboratories.

Paragraph 28.

106. (K/Pr.) The noncyclic mechanism however cannot by itself supply all the ATP needed for assimilating CO_2 in the manufacture of carbohydrates, and additional ATP must be supplied by cyclic photophosphorylation.

Paragraph 29.

107. (K/Th.) Our theoretical model of photosynthesis is reasonably complete, although several features remain to be confirmed by experts.

108. (K/Th.) The role of light in the primary photo chemical act is simply to raise the energy of the electrons in chlorophyll.

109. (K/Th.) Then cellular chemistry takes over, shunting the excited electrons into different downhill paths, where their energy is converted into chemical energy and is harnessed to derive several possible reactions.

110. (K/Th.) Thus the essentials of photosynthesis is the conversion of light energy into chemical energy, which can be used by the cell in various ways.

111. (K/Th.) Most commonly it is applied to the assimilation of CO_2, but this is by no means its only possible use.

Paragraph 30.

112. (K/Th.) In all photosynthesis, bacterial or green plant the common denominator of the energy conversion process is cyclic photophospherylation; the manufacture of ATP at the expense of light energy.

All photosynthetic organisms and only photosynthetic organisms perform this feat.

113. (K/Th.) The assimilation of CO_2 and the evaluation of oxygen are processes that the cell may but need not carry out while performing photosynthesis.

114. (K/Th.) Indeed bacterial studies show, the list of processes that are driven by trapped light energy should be extended to include nitrogen fixation and the evolution of hydrogen gas.

TEXT B.

The Mechanism of Immunity

ITEMS

Paragraph 1.

1. (K/Tr.) Deliberate defense against infectious disease started in the late 18th Century with Jenner's discovery of the principle of immunity, so triumphantly demonstrated by the success of Jenner's vaccine against smallpox.

2. (K/Tr.) Today the technique of immunization provides protection against all the significant diseases that have not been eliminated by public health measures or by chemotherapy.

Paragraph 2.

3. (K/Cl.) Although the practical problems of immunization have been solved, immunization remains an important branch of modern medicine.

4. (K/Crit.) The immunologist of today is not so interested in how to immunize effectively against diptheria or poliomyelitis, but in understanding the process of immunity.

5. (K/Cl.) He is concerned with such problems as skin grafts, which are successful between identical twins or on one individual but not from any one individual to another.

6. (K/Cl.) Why occasionally fraternal twins share 2 blood groups and accept skin grafts from each other.

7. (K/Cl.) Why an individual who suffered a single attack from a virus 20 or 60 years ago continue to produce antibody against the virus.

8\. Why are there '<u>autoimmune</u>' <u>diseases</u> such as rheumatoid athritis in which an abnormal immune reaction is directed against the body's own cells and tissues.
(K/Crit.)

9\. Any modern formulation of immunological theory must supply at least provisional answers to these and more other equally complex questions.
(K/Th.)

<u>Paragraph 3.</u>

10\. <u>Immunology</u> is a discipline in its own right, able to make rich contributions to the understanding of central problems of biology, notably the nature of genetic information and the mechanism of protein synthesis.
(K/Th.)

11\. Both these problems are tied to the <u>theory of immunity.</u>
(K/Th.)

<u>Paragraph 4.</u>

12\. In its modern form orthodox <u>immunological theory</u> holds that the central feature of immunity is the production of antibody by a specialized group of tissue cells known as plasma cells.
(K/Th.)

13\. <u>Antibody</u> is a globular protein of blood plasma which can be identified by its physical behaviour as a 'gamma globulin'.
(K/Sp.)

14\. Each antibody has a highly specific affinity with the particular antigen which stimulates its production.
(K/Pr.)

15\. An antigen may be part of a virus, bacterium or foreign tissue cell, or a fragment of some such structure, a protein or polysaccharide.
(K/Sp.)

16\. Antibody protects the organism against a foreign substance by combining with it and thereby rendering it inactive.
(K/Pr.)

Paragraph 5.

17. Antigen and antibody are large in the chemical sense.
(K/Sp.)

18. Antibody globulin has a molecular weight of 160,000, and
(K/Sp.)
antigens are of the order.

19. The sites of chemical activity which bring antibody and
(K/Sp.)
antigen together represent small portion of these complex molecules.

20. A single site is equivalent to the region occupied by
(K/Sp.)
3 to 5 of the hundreds of amino acid units in a protein, or monosacchanide units in a polysacchanide.

21. These small regions of unions are called antigenic determinants
(K/Sp.)
or the antigen and specific patches on the antibody.

22. According to the orthodox theory the 2 combine because the
(K/Pr.)
geometrical configuration of the specific patch is complementary to the pattern of the antigenic determinant.

23. They fit each other as a key matches a lock.
(K/Crit.)

24. In this scheme which was influenced by Ehlreich, Landsteiner
(K/Pr.)
and Pouling the specific patch on the antibody acquires its pattern by being synthesized in contact with the antigenic determinant.

25. The antigen itself is presumably taken into the cell and
(K/Tr.)
comes into action after the amino-acid units of globulin have been assembled by the cells machinery and are in the process of being folded into globulin form.

26. (K/Tr.) At the folding stage the globulin is brought into contact with the antigen and is moulded into the required complementary pattern.

Paragraph 6.

27. (K/Th.) This is the simplest form of the 'instructive' theory of antibody formation, the antigenic determinant supplies the information from which each specific antibody is constructed.

28. (K/Crit.) The instructive theory does not account for several significant processes associated with immunity, such as the persistence of immunity and the origin of the autoimmune diseases.

29. (K/Th.) A fundamentally different view has been advanced by the proponents of the selection theory.

Paragraph 7.

30. (K/Th.) The theory holds that antibody molecules are made in essentially the same way that other proteins are synthesized, i.e. according to genetic instructions of the cell.

31. (K/Pr.) At no time does information enter the cell from the outside.

32. (K/Pr.) Instead, for each one of the thousands of possible foreign antigens, the body already contains a cell or group of cells genetically capable of synthesizing the appropriate antibody.

33. (K/Pr.) Each of these cells of groups of cells "knows" how to make the specific antibody, even if the complementary antigen never enters the body.

34. (K/Pr.) The function of the antigen is simply to select and stimulate the proliferation of the approximate group of cells, thus increasing production of the required antibody.

Paragraph 8.

35. (K/Pr.) The idea of selection has been central to biology ever since the publication of the 'Origin of Species'.

36. (K/Pr.) The environment selects among organisms for the differential survival attributes or potentialities which are conferred upon them by genetic processes.

37. (K/Crit.) The sun does not breed maggots in a dead dog unless the fertilized fly deposits the necessary genetic information in the carrion.

38. (K/Pr.) No one now seriously argues that evolution produced the whale and the giraffe by the Lamarchian formula according to which the function of the environment is to mould, first physically and then inheritably - in the right direction.

39. (K/Tr.) Recently, however, some investigators have held that bacteria show a wide capacity to produce 'adaptive' enzymes on demand.

40. (K/Sp.) It was indeed observed that bacterial cultures can start producing new enzymes when presented with unusual substances in their nutrient.

41. (K/Crit.) But it soon became clear that the 'adaptive' enzyme formation is a much subtler phenomenon.

42. (K/Pr.) Current interpretation tends towards the view that a bacterium can produce a given enzyme only if the necessary information is incorporated in its genetic mechanism, the experimental change in the environment allows the emergence into activity of what was formerly only a latent capacity.

Paragraph 9.

43. (K/Th.) It is likely that views of antibody formation will change in the same direction, toward a wider acceptance of selection theories. This approach of selection leads more directly to the central process in immunology, which is defined as the differentiation between the self and the not-self.

44. (K/Sp.) The body does not normally produce antibody against its own tissues, although it is at least potentially capable of producing antibodies against any protein or any other substance of appropriate molecular character that is not present in the body.

45. (K/Crit.) The implications of this fact are the most important reasons for favouring a selection theory of immunity.

Paragraph 10.

46. (K/Sp.) Most proteins are antigenic to an organism that has not been concerned in producing them.

47. (K/Crit.) At present only one protein is known well enough to permit a comparison of its chemical structure with its immunological activity.

48. (K/Sp.) This is insulin, one of the smallest proteins, the full sequence of amino-acid units has been worked out for the insulins of several animal species.

49. (K/Sp.) Insulin is not antigenic in the animal that produces it and it also happens that it is a rather mild antigen, most diabetics can receive beef or sheep insulin for years without trouble, but some become resistant because they are making antibodies against it.

50. (K/Sp.) This difficulty can usually be circumvented between by using pig insulin.

51. (K/Sp.) The difference between pig and beef insulin is known.

52. (K/Sp.) If an insulin is antigenic for a mammal it is because this sequence differs from the corresponding sequence of the animals' own insulin.

Paragraph 11.

53. (K/Cl.) These days genetics has become very close to biochemistry, and an antigen, like a gene is a relative concept.

54. (K/Crit.) A gene is an entirely devised entity to explain an observable hereditary difference between two inter-breeding stocks or individuals.

55. (K/Crit.) Long stretches of a chromosome must remain genetically silent, if there are no regions of observable difference between available stocks.

56. (K/Crit.) An antigen is also an expression of difference. It contains patterns which differ from any pattern present in the animal in which it is tested for antigenicity.

57. (K/Crit.) In one animal, one part of a foreign protein may be antigenic in another species an entirely different segment of the same molecule may stimulate the antibody reaction.

Paragraph 12.

58. (K/Pr.) Even though insulin is a poor antigen it does present the central question, how does the 'insulin resistant diabetic' recognise the tiny difference between beef insulin and his own insulin and so make antibody against the former?

59. (K/Pr.) This is a question of information in that how does the body generate the information needed to distinguish foreign chemical configurations from its own?

Paragraph 13.

60. (K/Crit.) The most important clue is provided by experimental manipulations that trick an organism into accepting as its own a substance or a cell that genetically speaking has no right to be there.

61. (K/Sp.) The most impressive examples comes from rare experts of nature by which genetically dissimilar human twins share a common placental circulation in their mother's uterus.

62. (K/Sp.) This will ensure that each twin receives a variety of cells from the other, including cells that can settle down in the bone marrow and multiply to produce the red blood cells.

63. (K/Sp.) Three pairs of such twins have been identified in life, they were found to have two blood groups, their own and their twin.

64. (K/Sp.) Such fraternal twins have a second striking difference from an ordinary pair of dissimilar twins; twins who have developed in the usual fashion from two separate placentas will not accept skin transplants from each other, while fraternal twins with double blood groups accept skin grafts.

65. (K/Pr.) This indicates that self-recognition in the antibody producing system is not due simply to hereditary traits. Rather, self-recognition seems to develop as a secondary process sometime during embryonic life.

Paragraph 14.

66. (K/Sp.) Much work has been done in recent years on the experimental demonstration of immunological tolerance, most often in mice and rats.

67. (K/Sp.) Laboratories possess likes so similar genetically that each individual will accept grafts.

68. (K/Meth.) Two illuminating experiments have been carried out with 2 suitable strains. A and B, in both an emulsion of cells from a mouse of strain B is inoculated into a vein in the face of a new born mouse of A strain.

Paragraph 15.

69. (K/Meth.) In the 1st experiment cells from the spleen and kidney of an embryo of mouse B are inoculated into a new born mouse of strain A and the mouse develops normally. When a piece of B skin is grafted it 'takes'.

70. (K/Sp.) If the A mice are white and the B black the A mouse presents the unprecedented anomaly of a patch of healthy black hair.

71. (K/Meth.) In the 2nd experiment another mouseling of strain A is inoculated with cells from the spleen of B mouse.

72. (K/Sp.) The result is disastrous. Depending upon the number of cells and the particular pair of mouse strains being used, the mouseling either dies or develops slowly into a scruffy individual suffering from runt's disease.

Paragraph 16.

73. (K/Crit.) An oversimplified explanation is that in the first experiment host A becomes tolerant of B cells implanted in its tissues after birth.

74. As a result A tolerates a graft of B skin.
(K/Crit.)

75. If an equilibrium is to be reached the implanted B cells
(K/Crit.)
must become tolerant of their foreign host as well as vice versa.

76. The embryonic B cells do become tolerant, but in the second
(K/Crit.)
experiment the adult B cells set up their own immune reaction against their host and produce runt or death.

Paragraph 17.

77. A detailed consideration of many phenomena of the same
(K/Pr.)
general quality permits the formulation of the key question in the self and not self problem. What is the process by which the body learns during development to differentiate its own substance from that of others?

78. Where or what is the dictionary that the body must consult
(K/Pr.)
to decide whether such and such is foreign or belongs to its own language.

79. Jerne beleives that the dictionary lists only foreign words
(K/Pr.)
and that it has in it a list of all the foreign words without ever having heard them !

Paragraph 18.

80. Such a dictionary can be pictured in several possible ways,
(K/Pr.)
but it must contain a large number of patterns (words) which among them can offer a complementary specific antibody patch to correspond with every possible antigenic determinant.

81. This is not as unlikely as it sounds because the number of
(K/Crit.)
determinants is not large, and both the antigenic determinants and the specific patches are small configurations.

82. (K/Pr.) The number of different 3 and 4 letter combinations to the 20 letter alphabet of amino acid units in proteins is respectively 8,000 and 150,000 and these are few compared with the number of cells in even a mouse.

83. (K/Pr.) It is estimated that only some 10,000 different patterns are needed.

Paragraph 19.

84. (K/Pr.) It is not difficult to imagine how the body might create its foreign word dictionary. The lymphocytes are the most likely carriers of the words, or antibody patterns.

85. (K/Pr.) In the early stages of embryonic life the ancestors of these cells are assumed to be highly mutable in this particular quality.

86. (K/Pr.) Their genetic material would change spontaneously in a random position creating all the antibody patterns.

87. (K/Pr.) Each cell through division would become the ancestor of a small group of cells called a clone, all identical and all carrying the pattern for one or at most a few specific antibodies.

88. (K/Th.) Since the mutation would be random, body antibody patterns against antigens in the body would arise, it is therefore necessary to posulate that such cells are destroyed by contact with their corresponding antigen.

89. (K/Pr.) Thus during the early phase of an embryonic development "forbidden" clones that match 'self'-antigens would be eliminated as they arose.

90\. (K/Pr.) Foreign antigens cannot normally reach an embryo, but when they do, they come to be accepted as self. If not foreign antigens reach the embryo, it retains all the foreign patterns.

Paragraph 20.

91\. (K/Pr.) Later in embryonic life the rate of mutations of immunological cells would decrease drastically to the mutation rate found everywhere in the body throughout life.

92\. (K/Pr.) Forbidden clones would continue to arise, though infrequently and would normally be killed off, or at least inhibited, while still immature.

93\. (K/Pr.) Mature immunological cells instead of being destroyed by the appropriate antigen, would be stimulated by it to proliferate, producing among their offspring a great many of the plasma cells that probably manufacture the actual antibody molecules to combine with and decultivate foreign antigens.

Paragraph 21.

94\. (K/Th.) The theory is called the clonal-selection theory because the action of the antigen is simply to select for proliferation that particular clone of cells which can react with it.

95\. (K/Th.) In the original form of the hypothesis each clone was believed to carry only the pattern, but two patterns per clone now seems to accord better with evidence from observations.

Paragraph 22.

96. (K/Th.) Many immunologists are highly sympathetic to the general idea of a clonal-selection theory, but are sceptical of the necessity of limiting the capacity of a given cell or clone to one, two or at most three patterns. They would prefer a substantial number, perhaps 10 to 20 related patterns per clone.

97. (K/Th.) Some press the idea to its logical conclusion and assume that every cell which is a potential antibody producer carries its own complete foreign-word dictionary and can therefore recognise any antigenic determinant and through its descendants produce antibody against it.

Paragraph 23.

98. (K/Crit.) The main virtue of the clonal selection theory in which not more than 3 antibody patterns are carried by a single cell or clone is that it is in principle and in practice amenable to a variety of experimental tests.

99. (K/Crit.) So far no one has offered an experimental means of differentiating between an instructive theory and the theory that every immunological cell carries all possible antibody patterns.

100. (K/Crit.) Furthermore it is difficult to picture how everyone of these cells could contain all the information needed for the recognition of every foreign antigenic determinant.

101. (K/Th.) The idea of a pre-adopted pattern determined by the genetic material which is the essence of the clonal selection theory seems to fit better with modern conceptions of protein synthesis than the rather crudely mechanical concept of the orthodox instructive theory.

APPENDIX A UNIT 2.

Experiment 2 (Unit 3)

2.6.3. The Question ~~Paper~~ A.

1. What are the series of interactions involved in hearing?

(Recall Complex)

2. Describe TWO feedback activities involved in integrated hearing behaviour. (Recall Complex)

3. List the main phases of hearing behaviour. (Recall Complex)

4. Reflex actions involved in an arousal reaction include changes in posture, selective inhibition and activation of smooth muscles and glands, the pupils of the eye (dilate / contract). Delete the erroneous reflex action. (Recognition)

5. What effect has the prolonged absence of sound on man and animals? (Recall Simple)

6. What are the three main physical properties of sound?

Physical

1
2
3 (Recall Simple)

7. Group a), b), c) and d) together into 2 pairs, so that the members of each pair have one factor in common.

a b

c d (Recognition)

8. What is the greatest sensitivity range of hearing in an average human? Tick the correct statement.

1,000 - 6,000 cps.

6,000 -20,000 cps.

1,000 - 4,000 cps. (Recognition)

9. The <u>range</u> of frequency affected is greater

a) the greater the

b) the lower the

Insert the appropriate missing words in the gaps in a) and b). (Recall Simple).

10. What is meant by sound discrimination? (Recall Complex).

11. Is the auditory organ of the inner ear called:-

a) the basilar membrane. b) the cochlea. c) organ of corti.

(Recognition).

12. Describe the effect on the cochlea if two tones of different intensity are present. (Recall Complex).

13. What is the effect of very intense sound on the cochlea?

(Recall Complex).

14. To which neural systems is the basilar membrane connected spatially? (Recall Simple).

15. Insert the missing group of words.

The maximum rate of firing of a single auditory neurone is not over .... (Recall Simple).

16. What is meant by integrative control? (Recall Complex)

<u>Recall Complex</u>	<u>Recognition</u>	<u>Recall Simple</u>
8	4	4

APPENDIX A. UNIT 2.

Experiment 2 (Unit 3).

2.6.3. The Question Paper B.

1. What are the series of interactions involved in hearing?

(Recall Complex)

2. There are FIVE forms of response which alter the metabolic or behavioural state in relation to sound stimuli. Describe TWO responses. (Recall Complex)

3. List the main phases of hearing behaviour. (Recall Complex)

4. What is the lowest reaction time of the arousal reaction to sound stimuli?

a) 0.01 - 0.05 sec.
b) 0.01 - 0.03 "
c) 0.01 - 0.08 " (Recognition)

Tick the correct time.

5. What effect has the prolonged absence of sound on man and animals? (Recall Simple)

6. What are the three main psychological properties of sound?

Psychological
1
2
3 (Recall Simple)

7. Select the statement which determines the frequency a) and intensity b) of a sound wave by inserting a), b) against the appropriate line:

(i) The number of complete cycles occurring in a second determines

(ii) The square of the amplitude of displacement (or height of curve) determines (Recognition)

8. The bat may hear tones as high as:

75,000 c.p.s.

95,000 c.p.s.

25,000 c.p.s.

Tick the correct statement. (Recognition)

9. The masking effect of a tone is (least / greater) for tones nearer the masking tone in frequency. Delete the incorrect word. (Recognition)

10. What is meant by sound discrimination? (Recall Complex)

11. What are considered to be the true receptors of hearing? (Recall Simple)

12. Of what importance is differential resonance values to the functioning of the cochlea? (Recall complex)

13. What is the electric potential found to exist between the fluid of the cochlear canal and the organ of corti? (Recall Simple)

14. What is a cochlear microphonic? (Recall Complex)

15. What is meant by neural tuning? (Recall Complex)

16. What regulates motivated listening? (Recall Complex)

Recall Complex	Recognition	Recall Simple
8	4	4

APPENDIX A. UNIT 2.

Experiment 3 (Unit 3)

2.6.3. The Question ~~Paper~~ .

Recall Simple

1. The genetic material of the living cell is the chain-like molecule .... Complete this sentence.

2. How many naturally occurring amino acids are there?

3. What is the message carried by DNA transcribed into?

4. Protein synthesis takes place on the intracellular inclusions called ....

5. In relation to the code, how is an amino acid largely selected?

6. What does poly-AUC make?

7. How did Khorana make long RNA molecules, with various repeating sequences of bases?

Recall Complex

8. What is implicit in the hypothesis that the genes contain all the information needed for the cell to reproduce?

9. Explain what is understood by the term 'codon'.

10. What is understood by the term 'anticodon'.

11. What is the role of transfer RNA?

12. Describe the nature of the pairing of a codon and anti-codon.

13. According to Crick, what problems should further work clarify?

14. What major problems will be extremely difficult to decide according to Crick?

Recognition

15. Synthesis of proteins is accomplished by the intracellular particles called ribosomes. The coded instructions for making proteins are carried to the ribosome by:-

a) A form of ribonucleic acid called "messenger" RNA.

b) " " " " " " "transfer" RNA.

c) " " " " " " "soluble" RNA.

d) " " " " " " "ribsomal" RNA.

Select the correct statement.

16. A codon is:-

a) A group of bases on the messenger RNA corresponding to a particular amino acid.

b) A code which was a triplet code.

c) A triplet of bases on "transfer" RNA.

d) A group of bases on "soluble" RNA corresponding to a particular amino acid.

Select the correct statement.

17. UGU-GUG-UGU-GUG-UGU......

When the biochemical machinery reads the above code as triplets a polypeptide will be produced with an alternating sequence of amino acids. It was found that the product was:-

a) cystine - histidine

b) histidine - glutamine

c) serine - arginine

d) cystine - valine.

Select the correct combination.

18. Unerline the amino acid(s) which differ in that the first two bases of the triplet can vary.

19. ANTICODON | CODON

ANTICODON		CODON	
a)	U	a)	U, C, A
b)	C	b)	U, C
c)	G	c)	G
d)	I	d)	A, G

Pair up the correct combination of anticodon to codon.

20. Which of the following codon - anticodon pairs can be identified with the amino acid alanine?

	a)	b)	c)	d)
CODON	$\xrightarrow{}$ GCC	$\xrightarrow{}$ UCU	$\xrightarrow{}$ GUC	$\xrightarrow{}$ UUC
ANTICODON	CGI $\xleftarrow{}$	AGI $\xleftarrow{}$	CAI $\xleftarrow{}$	AAG $\xleftarrow{}$

21. The "Wobble" Hypothesis accounts for:-

a) that one tRNA can recognise several codons

b) that leucine codons can start with UU or CU

c) that messenger RNA differs in the first place of the codon

d) the formation of a two hydrogen bond link.

22. Of the 40 codon compositions listed it is known that:

a) 35

b) 25

c) 23

d) 33

were correct. Select the correct answer.

APPENDIX A. UNIT 2.

Experiment 3 (Unit 3).

2.6.3. The Question Paper A.

Recall Simple

1. There are four standard bases. Name them.

2. The number of amino acids in a polypeptide chain range from?

3. Of the 40 codons listed by Nirenberg it is now known that ...,....... were correct. Insert missing number.

4. What was the trick used by Leder and Nirenberg?

5. How many kinds of amino acids would be theoretically contained in a repeating sequence of four bases, X X Y Z ?

6. What have the results to date demonstrated about the code?

7. Close to .... of the 64 triplets give a clearly unambiguous answer in the binding test. Insert the missing number.

Recall Complex

8. What do the DNA molecules consist of?

9. What was the technique used by Marshall W. Nirenberg to determine the composition of the 64 triplets by experiment?

10. What is understood by the term "anticodon"?

11. Explain why it is concluded that an amino acid is largely selected by the first two bases of the triplet.

12. What is the "Wobble" hypothesis?

13. What is to be discovered about the machinery of protein synthesis?

14. In what way is the genetic code a major milestone in molecular biology?

Recognition

15. To the backbone of DNA side groups called bases are attached at regular intervals. These bases are:-

a)	adenine	guanidine	thymine	uracil
b)	cytosine	thymine	uracil	adenine
c)	guanine	thymine	adenine	cytosine
d)	thymine	inosine	adenine	cytosine

Select the correct statement.

16. GENETIC CODE

ACU)
ACC)
ACA)
ACG)

GCU)
GCC)
GCA)
GCG)

GGU)
GGC)
GGA)
GGG)

UUA)
UUG)
CUU)
CUA)

Against each block pair up the corresponding amino acid from:

(i) the list below:

a) leucine
b) glyceine
c) threonine
d) valine.

17. Underline the amino acid which differs in its coding characteristics.

18. <u>RNA BASE Sequence</u> — <u>AMINO ACID Sequence expected</u>

RNA BASE Sequence	AMINO ACID Sequence expected
a) (XXYZ)n	a) abab
b) (XYZ)n	b) aaa
c) (XY)n	c) abcd
d) (XYXZ)n	d) abcd

<u>Pair</u> up the correct combination from the list of RNA Base Sequence and the expected Amino Acid Sequence.

19. A method of checking the genetic code is to discover the three bases making up the anticodon in a particular type of "transfer" RNA (tRNA).

Alanine tRNA from yeast contains:

79 bases
99 "
67 "
77 "

Select the correct answer.

20. Which of the following statements does Crick regard as a major unsolved problem?

a) How many types of tRNA are there?

b) To extend the code to many other species?

c) Is the code the result of a series of evolutionary accidents?

d) The exact machinery of protein synthesis.

21. Probably the most direct way to confirm the genetic code is to synthesize a messenger RNA molecule with a strictly defined base sequence and find the amino acid sequence of the polypeptide produced under its influence. The most extensive work of this nature has been done by:–

a) Nirenberg and Leder. b) Holley. c) Khorana. d) Crick.

<u>Select</u> the correct name.

22. Which of the following molecules represent the genetic material of the living cell?

a) Transfer ribo-nucleic acid.

b) Deoxy ribo-neucleic acid.

c.) Messenger ribo-nucleic acid.

d) Amino acids.

Select the correct answer.

APPENDIX A. UNIT 2.

Experiment 4 (Unit 5).

2.6.3. The 6 types of tasks used in the test booklets in Experiment Four.

TASK 1.

Insert the missing key word(s) with the exact original word(s).

TASK 2.

Select the original missing key word(s) from the list, and insert in the sentence.

TASK 3.

Insert another word (or group of words), to equate with the meaning of the original missing key word(s).

TASK 4.

Select the word (or group of words) to equate with the meaning of the original missing key word(s), from the list and insert in the sentence.

TASK 5.

Generalise each sentence; i.e. use the set of particulars in the sentence, to abstract a more general statement, which may extend beyond the given data.

TASK 6.

Apply the concept of parsing, reviewed in the sentence Analysis Programme, to each sentence.

APPENDIX B. UNIT 3.

Experiment 1.

3.3.1. - Experimental Group, Item Score, Theme Score, Control Group, Item Score, Theme Score.

- The Mean item scores, standard deviation and t tests for Experimental and Control Groups.

- The distribution of subjects into high, medium and low item scorers.

3.3.2. - The Input Time (I.T.) Summary Time (S.T.) and Summary Length (S.L.) for the Abstractors (C) in the Experimental Group.

- The Input time (I.T.) Summary Time (S.T.) and Summary Length (S.L.) for the Mass Producers (A) in the Experimental Group.

- The Input Time (I.T.) Summary Time (S.T.) and Summary Length (S.L.) for the Selectors (B) in the Experimental Group.

- The Input Time (I.T.) Summary Time (S.T.) and Summary Length (S.L.) for the Abstractors (C), Mass Producers (A) and Selectors (B), in the Control Group.

- The Mean I.T., S.T., and S.L. of the Mass Producers (A) in the Experimental and Control Groups.

- The Mean I.T., S.T., and S.L. of the Abstractors (C) in the Experimental and Control Groups.

- The Mean I.T., S.T., and S.L. of the Selectors (B) in the Experimental and Control Groups.

Experiment 1 (Cont'd)

3.3.2. - A Comparison of the I.T., S.T., and S.L. in Experimental and Control Groups.

- An Analysis of I.T., S.T., and S.L. in Experimental and Control Groups for each of the 3 Texts.

3.3.4. - Original Scores of subjects in Experimental and Control Groups.

- Total Item Score percent, Measure of Performance (P) and Measure of Selection (S) for subjects in the Experimental Group in Text 1.

- Total Item Score percent, Measure of Performance (P) and Measure of Selection (S) for subjects in the Experimental Group in Text 3.

- Total Item Score percent, Measure of Performance (P) and Measure of Selection (S) for subjects in the Control Group in Text 3.

- Distribution of subjects in the Experimental Group, according to Total Item Score, Measure of Performance, Measure of Selection in Text 1.

- Distribution of subjects in the Experimental Group, according to Total Item score, Measure of Performance, Measure of Selection, in Text 3.

- Distribution of subjects in the Control Group, according to Total Item score, Measure of Performance, Measure of Selection in Text 3.

- The Mean Difference, Standard Deviation and related t tests for the Total Item score, Measure of Performance, and Measure of Selection from Text 1 to Text 3 in the Experimental Population.

APPENDIX n. 3.3.1. EXPERIMENT 1.

CHART 1A

EXPERIMENTAL GROUP

SUBJECT	ITEM SCORE			THEME SCORE		
	TEXT 1 (42)	TEXT 2 (47)	TEXT 3 (85)	TEXT 1 (3)	TEXT 2 (3)	TEXT 3 (4)
1	34	40	73	3	3	4
2	30	37	66	2	3	4
3	36	39	48	3	3	4
4	33	26	40	2	3	4
5	36	41	49	3	3	4
6	33	39	78	2	3	4
7	29	40	76	2	3	4
8	9	10	19	0	0	0
9	11	12	20	2	3	4
10	10	12	17	2	3	3
11	6	9	12	3	3	3
12	18	25	35	1	1	1
13	16	17	32	0	1	0
14	12	18	36	0	2	2
15	13	21	20	0	1	1
16	16	26	33	0	1	1
17	22	25	41	3	2	3
18	21	24	39	2	3	3
19	18	20	36	1	2	3
20	17	20	36	1	2	4

APPENDIX B. 3.3.1.

CHART 1b

Experiment 1.

SUBJECT CONTROL GROUP

	ITEM SCORE (85)	THEME SCORE (4)
21	64	3
22	70	3
23	68	3
24	72	3
25	66	3
26	17	0
27	13	0
28	21	3
29	33	1
30	31	1
31	32	1
32	32	1
33	26	0
34	30	1
35	28	2
36	29	2
37	39	2
38	45	2
39	47	2
40	49	3

APPENDIX B. 3.3.1.

Chart 1C

The Mean Item Scores, standard deviation and t tests

for the experimental and control groups.

GROUP	SUB-GROUP	Mean Score Text 1	Mean Score Text 3	Standard Deviation Text 1	Standard Deviation Text 3	t value	Probability Level
Experimental	A	78.71	86.75	6.65	7.30	1.884	0.10
	B	40.44	44.33	7.66	6.99	1.151	0.25
	C	21.25	20.0	5.25	4.32	.345	0.25
Control	A		79.8		3.96	1.855	0.10
	B		41.16		9.27	.009	0.25
	C		20.0		5.0		

Chart 1D

Distribution of subjects into high, medium and low

item scores in Text 1 in the Experimental Group.

		NUMBER OF THEMES			
		0	1	2	3
HIGH SCORE	A	0	0	4	3
MEDIUM SCORE	B	4	3	1	1
LOW SCORE	C	1	0	2	1

(CHi square = 15.805 p = .02)

APPENDIX B. 3.3.1

Distribution of subjects into high, medium and low item scores in Text 2 in the Experimental Group

		NUMBER OF THEMES			
		0	1	2	3
HIGH SCORE	A	0	0	0	6
MEDIUM SCORE	B	0	4	4	2
LOW SCORE	C	1	0	0	3

(CHi square = 16.72 p = .01)

Distribution of subjects into high, medium and low item scores in Text 3 in the Experimental Group

		NUMBER OF THEMES				
		0	1	2	3	4
HIGH SCORE	A	0	0	0	0	4
MEDIUM SCORE	B	1	3	1	3	4
LOW SCORE	C	1	0	0	2	1

(CHi square = 9.3 p = .30)

APPENDIX B, 3.3.1

Distribution of subjects into high, medium and low item scores in Text 3 in the Control Group.

	NUMBER OF THEMES				
	0	1	2	3	4
HIGH SCORE A	0	0	0	5	0
MEDIUM SCORE B	1	5	5	1	0
LOW SCORE C	2	0	0	1	0

(CHi square = 22.385 p = .01)

APPENDIX B, 3.3.2.

Experiment 1.

CHART 2A

SUBJECT NUMBER	TEXT	EXPERIMENTAL GROUP INPUT TIME (IT) per 15 lines of text	ABSTRACTORS (C) SUMMARY TIME (ST) per 15 lines of text	INDIVIDUAL IT, ST, AND SL SUMMARY LENGTH (SL) per 15 lines of text
	1	.92	.8	3.92
8	2	.95	.8	3.62
	3	.88	.8	3.33
	1	2.56	.6	9.68
9	2	2.47	1.4	12.8
	3	2.21	.9	8.42
	1	1.8	.84	8.96
10	2	2.38	.66	7.24
	3	2.15	.545	4.57
	1	3.16	.82	3.84
11	2	3.14	1.52	11.33
	3	2.3	.636	7.63

APPENDIX B, 3.3.2.

Experiment 1.

CHART 2b

SUBJECT NUMBER	TEXT	EXPERIMENTAL GROUP: INPUT TIME (IT) per 15 lines of text	MASS PRODUCERS (A): SUMMARY TIME (ST) per 15 lines of text	INDIVIDUAL IT, ST, and SL: SUMMARY LENGTH (SL) per 15 lines of text
1	1	3.64	2.5	32
	2	4.95	2.2	28
	3	3.51	2.5	32
2	1	6.0	1.2	24
	2	5.0	2.6	39
	3	4.6	1.2	23
7	1	4.9	1.8	19
	2	4.4	1.7	28
	3	3.7	1.56	28
3	1	6.04	1.0	19
	2	4.14	1.1	20
	3	3.27 *	.9 *	13 *
4	1	3.5	1.2	22
	2	1.6 *	.86 *	14 *
	3	1.4 *	.45 *	11 *
5	1	6.8	1.6	31
	2	5.05	1.2	27
	3	4.63 *	1.2 *	17 *
6	1	3.04	1.28	22
	2	3.61	1.9	35
	3	3.60	1.6	32

* - moved out of group to Selectors.

APPENDIX B, 3.3.2.

Experiment 1.

CHART 2c

SUBJECT NUMBER	TEXT	EXPERIMENTAL GROUP INPUT TIME (IT) per 15 lines of text	SELECTORS (B) SUMMARY TIME (ST) per 15 lines of text	INDIVIDUAL IT, ST and SL SUMMARY LENGTH (SL) per 15 lines of text
20	1	2.8	1.4	10.24
	2	4.43	1.3	13.43
	3	4.12	.909	17.0
12	1	4.60	.4	17.2
	2	4.23	.95	19.04
	3	4.36	.909	15.15
13	1	1.4	.81	11.4
	2	1.33	.80	11.2
	3	1.42	.9	11.9
14	1	2.24	1.48	13.2
	2	4.00	1.517	15.23
	3	3.90	.909	17.15
19	1	3.2	1.6	9.6
	2	2.52	2.14	17.52
	3	3.03	2.27	17.45
15	1	1.24	1.2	14.08
	2	2.43	1.85	22.71
	3	1.24	,70	11.21
16	1	2.6	1.12	9.68
	2	3.71	1.04	20.95
	3	3.0	2.1	20.33
17	1	1.76	1.0	9.68
	2	1.14	1.0	12.8
	3	1.06	1.03	8.73
18	1	3.56	1.6	13.76
	2	4.85	1.517	21.43
	3	2.39	1.03	16.36

APPENDIX B, 3.3.2.

Experiment 1.

CHART 2d

CONTROL GROUP INDIVIDUAL IT, ST, and SL

SUBJECT (TEXT 3)	INPUT TIME (IT) per 15 lines of text	SUMMARY TIME (ST) per 15 lines of text	SUMMARY LENGTH (SL) per 15 lines of text
MASS (A)			
21	5.636	1.51	24.45
22	3.45	2.27	23.15
23	7.69	2.87	28.38
24	3.757	2.575	24.54
25	3.606	2.21	26.66
ABSTRACTORS (C)			
26	3.00	.303	2.42
27	3.57	1.21	10.18
28	4.60	.515	5.45
SELECTORS (B)			
40	1.66	.969	16.81
16	3.36	1.42	14.21
39	2.42	1.363	16.12
38	3.151	1.666	20.36
34	5.90	1.87	18.66
37	1.84	.878	13.63
35	1.484	1.212	10.90
29	3.53	.606	18.33
30	3.93	.515	9.54
32	4.09	.757	11.51
33	1.30	.606	10.90
31	5.00	.909	8.909

APPENDIX B, 3.3.2.

Experiment 1.

CHART 2e

Experimental Group - Mass Producers(A) Mean and Standard Deviation

		INPUT TIME	SUBJECTS	SUMMARY TIME	SUMMARY LENGTH
TEXT 1	Mean	4.845	(7)	1.511	21.00
	Dev.	1.477		.512	9.933
TEXT 2	Mean	4.525	(6)	1.783	29.50
	Dev.	.5296		.527	6.07
TEXT 3	Mean	3.652	(4)	1.70	28.75
	Dev.	.436		.484	3.699
	CONTROL GROUP - MASS PRODUCERS (A)				
TEXT 3	Mean	5.133	(5)	2.287	30.83
	Dev.	1.636		.454	6.201

APPENDIX B, 3.3.2.

Experiment 1.

CHART 2f

Experimental Group - Abstractors(c)Mean and Standard Deviation

		INPUT TIME	SUBJECTS	SUMMARY TIME	SUMMARY LENGTH
TEXT 1	Mean	2.11	(4)	.76	6.575
	Dev.	.839		.09	2.714
TEXT 2	Mean	2.235	(4)	1.095	8.747
	Dev.	0.797		.370	3.593
TEXT 3	Mean	1.885	(4)	.720	5.987
	Dev.	.582		.138	2.102
CONTROL GROUP - ABSTRACTORS (C)					
TEXT 3	Mean	3.723	(3)	.676	5.99
	Dev.	.662		.387	3.15

APPENDIX B, 3.3.2.

Experiment 1.

CHART 2g

Experimental Group - Selectors (B) Mean and Standard Deviation

		INPUT TIME	SUBJECTS	SUMMARY TIME	SUMMARY LENGTH
TEXT 1	Mean	2.60	(9)	1.19	12.093
	Dev.	1.02		.366	2.490
TEXT 2	Mean	3.024	(10)	1.30	16.82
	Dev.	2.981		.429	3.85
TEXT 3	Mean	2.532	(12)	1.168	13.844
	Dev.	1.186		.514	3.031
CONTROL GROUP - SELECTORS (B)					
TEXT 3	Mean	3.282	(12)	1.0226	13.924
	Dev.	2.191		.430	3.780

APPENDIX B, 3.3.2. Chart 2h

GROUP	INPUT TIME mins. per 15 lines Text						SUMMARY TIME mins. per 15 lines Text						SUMMARY LENGTH words per 15 lines text					
	Exptl./Control						Exptl./Control						Exptl./Control					
	Mean	S.D.	Mean	S.D.	t	p	Mean	S.D.	Mean	S.D.	t	p	Mean	S.D.	Mean	S.D.	t	p
TOTAL Exptl. TEXT 1 Control TEXT 3	↑ 3.36	↑ 1.78	3.47 ↓	1.63 ↓	.198	<0.25	↑ 1.23	↑ .52	1.17 ↓	.52 ↓	.355	<0.25	↑ 14.72	↑ 7.54	16.17 ↓	8.54 ↓	.554	0.25
TOTAL Exptl. TEXT 3 Control TEXT 3	↑ 2.94	↑ 1.38	3.47 ↓	1.63 ↓	1.30	0.25	↑ 1.16	↑ .57	1.17 ↓	.52 ↓	.056	<0.25	↑ 16.12	↑ 7.90	16.17 ↓	8.54 ↓	.018	<0.25
SUB-GROUP A TEXT 3 Exptl. Control	↑ 3.85	↑ .436	5.133 ↓	1.63 ↓	1.479	0.10	↑ 1.70	↑ .484	2.287 ↓	.454 ↓	1.73	0.10	↑ 28.75	↑ 3.699	31.8 ↓	6.20 ↓	1.35	0.25
SUB-GROUP B TEXT 3 Exptl. Control	↑ 2.53	↑ 1.18	3.28 ↓	2.19 ↓	.998	<0.25	↑ 1.16	↑ .514	1.02 ↓	.430 ↓	.719	<0.25	↑ 13.84	↑ 3.03	13.92 ↓	3.78 ↓	.054	<0.25
SUB-GROUP C TEXT 3 Exptl. Control	↑ 1.88	↑ .582	3.72 ↓	.662 ↓	3.293	.02	↑ .720	↑ .138	.676 ↓	.387 ↓	.177	<0.25	↑ 5.987	↑ 2.10	5.99 ↓	3.15 ↓	.001	<0.25

A Comparison of Input Time, Summary Time and Summary Length in Experimental and Control Groups.

APPENDIX B 3.3.2. Chart 21.

GROUP		Low Scorers/Medium Scorers C / B						Low Scorers/High Scorers C / A						Medium Scorers/High Scorers B / A					
		Mean	Dev	Mean	Dev	t	p	Mean	Dev	Mean	Dev	t	p	Mean	Dev	Mean	Dev	t	p
TEXT 1 Exptl.	X	2.11	.839	2.60	1.02	..835	0.25	2.11	.839	4.85	1.47	3.54	.01	2.60	1.02	4.85	1.47	3.21	.01
	Y	.76	.09	1.19	.366	3.04	.01	.76	.09	1.51	.512	2.63	.02	1.19	.366	1.51	.512	1.36	.25
	Z	6.57	2.71	12.09	2.49	3.19	.01	6.57	2.71	21.00	9.93	2.57	.01	12.09	2.49	21.00	9.93	2.16	.05
TEXT 2 Exptl.	X	2.23	0.79	3.02	2.98	.713	0.25	2.23	0.79	4.52	.529	4.88	.001	3.02	2.98	4.52	.529	1.14	0.25
	Y	1.09	.370	1.30	.429	.827	0.25	1.09	.370	1.78	.527	2.02	0.25	1.30	.429	1.78	.527	1.77	.10
	Z	8.74	3.59	16.82	3.85	3.44	.01	8.71	3.59	29.50	6.07	6.06	.001	16.82	3.85	29.50	6.07	5.51	.001
TEXT 3 Exptl.	X	1.88	.582	2.532	1.186	1.35	0.10	1.88	.582	3.85	.436	4.68	.001	2.532	1.186	3.85	.426	3.03	.01
	Y	.720	.138	1.168	.514	2.56	0.01	.72	.138	1.70	.484	3.37	.01	1.268	.514	1.70	.484	1.70	.10
	Z	5.98	2.10	13.841	3.03	5.37	0.001	5.98	2.10	28.75	3.69	9.26	..001	13.841	3.03	28.75	3.69	6.81	.001
TEXT 3 CONTROL	X	3.72	.662	3.28	2.19	.320	0.25	3.72	.662	5.13	1.636	1.24	.25	3.28	2.19	5.13	1.636	1.59	0.25
	Y	.676	.387	1.02	.430	1.18	0.25	.676	.387	2.28	.454	4.41	.01	1.02	.430	2.28	.554	5.10	.001
	Z	5.99	3.15	13.93	3.78	3.12	.01	5.99	3.15	30.83	6.20	5.59	.001	13.93	3.78	30.83	6.20	6.44	.001

Analysis of Input Time, Summary Time and Summary Length in Experimental and Control Groups.

X = INPUT TIME   Y = SUMMARY TIME   Z = SUMMARY LENGTH

APPENDIX B. 3.3.4.

CHART 4a - Experiment 1.

RESULTS. ANALYSIS OF 1 THEME IN TERMS OF •••
Experimental Group

Theme 1 Text 1
Total items = 33 5••• 15•• 13•

Theme 3 Text 3
Total items = 44 8••• 11•• 25•

SUBJECT	Total items	No. of •••	No. of ••	Total items	No. of •••	No. of ••
1	22	4	8	35	7	9
2	22	4	8	32	6	8
3	27	5	10	25	7	9
4	23	4	8	23	8	9
5	26	5	9	26	8	8
6	22	5	7	36	8	10
7	21	5	6	37	7	11
8	9	2	4	11	3	5
9	10	5	6	8	7	1
10	8	5	4	7	7	0
11	7	5	2	10	8	2
12	16	2	5	21	3	5
13	14	1	5	17	1	5
14	12	1	5	18	2	4
15	15	1	4	19	2	3
16	12	2	4	16	3	4
17	18	3	8	23	6	9
18	18	3	7	20	5	8
19	14	2	6	19	4	8
20	15	2	6	20	5	7

••• - Very highly relevant items

•• - Highly relevant items

• - Least relevant items.

CHART 4a Original Scores of subjects in experimental and control groups as measured by number of total items and number of items in each category of relevance.

AND *

Control Group

Theme 3 Text 3

Total items	No. of***	No. of **	SUBJECT
28	5	7	21
32	7	6	22
30	6	7	23
32	8	7	24
31	7	8	25
12	3	6	26
10	3	5	27
12	7	4	28
16	3	6	29
14	2	5	30
18	4	6	31
16	2	6	32
13	2	6	33
14	2	7	34
13	3	5	35
14	3	6	36
24	5	7	37
25	6	6	38
26	6	6	39
26	7	5	40

APPENDIX B, 3.3.4.

CHART 1.b

Experiment 1.

RESULTS

EXPERIMENTAL GROUP

Theme 1 Text 1

Total items = 33 5••• 15••: 13•

Subject	Item %	Measure of Performance$_1$	Measure of Selectivity$_1$	Measure of Performance$_2$	Measure of Selectivity$_2$
1	70	80	18	67	52
2	67	80	18	67	52
3	81	100	19	83	56
4	70	80	17	67	52
5	78	100	19	78	54
6	67	100	23	67	55
7	64	100	24	61	52
8	27	40	22	33	66
9	30	80	40	56	100
10	24	80	50	44	100
11	21	100	71	39	100
12	48	40	13	39	44
13	42	20	7	33	43
14	36	20	8	33	50
15	45	20	6	28	33
16	36	40	17	33	50
17	54	60	17	61	61
18	54	60	17	61	61
19	42	40	14	44	57
20	45	40	13	44	53

$P_1 \quad S_1 = \cdots$

$P_2 \quad S_2 = \cdot\cdot + \cdots$

APPENDIX B, 3.3.4.

Experiment 1.

CHART 4a

RESULTS

EXPERIMENTAL GROUP

Theme 3 Text 3

Total = 44 items, 8*** 11** 25*

Subject	Item %	Measure of Performance$_1$	Measure of Selectivity$_1$	Measure of Performance$_2$	Measure of Selectivity$_2$
1	75	88	20	89	52
2	73	75	18	84	50
3	57	88	28	84	64
4	52	100	35	89	74
5	59	100	31	84	61
6	82	100	22	95	50
7	84	88	19	100	51
8	25	38	27	42	73
9	18	88	88	42	100
10	16	88	100	37	100
11	18	100	80	42	100
12	48	38	14	42	38
13	39	13	6	32	35
14	41	25	11	32	33
15	43	25	10	26	26
16	36	38	19	37	44
17	52	75	26	84	69
18	45	62	25	68	65
19	43	50	31	63	63
20	45	62	25	63	60

$P_1 \quad S_1 = \ldots$

$P_2 \quad P_2 = \ldots + \ldots$

APPENDIX B, 3.3.4.

CHART 4d

Experiment 1.

RESULTS

CONTROL GROUP

Theme 3 Text 3

44 items 8*** 11** 25*

Subject	Item %	Measure of Performance$_1$	Measure of Selectivity$_1$	Measure of Performance$_2$	Measure of Selectivity$_2$
21	64	63	18	63	43
22	73	88	22	68	41
23	68	75	20	68	43
24	73	100	25	79	47
25	70	88	23	79	48
26	27	38	25	47	75
27	23	38	30	42	80
28	27	88	58	58	90
29	36	38	19	47	56
30	31	25	14	37	50
31	41	50	22	53	55
32	36	25	13	42	50
33	29	25	15	42	62
34	32	25	14	47	64
35	29	38	23	42	62
36	32	38	21	47	64
37	54	63	21	42	50
38	57	75	24	63	48
39	59	75	22	63	44
40	59	88	27	63	46

$P_1 \; S_1 = \cdots$

$P_2 \; S_2 = \cdot\cdot + \cdots$

APPENDIX B. 3.3.4. Chart 4e

EXPERIMENTAL GROUP

Theme 1 Text 1

Total items = 33 5••• 15•• 13•

••• very highly relevant
•• highly relevant
• least relevant

SUBJECT	Total Item %	Measure of Performance	Measure of Selection	Measure of $Performance_2$	Measure of $Selection_2$
3	81	100	19	83	56
5	78	100	19	78	54
4	70	80	17	67	52
1 A	70	80	18	67	52
2	67	80	18	67	55
6	67	100	23	67	55
7	64	100	24	61	52
17	54	60	17	61	61
18	54	60	17	61	61
12	48	40	13	39	44
15	45	20	6	28	33
20 B	45	40	13	44	53
19	42	40	14	44	57
13	42	20	7	33	43
16	36	40	17	33	50
14	36	20	8	33	50
9	30	80	40	56	100
8 C	27	40	22	33	66
10	24	80	50	44	100
11	21	100	71	39	100
11	21	100	71	39	100
10 Ci	24	80	50	44	100
9	30	80	40	56	100
8 Cii	27	40	22	33	66

The score distribution for Total items, Measure of Performance and Measure of Selection in theme 1 of Text 1 in the Experimental Group.

APPENDIX B. 3.3.4. Chart 4f.

EXPERIMENTAL GROUP

Theme 3 Text 3

Total items = 44. 8••• 11•• 25•

••• very highly relevant
•• highly relevant
• least relevant

SUBJECT	Total item %	Measure of Performance$_1$	Measure of Selection$_1$	Measure of Performance$_2$	Measure of Selection$_2$
7	84	88	19	100	51
6 A	82	100	22	95	50
1	75	88	20	89	52
2	73	75	18	84	50
5	59	100	31	84	61
3	57	88	28	84	64
17	52	75	26	84	69
4	52	100	35	89	74
12	48	38	14	42	38
18 B	45	62	25	68	65
20	45	62	25	63	60
19	43	50	31	63	63
15	43	25	10	26	26
14	41	25	11	32	33
13	39	13	6	32	35
16	36	38	19	37	44
8	25	38	27	42	73
11	18	100	80	42	100
9 C	18	88	88	42	100
10	16	88	100	37	100

Chart 4f cont'd.

SUBJECT	Total item %	Measure of Performance$_1$	Measure of Selection$_1$	Measure of Performance$_2$	Measure of Selection$_2$
5	59	100	31	84	61
4	52	100	35	89	74
3	57	88	28	84	64
17 Bi	52	75	26	84	69
18	45	62	25	68	65
20	45	62	25	63	60
19	43	50	31	63	63
16	36	38	19	37	44
12	48	38	14	42	38
14 Bii	41	25	11	32	33
15	43	25	10	26	26
13	39	13	6	32	35
11	18	100	80	42	100
10 Ci	16	88	100	37	100
9	18	88	88	42	100
2 Cii	25	38	27	42	73

The score distribution for total items, Measure of Performance and Measure of Selection in Theme 3 of Text 3 in the Experimental Group.

A = Uniform group of Mass Producers
Bi = Uniform group of Selectors
Bii = Uniform group of Selectors
Ci = Uniform group of Abstractors
Cii = Uniform group of Abstractors

APPENDIX B. 3.3.4. Chart 4g.

CONTROL GROUP

Theme 3 Text 3

Total Items = 44 8••• 11•• 25•

••• very highly relevant
•• highly relevant
• least relevant

SUBJECT		Total Item %	Measure of Performance$_1$	Measure of Selection$_1$	Measure of Performance$_2$	Measure of Selection$_2$
24		73	100	25	79	47
22		73	88	22	68	41
25	A	70	83	23	79	48
23		68	75	20	68	43
21		64	63	18	63	43
39		59	75	22	63	44
40		59	88	27	63	46
38	Bi	57	75	24	63	48
37		54	63	21	42	50
31		42	50	22	53	55
29		36	38	19	47	56
33	Bii	36	25	13	42	56
34		32	25	14	47	64
36		32	38	21	47	64
30		31	25	14	37	50
35		29	38	23	42	62
33		29	25	15	42	62
28		27	88	58	58	90
26	C	27	38	25	47	75
26		23	38	30	42	80
	Ci	27	88	58	58	90
	Cii	27	38	25	47	75
		23	38	30	42	80

The score distribution for total items, Measure of Performance and Measure of Selection in Theme 3 of Text 3 in the Control Group.

APPENDIX B. 3.3.4.

Chart 4H.

The Mean Difference, Standard deviation and related t values of subjects in Text 1 and Text 3 in terms of Total item score percent, Measures of Performance and Measure of Selection

M of P = Percentage of total items selected from most relevant items in the text.

M of S = Percentage of most relevant items selected out of total items selected in summary.

Diff. in Total item score		Mean Diff.	St. Dev.	t & p value	Diff. in M. of Performance	Mean Diff.	St. Dev.	t & p value	Diff. in M. of Selection	Mean Diff.	St. Dev.	t & p value	Subject		
+20 +15 + 5 + 6	A i	+11.5	7.2	t = 2.76 p > .05 < .02	+39 +28 +22 +17	+26.5	9.46	t = 4.88 p = .002	-1 -5 0 -5	-2.75	2.6	t = 1.831 p 0.25 > .10	7 6 1 2	MASS	A
-19 -18 -24	A ii	-20.3	3.2	t = 8.97 p = .001	+ 6 +22 +1	+9.66	10.9	t = 1.25 p = 0.25	+7 +22 +8	+12.3	8.3	t = 2.095 p = 0.10	5 4 3		
-2 -9 0 +1	B i	-2.5	3.9	t = 1.11 p = 0.25	+23 + 7 +19 +19	+17	6.9	t = 4.267 p > .01 < .002	+8 +4 +7 +6	+6.25	1.7	t = 6.36 p = .001	7 18 20 19	SELECTORS	B
-2 +5 -3 0 0	B ii	0	2.75	-	-2 -1 +4 +3	+.6	2.4	t = 0.5 p = 0.25	-7 -17 -8 -6 -6	-8.8	4.65	t = 3.78 p < 0.1 > .002	15 14 13 16 12		
-3 -8 -12 -2	C i C ii	-7.66	4.5	t = 2.40 p > .10 < .05	+3 -7 =14 +9	+3.33	8.58	t = .548 p = 0.25	0 0 0 +7	0	0	-	1 10 9 8	ABSTRACTOR	C

APPENDIX B. UNIT 3.

Experiment 2.

3.8.1. - Objective Test Scores for individual subjects in Group 1; in Group 2; in Group 3.

3.8.2. - Individual distribution of Objective Test Scores for the Experimental Population in Experiment 2.

3.8.3. - Individual differences in Recall Simple and Recognition Scores and Recall Complex Scores in Pretested and Unpretested Question papers.

3.8.5. - Individual Input and Output Times for subjects in Group 1; in Group 2; in Group 3.

- The t and p values of the Mean Input and Output times of the sub-division of Group 1.

- The t and p values of the Mean Input and Output times of the sub-division of Groups 2 and 3.

APPENDIX B.3.8.1. Experiment 2.

CHART 1a

Objective test scores for individual subjects in GROUP 1.

EFFECTIVE — INEFFECTIVE

SUB-GROUP 1 — SUB-GROUP 2 — SUB-GROUP 3

GP.1			Total	Mean				Total	Mean			Total	Mean				Total	Mean	Total Score possible
RS A	4/4	4/4	8	4	3/4	4/4	4/4	11	3.7	3/4	3/4	6	3	2/4	1/4	2/4	5	1.6	4
B	4/4	4/4	8	4	4/4	4/4	4/4	12	4	2/4	3/4	5	2.5	2/4	2/4	1/4	5	1.6	4
Rec. A	4/4	4/4	8	4	4/4	3/4	3/4	10	3.3	3/4	2/4	5	2.5	2/4	2/4	3/4	7	2.3	4
B	4/4	3/4	7	3.5	3/4	3/4	4/4	10	3.3	3/4	3/4	6	3	3/4	2/4	2/4	7	2.3	4
RC A	7/8	8/8	15	7.5	8/8	6/8	7/8	21	7	2/8	3/8	5	2.5	0/8	1/8	1/8	2	.6	8
B	8/8	7/8	15	8	7/8	6/8	8/8	21	7	3/8	3/8	6	3	0/8	0/8	0/8	0	0	8

APPENDIX 3.8.1. Experiment 2.

CHART 1a. cont.

Objective test scores for individual subjects in GROUP 2.

	Effective SUB-GROUP 1								Effective in Pre-test SUB-GROUP 2								Ineffective SUB-GROUP 3								
GP.2	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Total	Mean	Pre	Post	Pre	Post	Pre	Post	Total	Mean	Pre	Post	Pre	Post	Pre	Post	Total	Mean	Total Score possible
RS A	1	4	2	4	1	4	2	4	16	4	1	3	0	4	1	3	10	3.3	1	4	0	3	1	3	10	3.3	4
B		4		3		4		4	15	3.7		3		4		4	11	3.7		3		3		3	9	3	
Rec A	1	4	8	4	1	4	0	4	16	4	1	3	1	4	0	4	11	3.7	0	3	0	4	0	4	11	3.6	4
B		3	0	3		4		4	14	3.5		3		3		3	9	3		4		3		3	10	3.3	
RC A	2	8	0	6	0	8	0	6	28	7	0	5	0	5	0	5	15	5	0	3	0	2	0	2	7	2.3	8
B		6		6		8		5	25	6.2		2		1		3	6	2		2		1		2	5	1.6	

APPENDIX B. 3.8.1. Experiment 2.

CHART 1a, cont.

Objective test scores for individual subjects in GROUP 3.

GP.3	Effective SUB-GROUP 1								Effective in Pre-test SUB-GROUP 2								Ineffective SUB-GROUP 3										Total Score possible
	Pre	Post	Pre	Post	Pre	Post	Total	Mean	Pre	Post	Pre	Post	Pre	Post	Total	Mean	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Total	Mean	
RS A		3		4		4	11	3.6		3		3		3	9	3		3		2		3		2	10	2.5	4
B	2	4	1	4	1	4	12	4	1	3	0	4	1	3	10	3.3	1	3	1	3	0	4	1	3	13	3.2	
Rec. A		4		4		3	11	3.6		4		3		3	10	3.3		3		3		4		3	13	3.2	4
B	0	4	1	4	0	4	12	4	0	4	0	3	1	3	10	3.3	0	3	1	4	0	3	0	3	13	3.2	
RC A		6		5		7	18	6.		3		1		2	6	2		2		2		1		2	7	1.7	8
B	2	6	1	7	1	6	19	6.3	0	5	1	5	0	5	15	5	0	3	1	2	0	2	0	2	9	2.2	

APPENDIX B. 3.8.2. Chart 2a.

The distribution of individual scores

in Groups 1, 2 and 3.

GRP. 2 & 3 Quest. (Not Protested) R.S.+ Recognition		GRP. 2 & 3 Quest. (Pretest). R.S.+ Recognition		GRP. 1 Quest. A & B (Not Pretest) R.S.+ Recognition	
SUBJECT	SCORE	SUBJECT	SCORE	SUBJECT	SCORE
22	8	21	8	1	8
13	8	22	8	1	8
14	8	23	8	2	8
17	7	11	8	5	8
16	7	12	8	2	7
11	7	13	8	5	7
29	7	14	8	3	7
24	7	16	8	3	7
23	7	24	7	4	7
21	7	25	7	4	7
18	7	28	7	9	6
25	6	29	7	10	6
26	6	17	7	9	5
27	6	18	7	10	5
12	6	19	7	8	5
15	6	20	7	6	5
19	6	26	6	6	4
20	6	27	6	7	4
28	5	30	6	7	3
30	5	15	6	8	3

APPENDIX B. 3.8.2. Chart 2a

The distribution of individual scores.

GP. 2 & 3 Quest. (Not Pretest) Recall Complex		GP. 2 & 3 Quest. (Pretest) Recall Complex		GP. 1. Quest. A & B (No Pretest) Recall Complex	
SUBJECT	SCORE	SUBJECT	SCORE	SUBJECT	SCORE
A 13	8	A 13	8	A 1	8
23	7	11	8	2	8
[illegible]	6	22	7	5	8
12	6	21	6	3	8
11.	6	23	6	1	7
14	5	12	6	2	7
22	5	14	6	3	7
B *17	3	15	5	5	7
*24	3	16	5	4	6
*15	2	17	5	4	6
-18	2	24	5	B 9	4
-20	2	25	5	10	3
*26	2	26	5	10	3
-27	2	B 18	3	9	2
-28	2	27	3	C 7	1
-30	2	20	2	8	1
C -29	1	28	2	6	0
*25	1	29	2	6	0
*16	1	30	2	7	0
-19	1	19	2	8	0

* = Effective in pretested Question paper

\- = Ineffective in pretested Question paper

A = Effective sub-group

B = Ineffective in sub-group

C = Very ineffective in sub-group.

APPENDIX B. 3.8.3. Chart 3a.

Individual differences in Recall Complex Scores in pretested and unpretested Question papers for Groups 2 and 3.

SUBJECT	Not P.T.	P.T.	Difference
13	8	8	0
23	7	6	-1
22	6	7	+1
21	6	6	0
12	6	6	0
11	6	8	+2
14	5	6	+1
17	3	5	+2
24	3	5	+2
15	2	5	+3
18	2	3	+1
20	2	2	0
26	2	5	+3
27	2	3	+1
28	2	2	0
30	2	2	0
29	1	2	+1
25	1	5	+4
16	1	5	+4
19	1	2	+1

11 - 20 A pretested

21 - 30 B pretested

Mean Difference = 1.25

APPENDIX B. 3.8.3. Chart 3a.

Individual differences in Recall Simple and Recognition scores in pretested and unpretested Question papers for Groups 2 and 3.

SUBJECT	Not P.T.	P.T.	Difference.
17	8	7	-1
23	8	8	0
13	8	8	0
14	8	8	0
16	7	8	+1
11	7	8	+1
29	7	7	0
24	7	7	0
23	7	8	+1
21	7	8	+1
18	7	7	0
25	6	7	+1
26	6	6	0
27	6	6	0
12	6	8	+2
28	5	7	+2
30	5	6	+1
15	6	6	0
19	6	7	+1
20	6	7	+1

11 - 20 A Pretested

21 - 30 B Pretested

Mean difference = .55

APPENDIX B.3.8.5

Experiment 2.

CHART 5a. Individual Input and Output times of subjects in GROUP 1, Experiment 2.

SUB-GROUP	SUBJECT	INPUT TIME			QUEST. A			QUEST. B.		
Sub-Group 1	1	8.4 (124	118		2.1 (21.5	23		.7 (20.5	21	
Effective	2		130			20			20	
	3		95	100)23.37		40	24)9.3		32	22)5.7
	4	9.8 (84	76		12.6 (25.6	16		7.9(23	17	
	5		81			21			17	
Sub-Group 2	9		61	67.5)9.19		13	16.5)4.9		18	17.5) .7
Ineffective	10		74			20			17	
		26.5 (40.4			6.4 (10			5.5(11.6		
Sub-Group 3	6		15			5			7	
Very Ineffective	7		25	21.67)5.78		7	5.67)1.15		10	7.67)2.08
	8		25			5			6	

APPENDIX B, 3.8.5. Experiment 2.

CHART 5a. Individual Input and Output times of subjects in Groups 2 and 3, Experiment 2.

GROUP 2 & 3

SUB-GROUP	SUBJECT	INPUT TIME			QUEST.<L.			QUEST. S.>L.					
	13	89			10			17			21		
	23	83			12			15			17		
Sub-Group 1	22	89			11			14			15		
Effective	21	78	79.4	7.67	14	12.5	1.8	21	16.1	2.9	25	18.2	4.2
	12	71			12			16			18		
	11	72			15			12			12		
	14	74			14			18			20		
	17	49			26			20			14		
Sub-Group 2	24	43			12			9			5		
Effective in pre-tested	15	64	52.8	8.4	18	20.3	5.4	11	14.5	4.1	8	9.6	3.38
questionnaire	26	57			18			14			10		
only	16	59			22			15			8		
	18	40			5			16			5		
Sub-Group 3	20	51			6			12			11		
Ineffective	27	57			5			9			11		
	28	36	47.7	10.76	4	5.7	1.1	12	13	2.3	14	12.0	3.7
	30	66			7			14			17		
	29	43			6			13			14		
	19	41			7			15			12		

APPENDIX B. 3.8.5. Chart 5b.

SUB-DIVISION	INPUT TIME	QU. A.	QU. B.
A Effective (a)	t = 4.3	t = .449	t = .475
A Effective (b)	p = .02	p = .25	p = .25
A Effective	t = 3.4	t = 2.48	t = 2.77
B Ineffective	p = .01	p = .05	p = .05
B Ineffective	t = 5.36	t = 2.38	t = 4.73
C Ineffective	p = .01	p = .10	p = .02
A Effective	t = 4.73	t = 3.78	t = 4.43
C Ineffective	p = 0.2	p = .01	p = .002

The t and p values of the mean input and output times of the sub-divisions for GROUP 1.

APPENDIX B. 3.8.5. Chart 5c.

The t and p values of the mean input and output times of the sub-divisions for GROUPS 2 and 3.

SUB-DIVISION	INPUT TIME	Qu. < L.	Qu. > LA.	Qu. > LB.	SUB-DIVISION	Qu. A>L Qu. B>L
AA Effective	t = 5.55	t = 3.3	t = .94	t = 3.9	AA	t = .959
BA, CA Effective in pretest	p = .001	p = .01	p = .25	p = .002		p .25
AA Effective	t = 6.04	t = 7.89	t = 2.98	t = 3.06	BA & CA	t = 2.081
BC, BB Ineffective	p = .001	p = .001	p = .01	p = .01		p = .05
BA, CA Effective in pretest	t = .865	t = 6.42	t = .487	t = 1.6	BB & BC	t = .562
BC, BB Ineffective	p = .25	p = .001	p = .25	p = .1		p = .25

APPENDIX B. UNIT 3.

Experiment 3.

3.13.	-	Objective Tests and Summary Scores for the subjects in GROUP A; in GROUP B; in GROUP C; in GROUP D;
3.13.	-	Input and Output Time in minutes for the individual subjects in Groups A and B; in Groups C and D.
3.13.1.	-	The Frequency Distribution of scores in the Recall Simple, Recall Complex and Recognition sections of the Objective Test A in the experimental population after learning.
3.13.1.	-	The Frequency Distribution of scores in the Recall Simple, Recall Complex and Recognition sections of the Objective Test B in the experimental population after learning.
3.13.1.	-	The Frequency Distribution of scores in the Recall Simple, Recall Complex and Recognition sections of the Objective Test in Groups A and B before learning (the Pretest).

Cont'd

3.13.2. - The Mean Input and Output times and the standard deviations in the experimental population.

3.13.2. - Comparisons of the Experimental groups within the identified effective and ineffective divisions.

3.13.2. - Comparisons of the effective and ineffective divisions within the Experimental Groups.

3.13.5. - Comparisons of the scores in the Pretested and Unpretested Question papers in the Experimental population.

APPENDIX B.3.13 Experiment 3.

CHART 1a.

Objective Tests and Summary Scores for the 15 subjects in GROUP A.

DIVISION	Pretest Qu.A<L			Post test immediate Qu.A>L			Post test, 1 week Qu.A>L			Post test immediate Qu.B>L			Post test, 1 week Qu.B>L			Summary no.of ... items
	RS	RC	Rec.	RS	RC	Rec.	RS	RC	Rec.	RS	RC	Rec.	RS	RC	Rec.	
EE	0	0	0	5	7	5	4	5	5	4	7	6	4	6	5	42
	1	1	1	6	6	7	6	6	7	7	6	5	6	5	5	41
	6	4	2	7	7	8	7	6	8	7	7	7	6	6	7	48
EI	3	2	1	6	7	6	5	4	6	6	5	5	5	2	4	15
	1	0	2	5	6	7	5	5	6	6	5	6	5	2	5	20
	2	0	2	4	4	6	3	1	4	5	4	4	4	1	4	11
	1	0	2	6	4	6	2	2	6	4	5	5	3	2	4	12
	4	1	2	6	5	5	6	2	5	5	4	7	4	2	6	7
	5	1	1	7	7	8	5	5	6	7	6	8	6	3	6	21
	0	0	0	4	6	4	2	4	2	6	4	5	4	1	4	6
	3	1	2	4	4	5	3	2	5	4	5	3	4	2	3	12
	1	1	2	6	5	6	6	2	5	7	6	5	5	3	4	11
II	3	1	1	4	3	4	4	1	4	4	1	3	2	0	3	12
	2	0	1	6	3	3	3	2	2	4	2	4	2	0	2	12
	1	0	2	4	2	3	4	2	3	4	1	5	2	0	3	9

APPENDIX B.3.13. Experiment 3.

CHART 1a.

Objective Tests and Summary Scores for 15 subjects in GROUP B.

DIVISION	Pretest			Post test immediate			Post test 1 week			Post test immediate			Post test 1 week			Summary no. of ... items
	Qu. B < L			Qu. B > L			Qu. B > L			Qu. A > L			Qu. A > L			
	RS	RC	Rec.	RS	RC	Rec.	RS	RC	Rec.	RS	RC	Rec.	RS	RC	Rec.	
EE	5	5	5	7	6	7	7	6	6	7	6	8	6	6	6	49
	1	1	1	6	6	6	6	6	5	6	5	7	6	5	7	31
	3	3	4	7	7	8	7	7	8	7	6	7	7	5	7	49
	1	0	1	7	7	8	7	7	7	7	7	8	7	6	8	34
EI	3	1	1	6	5	6	6	5	5	6	4	7	6	2	5	24
	1	0	2	6	4	6	4	3	5	4	4	4	3	1	3	9
	0	0	0	4	4	4	3	1	3	5	4	5	4	0	3	14
	0	0	0	5	5	5	3	2	4	6	6	4	4	2	4	7
	4	5	4	7	7	8	7	6	8	6	6	8	6	4	8	25
II	1	1	2	7	4	6	5	2	4	5	1	6	2	0	4	11
	1	1	2	4	0	4	2	0	3	3	2	4	2	1	1	11
	1	0	2	5	3	5	5	2	4	3	1	4	1	0	3	5
	2	0	3	7	1	5	6	0	3	4	2	3	1	1	2	15
	1	0	2	6	1	7	5	0	6	3	1	4	0	0	2	5
	1	0	1	6	2	5	5	0	5	4	2	4	2	0	2	14

APPENDIX B Experiment 3.

/3.13. CHART 1a.

Objective Tests and Summary Scores for the 15 subjects in GROUP C.

DIVISION	Post test immediate			Post test 1 week			Post test immediate			Post test 1 week			Summary number of ... items
	Qu. A>L			Qu. A>L			Qu. B>L			Qu. B>L			
	RS	RC	Rec.	RS	RC	Rec.	RS	RC	Rec.	RS	RC	Rec.	
EE	5	7	8	5	7	8	7	5	7	7	5	6	33
	7	6	8	7	6	8	7	7	7	6	6	7	50
	4	6	5	4	6	5	5	6	7	5	5	7	34
	6	4	6	6	4	6	6	4	6	6	3	5	34
	7	5	8	7	5	8	6	7	8	5	6	8	49
	5	7	8	5	7	8	7	5	7	7	5	6	37
	7	7	8	7	7	8	6	7	8	7	7	8	53
EI	4	6	4	4	3	4	6	6	5	4	1	3	19
	6	4	6	5	2	5	4	5	5	4	2	5	16
	5	4	3	3	2	2	4	4	6	3	1	4	19
	6	4	6	5	1	4	6	4	5	5	2	5	19
II	3	1	3	1	0	2	2	0	4	1	0	2	8
	3	1	3	2	0	2	3	1	3	1	0	3	4
	3	2	3	1	0	2	3	1	3	1	0	2	4
	4	3	4	3	1	2	6	4	5	3	1	2	10

APPENDIX B. Experiment 3.

3.13. CHART 31a. Objective Tests and Summary Scores for 15 subjects in GROUP D.

DIVISION	Post test immediate			Post test 1 week			Post test immediate			Post test 1 week			Summary number of ... items
	Qu. A > L			Qu. A > L			Qu. B > L			*Qu. B > L			
	RS	RC	Rec.	RS	RC	Rec.	RS	RC	Rec.	RS	RC	Rec.	
EE with guide	7	7	8	7	7	8	6	7	7	6	6	6	50
	6	6	7	6	6	6	7	6	8	7	5	7	30
	5	6	5	5	6	5	4	7	5	3	7	4	37
	6	6	8	6	6	6	7	5	6	6	5	6	40
	6	5	7	6	5	6	7	6	6	7	6	6	32
	6	4	6	6	4	6	5	4	5	4	4	4	30
	7	7	7	7	7	6	7	6	6	6	6	6	48
	7	7	5	7	7	5	5	7	6	5	6	6	46
	6	4	6	6	4	6	7	6	5	7	6	4	41
	6	6	8	5	6	8	7	6	7	6	6	5	43
	7	6	6	7	6	6	7	7	8	6	7	8	42
without guide	5	5	8	5	4	7	6	5	7	4	4	6	31
EI without guide	5	4	5	3	2	3	5	5	5	4	2	5	17
	4	4	5	4	3	4	4	4	5	4	2	5	18
II without guide	3	2	4	1	0	2	3	3	5	1	1	2	14

APPENDIX 3.3.13. Experiment 3.

CHART 1b.

Input and Output times in minutes for the individual subjects (30) in GROUPS A and B.

DIVISION		Machine time	Qu. < L.	1st Qu. > L.	2nd Qu. > L	Summary
EE	A	50	28	15	18	53
		102	10	20	20	74
		120	15	15	20	85
	B	35	24	9	15	50
		110	15	26	15	86
		90	25	12	20	78
		117	21	12	19	68
EI	A	108	22	25	33	24
		90	12	34	24	26
		102	16	11	12	24
		69	21	15	10	22
		68	16	12	16	19
		89	23	16	21	26
		62	15	8	8	34
		63	10	20	20	26
		87	9	26	32	14

	B	81	14	12	10	36
		103	15	23	33	21
		94	10	20	27	23
		70	16	15	10	11
		36	15	23	22	34
II	A	22	10	18	20	18
		38	10	19	20	18
		46	11	10	10	25
		43	8	10	14	16
	B	36	17	20	14	18
		55	18	20	15	10
		58	25	20	13	29
		45	30	20	12	17
		46	26	26	20	16

APPENDIX C.3.13. Experiment 3.

CHART 3b.

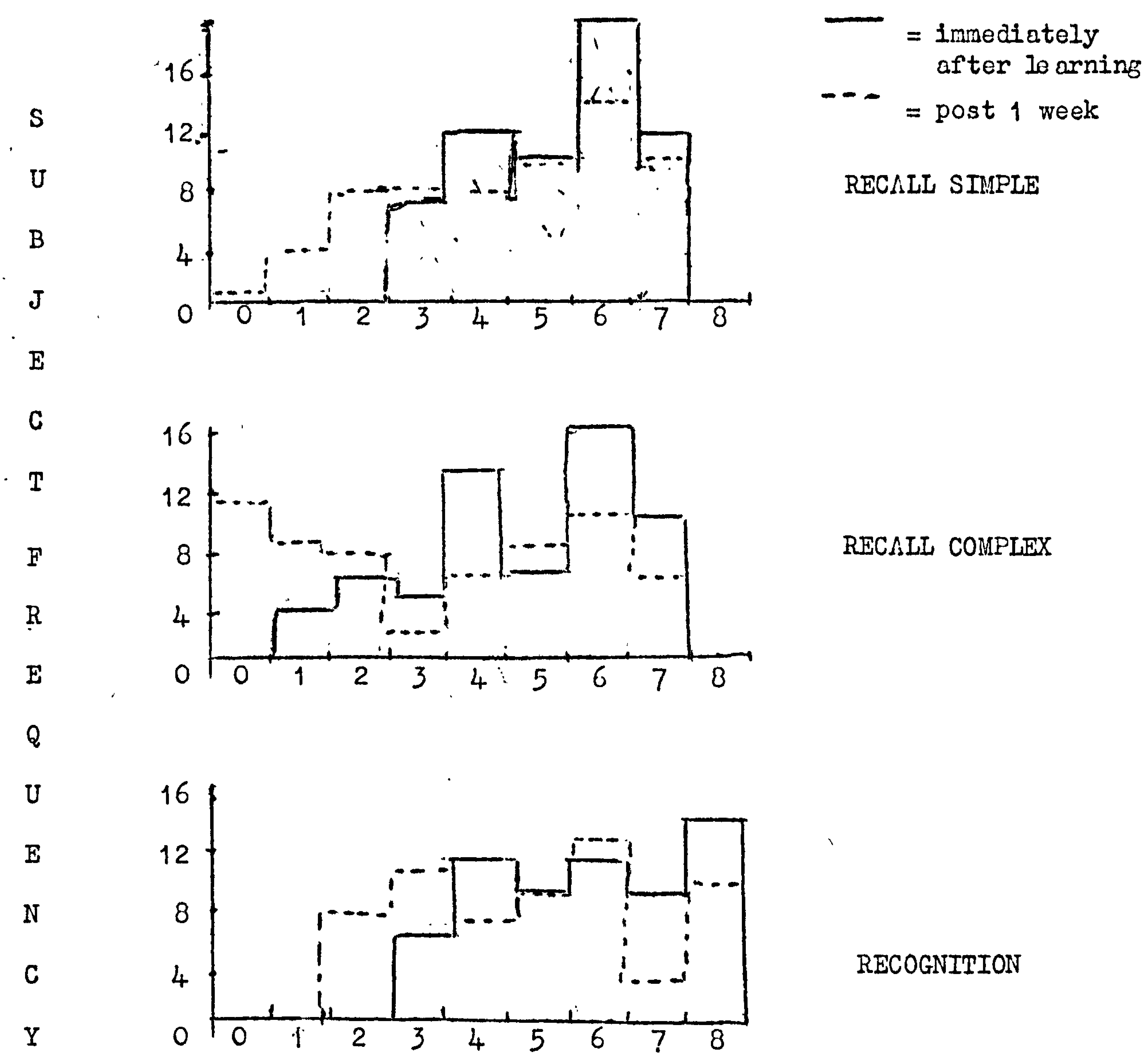
Input and Output times in minutes for the individual subjects (30) in GROUPS C and D.

DIVISION		Mean Time	Qu. A > L.	Qu. B > L.	Summary
EE		150	15	18	45
		120	15	20	60
	C	160	10	15	56
		125	15	12	46
		138	14	16	75
		150	21	19	45
		22	15	15	44
without guide	D	134	19	20	52
		152	16	14	38
		159	15	16	44
		133	11	12	48
with guide	D	187	18	16	32
		207	16	15	42
		174	25	25	44
		185	22	16	36
		180	15	13	43

		146	12	14	36
		161	18	14	31
		124	10	12	35
EI		60	12	13	50
	C	60	12	16	20
		55	14	12	49
		72	14	17	23
without guide	D	79	15	17	32
		67	16	18	29
II		47	10	10	33
		59	10	17	32
	C	45	15	10	45
		49	14	12	18
without guide	D	55	15	14	39

APPENDIX B. 3.13.1.

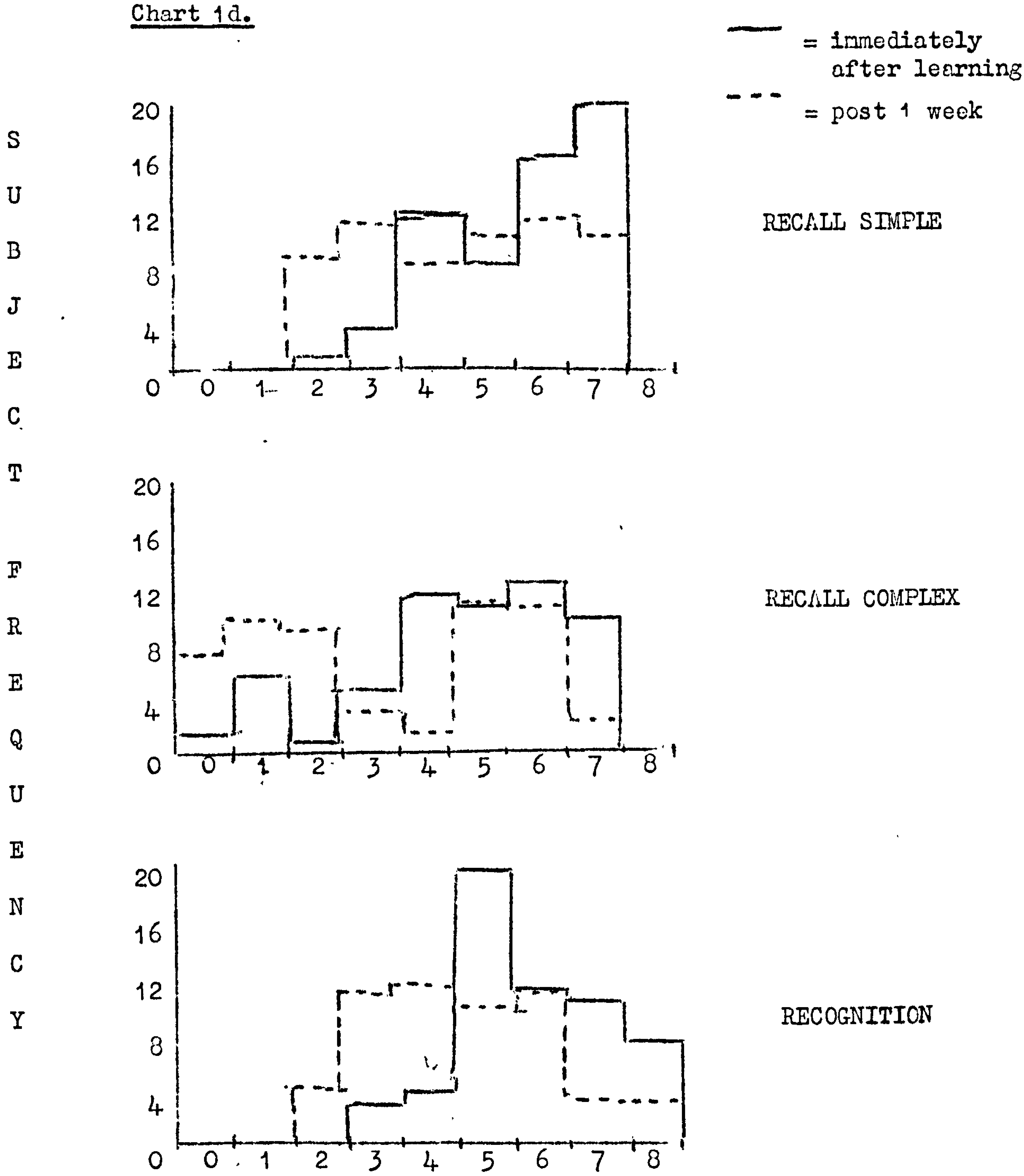
Chart 1c.



The frequency distribution of scores on the Recall Simple, Recall Complex and Recognition sections of the Objective Text A in the experimental population after learning.

APPENDIX B. 3.13.1.

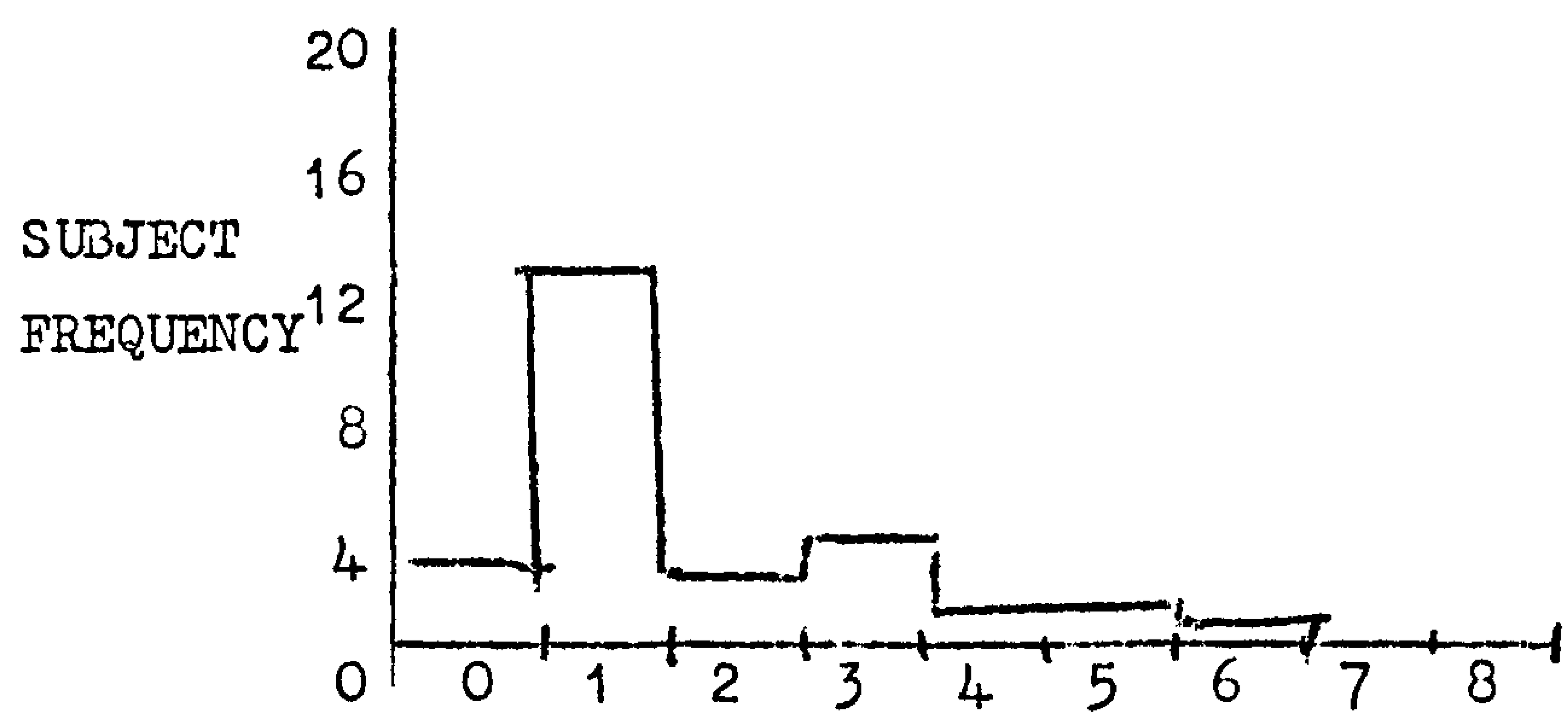
Chart 1d.



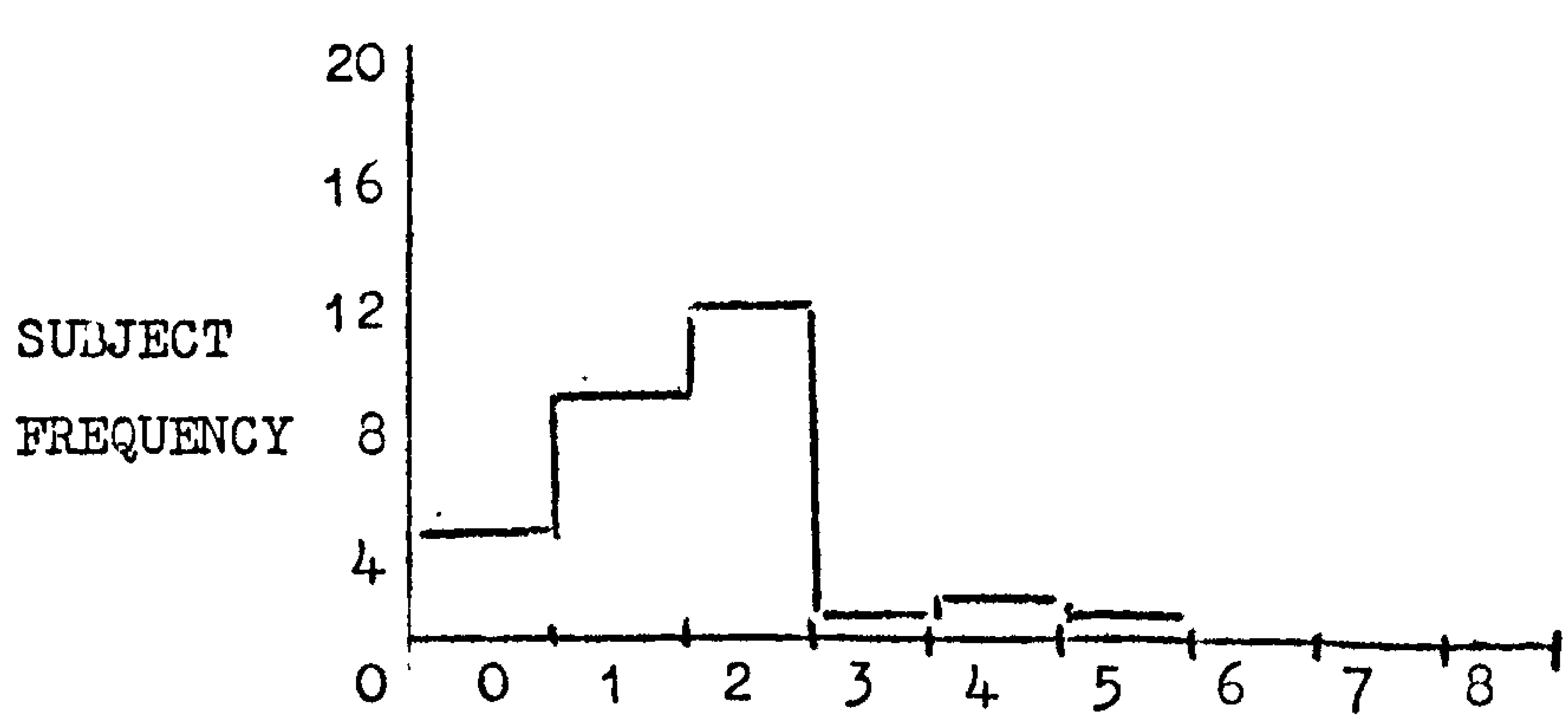
The frequency distribution of scores on the Recall Simple, Recall Complex and Recognition sections of Objective Test B in the experimental population after learning.

APPENDIX B. 3.13.1.

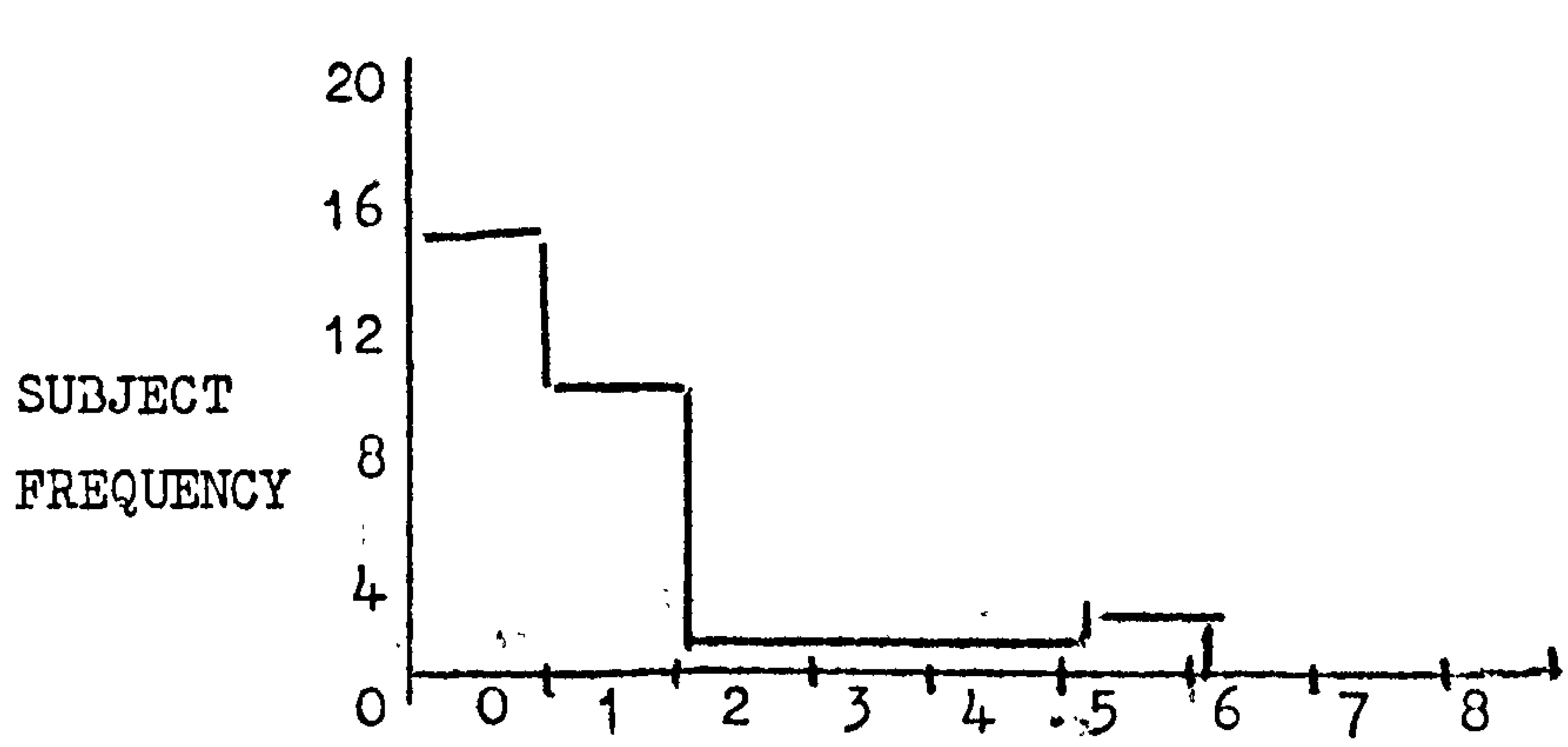
Chart 1e.



The frequency distribution of scores on the Recall Simple Objective Test in Groups A and B before learning.



The frequency distribution of scores on the Recognition or Multiple Choice Objective Test in Groups A and B before learning.



The frequency distribution of scores on the Recall Complex Objective Test in Groups A and B before learning (the Pretest).

APPENDIX B. 3.13.2.

T I M E.

Chart 2a.

DIVISION	INPUT Mean (mins.)	INPUT Standard Dev.	SUMMARY Mean (mins.)	SUMMARY Standard Dev.	THE PRETEST Mean (mins)	THE PRETEST Standard Dev.	THE PRETESTED QUESTION PAPER AFTER LEARNING Mean (mins.)	THE PRETESTED QUESTION PAPER AFTER LEARNING Standard Dev.	THE UNPRETESTED QUESTION PAPER AFTER LEARNING. Mean (mins)	THE UNPRETESTED QUESTION PAPER AFTER LEARNING. Standard Dev.
E.E. A/B	108	10.85	78.2	6.76	17.2	5.2	17	.36	16.5	1.93
C/D	156	23.86	44.5	10.68	-	-	15.7	3.81	15.7	3.24
C	141	14.3	55	10.84	-	-	15	3.2	16.6	2.68
D	164	23.81	39	5.2	-	-	16	4.3	15.1	3.4
E.I. A/B	85	15.29	23	6.5	15.3	4.19	18.2	7.0	19.6	9.0
A	82	16.1	23.9	5.17	16.00	4.85	18.5	7.94	19.6	8.51
B	87	12.5	22.8	8.89	14.00	2.096	17.5	4.27	20	10.22
C/D	66	8.13	34	11.73	-	-	14.5	2.13	15.5	2.21
C	62	6.25	36	14.0	-	-	13.0	1.0	14.5	2.06
D	73	6.0	30.5	1.5	-	-	15.5	0.5	17.5	0.5
I.I. A/B	44	12.9	20	7.28	16.7	7.73	18.1	5.7	16.3	3.8
a	40	3.96	19.3	3.41	9.8	1.08	14.2	4.2	16.0	4.2
b	48	7.82	18	6.16	23.2	6.14	21.2	2.4	15.2	3.5
C/D	50	5.3	32	9.56	-	-	12.3	2.27	12.3	2.8

The Mean Input and Output times and the standard deviations in the experimental population.

APPENDIX B. 3.13.2.

Chart 2b.

The t values and probability levels of significance in a two-tailed test of comparisons of the experimental groups within the identified effective and ineffective divisions.

DIVISION	Experimental	GROUP	INPUT	SUMMARY	Qu. > L.	Qu. > L.
E.E.	AB (7)	CD (49)	AB – CD t = 4.261 p = .001	AB – CD t = 6.974 p = .001	AB – CD t = .472 p = .25	AB – CD t = 1.498 p = .25
	AB 97)	C (7)	AB – C t = 4.11 p = .002	AB – C t = 2.975 p = .01	AB – C t = .417 p = .25	AB – C t = .723 p = > .25
	C (7)	D (12)	C – D t = 2.21 p = .02	C – D t = 3.856 p = .001	AB – D t = .468 p = .25	C – b t = .877 p = > .25
E.I.	AB (14)	CD (6)	AB – CD t = 2.70 p = .02	AB – CD t = 2.033 p = .05	AB – CD t = 1.556 p = .25	AB – CD t = 1.24 p = > .25
	AB (14)	C (4)	AB – C t = 3.423 p = .01	AB – CD t = 2.41 p = .02	AB – CD t = 2.436 p = .02	AB – CD t = 1.774 p = .10
	A (9)	B (5)	A – B t = .507 p = >.25	A – B t = .257 p = >.25	A – B t = .270 p = >.25	A – B t = .786 p = >.25
	C (4)	D (2)	C – D t = 1.68 p = >.25	C – D t = .411 p = .25	C – D t = 2.88 p = >.25	C – D t = 1.104 p = >.25
I.I.	AB (9)	CD (5)	AB – CD t = .825 p = >.25	AB – CD t = 2.28 p = .05	AB – CD t = 1.71 p = .10	AB – CD t = 1.765 p = .10
	ABa (4)	ABb (5)	ABa – ABb t = 1.536 p = .10	ABa – ABb t = .307 p = >.25	ABa – ABb t = 2.61 p = .02	ABa – ABb t = .274 p = >.25

APPENDIX B. 3.13.2.

Chart 2c.

The t values and probability levels of significance in a two-tailed test of comparisons of the effective and ineffective divisions of the experimental group.

Experimental Group	DIVISION	INPUT	DIVISION	SUMMARY	POST TEST Qu. >L.	POST TEST Qu.>L.	PRETEST Qu. <L.
AB	E.E.(7)	t = 3.15, p = .01	E.I.(14)	AB t = 16.07, p = .001 AB	AB t = 0.293, p = <.25 AB	AB t = .203, p = <.25 AB	(7) EE AB t = .718, p = .25 (14) E.I.AB
AB	E.E.(7)	t = 9.98, p = >.001	I.I. (9)	AB t = 18.45, p = >.001 AB	AB t = .350, p = <.25 AB	AB t = 1.43, p = .25 AB	EE AB t = .278, p = >.25 I.I.AB
AB	E.I.(14)	t = 6.36, p = .001	I.I.(9)	AB t = .965, p = <.25 AB	AB t = .035, p = <.25 AB	AB t = 1.215, p = <.25 AB	(14) EI AB t = .484, p = .25 I.I.AB
C	E.E.(7)	t = 9.30, p = .001	E.I.(4)	C t = 2.052, p = .05 C	C t = 1.27, p = .25 C	C t = 1.287, p = .25 C	I.I. ABa(4) t = 3.546, p = .01 I.I. ABb (5)
C	E.E.(7)	t = 12.69, p = .001	I.I.(4)	C t = 3.158, p = .01 C	C t = 2.584, p = .05 C	C t = 1.836, p = .10 C	
C	E.I.(4)	t = 2.53, p = .05	I.I.(4)	C t = .408, p = <.25 C	C t = .523, p = <.25 C	C t = .859, p = <.25 C	

APPENDIX B. 3.13.5.

Chart 5a.

DIVISION	GROUP	Qu. Pretested QU. > L.	Qu. Unpretested Qu.>L.
E.E.	A/B (7)	t = .578 p = >.25 - immediate t = 1.52 p = .25 - post 1 week	
	C/D (19)	t = .293 p = .25 t = .61 p = .25	
	AB/CD	t = 1.71 p = 10 t = .929 p = >.25	t = .867 p = >.25 t = .32 p = >.25
E.I.	A/B (14)	t = .064 p = >.25 t = 2.43 p = .02	
	C/D (6)	t = 0 t = .378 p = .25	
	AB/CD	t = .248 p = >.25 t = 2.35 p = .02	t = .131 p = >.25 t = .640 p = >.25
I.I.	A/Ba (4)	t = .656 p = >.25 t = 1.21 p = .25	
	b (5)	t = 4.82 p = .002 t = 9.0 p = >.001	
	C/D (5)	t = .236 p = .25 t = 0	
	ABa/C	t = .360 p = >.25 t = 1.17 p = >.25	t = .226 p = >.25 t = .844 p = > .25
	ABb/C	t = 2.37 p = .05 t = 5.23 p = .001	t = .385 p = >.25 t = 1.17 p = >.25

The t and probability values for comparisons of the scores in the Pretested and Unpretested Question papers in the experimental population.

APPENDIX C. UNIT 5.

Experiment 4.

5.3. - Individual scores for the sentences in the six groups for the six types of Tasks.

- Individual combined input/output time for the sentences in the six groups in the six types of Tasks.

5.3.1. - The mean time (minutes), standard deviation, t and p values for the six groups according to the Task order.

- The mean score, standard deviation, t and p values for the six groups according to the Task order.

- Friedman two way analysis of variance by ranks.

- The summary of the analysis of variance F tests,

  a) Score/order of task

  b) Time/order of task.

5.3.2. - The individual distribution of scores for Category C, B and A sentences for the combined Tasks in the experimental population.

5.3.3. - The a/b, c and d mean score % in the six groups for the combined A, B and C Categories of sentences on all Tasks.

- The a/b, c and d mean score %, standard deviation %, t and p values in the six groups for the combined categories of sentences in Tasks 1-6 inclusive.

- The a/b, c and d mean score %, standard deviation %, t and p values in the six groups for Category A sentences in Tasks 1-6 inclusive.

5.3.3. (Cont'd) - The a/b, c and d mean score % , standard deviation %, t and p values in the six groups for Category C sentences in Tasks 1-6 inclusive.

5.3.4. - The summary of the analysis of variance

a) Score/Type of Task in the combined A,B and C Categories of sentence.

b) Score/Type of Task in the C Category only.

5.3.5. - The mean time (in minutes), standard deviation, t and p values in the six groups, according to the Type of Task for Category A sentences.

- The mean time (in minutes), standard deviation, t and p values in the six groups, according to the Type of Task with d (semantic distortion) sentences excluded, for the Category A sentences.

- The mean time (in minutes), standard deviation, t and p values in the six groups, according to the Type of Task with d (semantic distortion) sentences excluded, for the Category B sentences.

- The mean time (in minutes), standard deviation, t and p values in the six groups, according to the Type of Task with d (semantic distortion) sentences excluded, for the Category B sentences.

- The mean time (in minutes), standard deviation, t and p values in the six groups, according to the Type of Task with d (semantic distortion) sentences excluded, for the Category C sentences.

.5.3.5. (cont'd)

- The mean time (in minutes), standard deviation, t and p values in the six groups, according to the Type of Task with d (semantic distortion) sentences excluded, for the Category C sentences.

- The Summary of the analysis of variance – F test for Time and Type of Task.

APPENDIX C: 5:3: Individual scores for A, B and C sentences,

UNIT 5. in the six Groups, for the six Types of Tasks:

Chart 3a.

GROUP	SUBJECT	Sentence A B C	8 8 1 18	TASK 8 8 2 18	SCORE 8 8 3 18	8 8 4 18	6 6 5 8	8 8 6 12
		A	7	6	8	8	6	8
	1	B	7	8	8	8	6	8
		C	12	17	13	14	8	12
		A	8	8	8	8	6	8
	2	B	4	7	6	8	4	8
		C	2	8	11	5	0	9
1		A	8	8	7	8	6	8
	3	B	8	7	6	7	6	6
		C	8	14	9	11	8	10
		A	8	7	1	7	6	-
	4	B	7	7	4	4	4	-
		C	3	9	0	2	0	-
		A	8	8	5	8	0	7
	5	B	6	7	5	5	0	8
		C	10	17	5	9	0	12
		A	5	8	4	6	6	8
	6	B	8	7	6	6	2	8
		C	10	18	4	6	0	12
		A	6	8	6	6	4	8
	7	B	6	8	3	6	2	7
		C	10	16	3	6	0	12
2		A	8	8	6	8	0	8
	8	B	6	8	5	8	0	8
		C	11	18	5	11	0	11
		A	8	8	8	8	6	8
	9	B	7	8	8	8	6	8
		C	14	18	16	16	8	12
		A	7	8	2	5	0	8
	10	B	8	8	2	5	0	8
		C	13	16	2	10	0	12

Continued Overlea

GROUP	SUBJECT	SENTENCE	TASK SCORE 1	2	3	4	5	6
3	11	A	7	8	7	5	0	8
		B	5	8	6	3	0	6
		C	13	17	7	6	0	11
	12	A	8	8	6	7	0	2
		B	4	8	6	6	0	6
		C	12	10	10	9	0	10
	13	A	8	8	8	5	0	8
		B	2	7	6	6	0	8
		C	8	14	10	4	0	11
	14	A	7	8	3	5	0	4
		B	6	8	3	5	0	4
		C	5	12	2	6	0	4
	15	A	8	8	8	8	6	8
		B	5	8	3	6	4	8
		C	6	15	7	6	0	7
4	16	A	8	8	8	8	6	8
		B	7	8	8	8	4	8
		C	9	17	6	9	0	10
	17	A	8	8	1	7	0	8
		B	5	8	5	5	0	8
		C	5	6	2	6	0	12
	18	A	8	8	8	5	0	8
		B	7	8	5	5	0	8
		C	8	18	4	8	0	12
	19	A	8	8	8	6	2	4
		B	4	8	4	7	4	4
		C	7	18	7	12	0	8
	20	A	8	8	8	8	6	7
		B	8	8	8	8	6	8
		C	12	18	16	16	8	11

Continued Overleaf/

GROUP	SUBJECT	SENTENCE	TASK SCORE					
			1	2	3	4	5	6
		A	8	8	8	6	6	8
	21	B	7	8	7	6	6	8
		C	12	14	11	8	4	10
		A	8	8	6	8	4	-
	22	B	8	8	7	8	0	-
		C	7	11	9	13	0	-
		A	8	8	5	6	2	-
5	23	B	7	8	5	7	2	-
		C	15	18	12	14	4	-
		A	8	8	8	8	0	8
	24	B	6	8	8	8	0	6
		C	14	18	16	17	0	8
		A	7	8	3	5	0	4
	25	B	7	8	3	5	0	5
		C	5	11	2	6	0	4
		A	8	8	8	8	6	8
	26	B	8	8	7	8	6	8
		C	12	16	15	14	8	11
		A	8	8	5	6	0	6
	27	B	6	8	2	6	2	4
		C	6	12	3	8	0	6
		A	8	8	8	8	4	8
6	28	B	8	8	8	8	6	8
		C	16	17	16	18	8	12
		A	4	6	3	4	0	4
	29	B	2	6	2	1	0	4
		C	3	8	2	0	0	2
		A	7	8	3	6	0	4
	30	B	6	8	4	6	0	5
		C	4	10	4	7	0	4

APPENDIX C. Experiment 4.

UNIT 5. CHART 3b.

5.3.

Individual sentence scores for the 6 groups for the 6 taks

			Task 1				Task 2				Task 3				Task 4				Task 5			Task 6			
Subject	Group	Sentence	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	a	b	c	d
1	1	A	2	2	1	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		B	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		C		4	4	4	5	6	6			4	5	4		5	5	4		4	4		4	4	4
2	1	A	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		B	2	2	0	0	2	2	2	1	2	2	1	1	2	2	2	2	2	2	0	2	2	2	2
		C		2	0	0		2	3	3		3	5	3		2	2	1			0		3	3	3
3	1	A	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2
		B	2	2	2	2	2	1	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	0	2
		C		3	3	2		4	6	4		4	3	2		3	5	3		4	4		3	4	3
4	1	A	2	2	2	2	2	2	2	1	0	0	1	0	2	2	2	1	2	2	2		-		
		B	2	2	2	1	2	2	1	2	1	1	1	1	2	1	0	1	2	0	2		-		
		C		0	2	1		3	3	3		0	0	0		1	1	0		0	0		-		
5	1	A	2	2	2	2	2	2	2	2	2	1	1	1	2	2	2	2	0	0	0	2	2	1	2
		B	2	2	1	1	2	1	2	2	1	1	2	1	2	2	0	1	0	0	0	2	2	2	2
		C		3	4	3		5	6	6		1	2	2		3	3	3		0	0		4	4	4

5.3. cont'd.

6	2	A B C	2 2 1 0 2 2 2 2 4 5 1	2 2 2 2 2 1 2 2 6 6 6	2 0 2 0 2 2 2 0 2 0 2	1 1 2 2 1 2 1 2 2 2 2	2 2 2 0 2 0 0 0	2 2 2 2 2 2 2 2 4 4 4
7	2	A B C	2 2 1 1 1 1 2 2 2 3 5	2 2 2 2 2 2 2 2 6 5 5	1 2 1 2 1 0 0 2 1 1 1	1 2 1 2 1 2 2 1 2 2 2	2 2 0 2 0 0 0 0	2 2 2 2 2 2 1 2 4 4 4
8	2	A B C	2 2 2 2 1 1 2 2 3 4 4	2 2 2 2 2 2 2 2 6 6 6	2 1 1 2 1 2 0 2 2 2 1	2 2 2 2 2 2 2 2 5 3 3	0 0 0 0 0 0 0 0	2 2 2 2 2 2 2 2 4 4 3
9	2	A B C	2 2 2 2 1 2 2 2 5 5 4	2 2 2 2 2 2 2 2 6 6 6	2 2 2 2 2 2 2 2 5 5 6	2 2 2 2 2 2 2 2 6 5 5	2 2 2 2 2 2 4 4	2 2 2 2 2 2 2 2 4 4 4
10	2	A B C	1 2 2 2 2 2 2 2 4 5 4	2 2 2 2 2 2 2 2 6 4 6	1 1 0 0 2 0 0 0 0 0 2	2 1 0 2 1 1 1 2 3 3 4	0 0 0 0 0 0 0 0	2 2 2 2 2 2 2 2 4 4 4

APPENDIX C. Experiment 4.

UNIT 5. CHART 5b.

5.3. Individual sentence scores in the 6 groups for the 6 tasks.

Subject	Group	Sentence	Task 1				Task 2				Task 3				Task 4				Task 5			Task 6			
			a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	a	b	c	d
11	3	A	1	2	2	2	2	2	2	2	2	2	2	1	1	2	2	0	0	0	0	2	2	2	2
		B	1	1	2	1	2	2	2	2	1	2	1	2	1	0	1	1	C	0	0	2	2	0	2
		C		5	5	3		5	6	6		1	3	2		2	2	2		0	0		4	3	4
12	3	A	2	2	2	2	2	2	2	2	2	1	1	2	1	2	2	2	0	0	0	0	2	0	0
		B	1	1	1	1	2	2	2	2	2	1	2	1	2	1	2	1	0	0	0	1	2	1	2
		C		4	4	4		3	3	4		5	2	3		4	3	2		0	0		3	3	4
13	3	A	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	0	0	0	2	2	2	2
		B	0	1	0	1	2	2	2	1	1	1	2	2	2	1	1	2	0	0	0	2	2	2	2
		C		3	2	3		4	5	5		4	3	3		1	1	2		0	0		4	3	4
14	3	A	2	2	1	2	2	2	2	2	1	1	1	0	1	2	1	1	0	0	0	1	1	1	1
		B	2	1	1	2	2	2	2	2	1	1	1	0	2	1	1	1	0	0	0	1	1	1	1
		C		1	2	2		4	4	4		1	1	0		2	2	2		0	0		2	2	0
15	3	A	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		B	2	2	0	1	2	2	2	2	1	2	0	0	2	2	0	2	0	2	2	2	2	2	2
		C		3	1	2		5	5	5		1	3	3		1	2	3		0	0		2	3	2

5.3. cont'd.

16	4	A	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2	2 2 2 2
		B	2 2 1 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 0	2 2 2 2
		C	4 3 2	5 6 6	3 2 1	3 4 2	0 0	3 4 3
17	4	A	2 2 2 2	2 2 2 2	0 0 1 0	2 2 2 1	0 0 0	2 2 2 2
		B	2 2 1 0	2 2 2 2	1 1 2 1	2 1 0 2	0 0 0	2 2 2 2
		C	1 2 2	2 2 2	2 0 0	2 3 1	0 0	4 4 4
18	4	A	2 2 2 2	2 2 2 2	2 2 2 2	1 2 1 1	0 0 0	2 2 2 2
		B	2 2 1 2	2 2 2 2	2 2 1 0	1 1 1 2	0 0 0	2 2 2 2
		C	2 3 3	6 6 6	1 1 2	3 4 1	0 0	4 4 4
19	4	A	2 2 2 2	2 2 2 2	2 2 2 2	2 2 1 1	2 0 0	2 2 0 0
		B	2 0 1 1	2 2 2 2	1 1 2 0	2 1 2 2	2 2 0	0 0 2 2
		C	3 4 0	6 6 6	4 3 0	4 4 4	0 0	2 2 4
20	4	A	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2	2 2 1 2
		B	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2	2 2 2 2
		C	4 5 3	6 6 6	6 6 4	6 4 6	4 4	3 4 4

APPENDIX C. Experiment 4.

UNIT 5. CHART 3b.

5.3.

Individual Sentence Scores in the 6 Groups for the 6 Tasks.

Subject	Group	Sentence	Task 1				Task 2				Task 3				Task 4				Task 5			Task 6			
			a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	a	b	c	d
21	5	A	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		B	2	2	2	1	2	2	2	2	2	2	2	1	2	2	1	1	2	2	2	2	2	2	2
		C		4	4	4		5	5	4		6	4	1		4	1	3			4		4	2	4
22	5	A	2	2	2	2	2	2	2	2	2	1	2	1	2	2	2	2	2	0	2		-		
		B	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	0	0	0		-		
		C		2	3	2		4	4	3		4	4	1		5	6	2		0	0		-		
23	5	A	2	2	2	2	2	2	2	2	1	1	2	1	1	1	2	2	0	2	0		-		
		B	1	2	2	2	2	2	2	2	2	1	1	1	2	1	2	2	0	2	0		-		
		C		3	6	6		6	6	6		4	5	3		4	5	5		0	4		-		
24	5	A	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	2	2	2	2
		B	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	2	2	0	2
		C		6	4	4		6	6	6		6	6	4		6	6	5		0	0		4	1	3
25	5	A	1	2	2	2	2	2	2	2	1	1	0	1	2	1	1	1	0	0	0	1	1	1	1
		B	2	2	1	2	2	2	2	2	2	1	0	0	2	1	1	1	0	0	0	2	2	0	1
		C		2	2	1		4	3	4		1	1	0		3	1	2		0	0		2	2	0

5.3. cont'd.

26	6	A	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2	2 2 2 2
		B	2 2 2 2	2 2 2 2	1 2 2 2	2 2 2 2	2 2 2	2 2 2 2
		C	4 4 4	5 6 5	5 5 5	4 6 4	4 4	4 4 3
27	6	A	2 2 2 2	2 2 2 2	1 1 2 1	2 1 1 2	0 0 0	2 2 0 2
		B	2 1 2 1	2 2 2 2	0 1 1 0	2 1 1 2	0 2 0	1 1 0 2
		C	2 2 2	3 3 6	1 1 1	3 3 2	0	3 0 3
28	6	A	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 0	2 2 2 2
		B	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2	2 2 2 2
		C	6 6 4	6 6 5	6 6 4	6 6 6	4 4	4 4 4
29	6	A	1 1 1 1	1 1 2 2	1 1 1 0	1 1 1 1	0 0 0	1 1 1 1
		B	1 1 0 0	2 2 1 1	1 1 0 0	0 0 0 1	0 0 0	1 1 1 1
		C	1 1 1	3 3 2	1 0 1	0 0 0	0 0	1 0 1
30	6	A	2 2 1 2	2 2 2 2	1 1 1 0	2 2 1 1	0 0 0	1 1 1 1
		B	2 2 1 1	2 2 2 2	2 1 0 1	2 2 1 1	0 0 0	1 2 1 1
		C	2 2 0	4 3 3	1 1 2	2 3 2	0 0	2 1 1

APPENDIX C. UNIT 5.

~~Experiment 4.~~

BC3. Chart 3c.

Individual input/output time for the 6 Groups in Task Type 1.

GROUP I

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
1	30.6	28	34	26	100	44	60	148	198	294	416	492
5	21.7	40	60	62	106	78	86	102	242	184	162	180
2	19.7	28	26	80	48	58	62	84	164	354	146	136
3	42.9	38	42	170	140	126	92	162	390	392	512	510
4	19.8	34	66	80	90	86	122	88	130	148	164	180

GROUP II

6	25.7	20	18	34	68	86	124	88	204	104	240	500
7	22.0	12	16	22	16	26	28	64	150	180	190	614
10	26.2	54	156	46	54	72	76	84	80	154	422	380
8	17.4	42	24	16	14	34	40	62	102	148	192	370
9	10.5	16	20	14	22	22	24	32	64	82	116	218

5.3. cont'd. Chart 3c.

GROUP III

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
13	22.2	50	22	34	90	46	116	90	104	194	272	312
12	24	76	74	60	54	78	96	84	174	168	316	260
11	20.5	16	22	22	40	70	70	72	156	186	308	270
15	20.0	34	84	44	72	30	86	84	92	162	220	288
14	37.1	60	68	70	94	150	124	142	182	412	442	486

GROUP IV

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
19	23.4	68	46	42	60	38	82	96	138	212	218	404
16	24.7	40	70	36	48	48	60	106	104	284	332	354
20	10.6	14	28	36	26	20	34	46	40	88	126	182
17	27.0	92	82	82	128	110	98	100	148	182	240	360
18	47.8	50	92	102	126	100	128	146	208	500	514	900

5.3. cont'd. Chart 3c.

GROUP V

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
24	38.7	120	70	72	106	114	184	154	200	496	366	444
21	23.2	30	20	34	60	54	54	64	164	158	206	254
25	37.9	50	50	94	86	178	174	180	232	378	406	444
22	39.6	112	64	90	102	132	160	174	310	340	406	490
23	65.9	80	86	82	100	128	184	162	376	690	1420	658

GROUP VI

28	10.8	38	30	30	28	28	34	44	44	80	108	190
29	5.8	14	16	24	22	24	22	22	22	64	58	66
27	43.2	234	134	160	110	180	150	160	208	294	386	580
26	38.4	60	66	60	140	150	130	130	100	320	288	850
30	32.8	82	72	66	96	176	214	126	216	256	274	386

APPENDIX C. UNIT 5.

Experiment 4:

5.3. Chart 3c. GROUP I

Individual input/output time for the 6 Groups in Task Type 2.

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
5	22.5	106	76	42	36	64	60	60	410	138	172	188
1	26	22	30	20	58	56	56	60	56	208	390	612
2	18.2	34	32	80	58	50	70	88	70	236	216	160
3	41.0	76	68	104	72	132	62	108	308	326	624	588
4	11.9	44	30	62	18	30	30	24	76	68	200	140

GROUP II

6	20.2	36	48	66	50	88	54	104	144	230	232	194
7	18.6	42	26	82	82	72	74	64	80	246	222	130
8	25.9	32	28	64	50	66	100	78	102	484	260	288
9	8	26	16	14	16	24	22	26	48	74	64	150
10	30.5	54	50	48	50	80	98	126	224	376	376	350

5.3. cont'd. Chart 3c.

GROUP III

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
13	29.2	64	56	118	70	94	102	142	192	310	344	266
11	13.1	24	12	16	20	26	22	36	68	120	196	250
12	34.1	62	60	46	56	74	68	92	120	376	404	692
14	35.1	62	52	88	76	176	142	176	190	350	404	374
15	14.4	38	34	70	52	32	112	40	40	112	128	210

GROUP IV

19	13.1	42	26	50	44	26	52	46	64	122	132	184
18	44.3	42	42	60	100	102	190	218	170	432	608	700
17	19.7	96	42	200	48	56	94	74	72	158	166	182
20	8.0	34	12	16	26	18	38	26	34	60	82	128
16	21.2	30	32	38	58	78	66	74	118	198	226	356

513. cont'd.   Chart 3c.

GROUP V

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
25	43.3	10	92	94	118	172	210	156	210	432	450	600
22	23.2	74	86	32	66	50	94	118	98	184	280	310
23	49.4	80	112	88	110	84	174	224	200	490	600	800
24	30.8	44	108	64	70	42	92	150	120	340	336	480
21	12.9	26	42	44	38	30	34	50	74	146	98	196

GROUP VI

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
28	9.4	10	12	12	28	20	30	44	38	90	106	174
29	8.7	24	22	32	16	32	40	34	42	72	124	88
27	31.9	74	50	62	66	58	88	82	66	408	184	796
30	31.5	108	124	120	116	136	210	170	172	270	166	300
26	21.3	30	32	40	44	72	64	58	88	242	244	368

APPENDIX C. UNIT 5. Individual input/output time for the 6 Groups in Task Type 3.

Experiment 4. 5.3. Chart 3c.

GROUP II

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
9	16.7	52	50	42	52	50	56	66	92	142	130	266
6	32.2	14	62	72	100	134	56	108	270	298	294	528
7	27.5	110	92	66	94	250	248	246	264	92	122	370
8	29.2	108	100	112	114	90	104	90	194	270	286	290
10	34.7	78	108	70	90	136	92	126	152	412	430	396

GROUP I Task III

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
5	26.6	48	64	78	154	122	122	100	136	218	350	208
1	35.8	92	48	44	96	106	84	272	194	262	440	704
3	66.3	224	98	170	144	174	284	224	450	676	746	600
2	32.3	94	94	58	66	118	96	130	128	322	476	356
4	15.4	54	74	68	56	62	80	86	72	86	126	162

5.3. cont'd. Chart 3c.

GROUP II

		A				B				C		
SUBJECT	Total time in mins.	a secs.	b secs.	c secs.	d secs.	a secs.	b secs.	c secs.	d secs.	a secs.	b secs.	c secs.
20	13.9	38	40	34	34	48	34	54	84	116	136	216
16	38.6	100	64	100	98	166	146	148	174	374	556	388
19	25.8	96	68	70	66	98	68	128	154	216	260	320
17	26	94	146	54	136	70	100	126	104	272	188	266
18	42.4	76	112	140	168	104	174	198	260	402	374	530

GROUP III

15	89.9	290	240	268	796	650	404	352	420	528	720	726
12	41.2	30	20	30	154	124	148	88	240	592	508	540
11	28.9	84	72	104	120	90	236	112	154	238	260	266
13	44.6	70	68	74	92	188	176	122	176	490	582	640
14	41.8	94	138	120	148	250	220	200	206	400	342	392

5.3. cont'd. Chart 5c.

GROUP VI

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
29	9.3	22	28	30	30	42	46	30	58	76	94	104
27	53.6	88	120	118	682	146	206	206	236	416	480	560
30	42.4	84	74	54	68	220	158	276	330	400	436	452
26	35.6	58	60	44	66	136	136	118	164	290	294	770
28	15.4	34	38	38	38	44	40	82	80	162	164	204

GROUP V

24	44.4	76	78	78	88	200	184	270	210	428	408	646
23	48.9	86	92	82	110	152	132	208	194	576	730	570
22	34.7	102	86	94	108	144	150	160	176	370	412	282
21	19.8	50	72	56	66	78	98	58	104	160	172	272
25	42.0	122	108	258	110	306	208	188	366	286	318	250

APPENDIX C. UNIT 5. Individual input/output time for the 6 groups in Task Type 4.

GROUP IV

5.3. Chart 3c.

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
20	13.4	20	56	36	30	36	70	38	30	130	116	250
18	39	50	32	54	72	78	98	114	166	600	424	648
17	23.4	76	78	102	86	68	108	100	136	228	192	240
19	25.4	102	48	58	104	68	68	108	104	318	316	240
16	34.4	60	74	110	108	110	108	96	124	388	558	324

GROUP I

1	28.2	60	72	62	74	108	92	104	112	248	396	364
5	23.8	50	80	62	74	68	72	92	134	294	262	240
3	27.8	58	52	48	78	120	112	120	110	260	358	356
2	22.6	78	48	74	66	58	96	68	100	252	262	256
4	17.0	54	48	82	80	48	88	84	120	130	160	124

5.3. cont'd. Chart 3c.

GROUP II

		A				B				C		
SUBJECT	Total time in mins.	a secs.	b secs.	c secs.	d secs.	a secs.	b secs.	c secs.	d secs.	a secs.	b secs.	c secs.
6	18.9	46	50	62	62	78	76	76	138	180	172	182
7	27.6	92	16	82	74	102	120	114	160	220	312	300
10	40.2	52	64	94	58	132	130	110	188	454	460	660
8	32.2	66	64	100	66	110	122	98	266	346	362	336
9	14.9	30	34	28	40	54	28	54	66	138	150	270

GROUP III

13	22.4	234	86	78	52	80	100	74	106	170	148	214
11	22.3	86	68	132	32	112	84	130	118	242	132	202
12	32.5	86	54	94	50	160	92	100	116	354	440	400
15	73.6	76	70	100	134	180	146	234	300	720	1060	1400
14	34.2	74	98	136	114	144	182	180	186	276	282	380

5.3. cont'd. Chart 3c.

GROUP V

		A				B				C		
SUBJECT	Total time in mins.	a secs.	b secs.	c secs.	d secs.	a secs.	b secs.	c secs.	d secs.	a secs.	b secs.	c secs.
21	30.3	62	80	44	82	72	116	86	200	208	266	600
24	26.2	60	68	50	48	92	114	98	116	260	332	334
22	23.3	52	58	42	68	72	68	116	54	256	418	188
25	45.4	160	156	120	196	250	148	174	140	394	388	600
23	24.2	42	50	44	60	78	84	120	112	244	292	324

GROUP VI

28	17.6	52	76	54	44	102	68	98	78	110	142	228
29	10.7	12	24	40	38	38	54	38	48	110	108	134
30	37.9	108	90	134	114	220	128	314	188	326	300	350
21	16.6	42	38	38	40	64	70	68	80	180	184	196
26	21.5	48	54	46	58	80	78	82	120	200	200	328

APPENDIX C. UNIT 5.

Individual input/output time for the 6 groups in Task Type 5.

Experiment 4. 5.3. Chart 3c.

GROUP III

		A			B			C	
SUBJECT	Total time in mins.	a secs.	b secs.	c secs.	a secs.	b secs.	c secs.	a secs.	b secs.
13	13.3	76	60	50	50	90	90	158	224
12	15.8	32	52	58	50	94	92	302	274
11	16.8	68	124	80	74	100	110	160	294
15	48.0	124	240	216	90	222	350	706	924
14	30.0	84	128	76	154	200	238	448	470

GROUP IV

20	12.1	50	58	60	62	52	114	136	196
18	35.7	150	124	150	286	148	194	486	600
17	29.2	94	186	170	260	290	220	240	290
19	29.1	90	90	86	152	52	128	514	640
16	27.0	126	72	94	266	180	158	344	374

5.3. cont'd. Chart 3c.

GROUP V

		A			B			C	
SUBJECT	Total time in mins.	a secs.	b secs.	c secs.	a secs.	b secs.	c secs.	a secs.	b secs.
21	20	46	64	108	112	196	154	218	302
24	33.9	168	128	124	114	192	220	494	580
22	36.6	156	64	308	160	162	398	454	492
25	27.5	90	110	140	180	196	224	320	390
23	39.3	146	88	248	288	216	190	460	724

GROUP VI

28	14.5	48	64	46	82	94	112	166	258
26	23.4	58	68	64	200	196	194	324	298
29	79	28	64	30	52	54	54	88	106
30	23.8	80	158	148	188	186	80	306	290
27	65.6	160	192	346	118	524	136	674	1784

5.3. cont'd. Chart 3c.

GROUP I

		A			B			C	
SUBJECT	Total time in mins.	a secs.	b secs.	c secs.	a secs.	b secs.	c secs.	a secs.	b secs.
1	25.4	62	70	60	208	202	266	306	346
4	11.3	68	40	42	48	46	88	132	216
5	15.6	68	30	66	128	52	120	188	284
3	42.5	264	114	124	192	232	314	508	800
2	22.7	242	76	120	156	194	196	146	232

GROUP II

6	19.1	76	42	32	54	338	138	96	372
7	20.5	156	92	78	164	60	152	266	264
8	31.5	196	216	224	170	132	290	342	320
10	24.8	88	134	156	204	100	96	346	362
9	8.6	36	46	50	76	46	56	114	94

Individual input/output time for the 6 groups in Task Type 6.

APPENDIX C. UNIT 5.

Experiment 4. 5.3. Chart 3c.
GROUP VI

		A				B				C		
SUBJECT	Total time in mins.	a secs.	b secs.	c secs.	d secs.	a secs.	b secs.	c secs.	d secs.	a secs.	b secs.	c secs.
28	17.9	26	54	40	76	70	64	90	110	154	176	208
26	70.3	390	276	166	130	320	392	450	466	270	660	700
29	12.0	30	18	26	30	70	54	50	80	114	106	146
30	34.1	84	104	172	68	178	162	122	196	308	360	292
27	32.9	68	82	96	66	202	222	192	190	300	296	264

GROUP V

21	40.4	98	80	90	340	164	88	170	490	286	254	368
24	57.0	128	140	100	170	316	266	212	380	488	628	590
22												
25	32.2	102	86	98	82	168	162	140	174	294	322	302
23												

5.3. cont'd. Chart 3c.

GROUP IV

		A				B				C		
SUBJECT	Total time in mins.	a secs.	b secs.	c secs.	d secs.	a secs.	b secs.	c secs.	d secs.	a secs.	b secs.	c secs.
20	18.4	52	40	44	40	92	84	102	88	154	226	180
18	63.2	128	72	150	156	224	226	186	166	856	924	708
17	52.2	94	120	140	300	154	184	256	332	454	608	490
19	53.9	140	166	184	244	246	184	234	588	440	274	540
16	39.8	108	150	88	54	204	188	230	188	420	416	350

GROUP III

13	32	72	72	64	64	88	100	108	220	328	332	418
11	60	88	142	186	202	136	288	300	500	570	588	492
12	68.4							346	266	366	548	1800
15	64	230	300	200	324	306	340	268	256	348	560	480
14	34.22	80	94	102	96	170	172	142	196	310	340	280

5.3. cont'd. Chart 3c.

GROUP I

SUBJECT	Total time in mins.	A a secs.	A b secs.	A c secs.	A d secs.	B a secs.	B b secs.	B c secs.	B d secs.	C a secs.	C b secs.	C c secs.
1	53	136	102	114	206	370	260	262	218	440	720	300
4												
5	60	104	114	266	134	154	182	300	204	474	708	880
3	69	140	200	316	516	182	300	472	488	560	510	450
2	24	110	90	96	70	122	94	180	80	270	360	156

GROUP II

6	38.5	96	56	78	70	110	96	150	250	286	800	280
7	44.8	140	110	230	156	166	170	340	236	336	416	388
8	33.7	80	118	134	120	166	166	176	146	224	346	
Y 10	36.6	78	70	220	102	124	170	192	136	362	424	320
9	14.9	36	38	36	38	84	84	52	76	158	124	168

APPENDIC C. 5.3.1.

Chart 3.1a. The mean time (minutes), standard deviation t and p values for the six groups according to Task ORDER.

	TASK ORDER					
	1st TASK	2nd TASK	3rd TASK	4th TASK	5th TASK	6th TASK
Mean	157.5	154.2	161.7	154.2	154.7	152.7
Standard deviation	48.08	36.93	48.63	51.34	36.75	54.06

t=.1217	t=.274	t=.237	t=.018	t=.069
p>.25	p>.25	p>.25	p>.25	p>.25

Chart 3.1b. The mean score, standard deviation, t and p values for the six groups according to Task ORDER.

	TASK ORDER					
	1st TASK	2nd TASK	3rd TASK	4th TASK	5th TASK	6th TASK
Mean	104.6	103.8	104.1	100.2	103.6	101.1
Standard deviation	48.3	37.5	44.7	35.9	41.1	40.4

t=0.025	t=0.152	t=0.097
p >.25	p >.25	p >.25

APPENDIX C. 5.3.1.

Chart 3.1c.

Friedman Two Way Analysis of Variance by Ranks Sums of Ranks for Treatments.

Number of Subjects	1	2	3	4	5	6		CHi Squared	Probability
Batch 1									
6	14.0	9.0	25.0	14.0	31.0	33.0	Time/ Task Type	23.90	$p<0.001$
Batch 2									
6	23.5	23.0	22.5	21.5	15.5	20.0	Time/ Task Order	2.10	$0.800 < p < 0.90$
Batch 3									
6	21.5	34.0	12.0	21.5	7.0	30.0	Score/ Task Type for the combined A,B,C, Categories of sentences.	25.12	$p<0.001$
Batch 4									
6	19.0	33.5	15.0	22.0	7.0	29.5	Score/ Task Type for the C Category	22.17	$p<0.001$
Batch 5									
6	21.0	22.5	17.0	23.0	22.5	20.0	Score/ Task Order	1.21	$0.900<p<0.95$

APPENDIX C. 5.3.1.

Chart 3.1d.

Summary of Analysis of Variance

Score/ Order of Task

Source of Variation	Sum of Squares	Of	Mean Squares	Variance Ratio	
Treatments	1892.9167	5	378.5833	0.190	not significant
Groups	96.5833	5	19.3167	0.010	at 1% or 5%
Residual	49831.2500	25	1993.2500		levels
Total	51820.7500	35			

APPENDIX C. 5.3.1.

Chart 3.1d.

Summary of Analysis of Variance

Time / Order of Task

Source of Variation	Sum of Squares	of	Mean Squares	Variance Ratio	
Treatments	2525.1389	5	505.0278	0.247	not significant
Groups	14569.4722	5	2913.8944	1.424	at 1% or 5%
Residual	51170.3611	25	2046.8144		levels.
Total	68264.9722	35			

APPENDIX C. 5.3.2.

Chart 3.2a.

The individual distribution of scores for Category C, B and A sentences for the combined tasks in the experimental population.

	SUBJECTS	C	B	A
TOTAL	30	92	46	46
High Scorers > 70 in C	28	87	46	44
	9	84	46	46
	20	81	46	45
	1	76	45	43
	26	76	45	46
	24	73	36	40
	23	71	35	35
Medium Scorers > 46 in C	3	60	40	45
	21	59	42	46
	8	56	35	38
	11	53	28	34
	5	53	32	36
	10	53	34	33
	19	52	31	36
	16	51	43	46
	12	51	30	31
	6	50	37	37
	18	50	33	37
	7	47	32	38
	13	47	29	37
	22	45	37	41
Low Scorers < 46 in C	15	41	34	46
	2	35	37	46
	27	35	28	33
	17	31	31	32
	30	29	29	28
	14	29	26	27
	25	28	20	27
	4	17	31	35
	29	15	15	21

APPENDIX C. 5.3.3.

Chart 3.3a.

The a/b, c and d mean score % in the six groups for the combined A, B and C Categories of sentences on all Tasks.

	Categories A,B and C sentences on all Tasks		
	normal	syntactic distortion	semantic distortion
	a/b	c	d
Mean Score %	69	63	67.0

APPENDIX C. 5.3.3. Chart 3.3b.

x = Mean score percent

y = standard deviation %

The a/b, c and d mean score %, standard deviation %, t and p values in the six groups for the combined categories of sentences in Tasks 1-6 inclusive.

GATEGORY A, & C SENTENCES

	TASK 1			TASK 2			TASK 3			TASK 4			TASK 5			TASK 6		
	normal	syn-tactic distortion	seman-tic distortion	normal	syn-tactic distortion	seman-tic distortion	normal	syn-tactic distortion	seman-tic distortion	normal	syn-tactic distortion	seman-tic distortion	normal	syn-tactic distortion	seman-tic distortion	normal	syn-tactic distortion	sema-tic distortion
	a/b	c	d	a/b	c	d	a/b	c	d	a/b	c	d	a/b	c	d	a/b	c	d
x	68.3	65.6	60.3	87.0	88.0	87.6	61.6	55	44.6	70.0	62.3	60.6	37	32.9	-	92.5	75.9	84.7
y	6.5	7.8	5.8	4.6	6.6	4.9	5.4	8.4	5.2	3.7	5.5	4.6	16.1	16	-	20.0	19.2	10.7
t	t .596 p >.25	t 1.222 p .25		t .138 p >25	t .108 p >25		t 1.481 p.10 -.25	t 2.359 p .05		t 2.502 p .02	t .531 p>.25		t .404 p >.25			t 1.670 p.10-25	t .925 p .25	
p	t 2.058 p >05			t .028 p>.25			t 5.083 p .001			t 3.570 p .01-.002						t .549 p >.25		

APPENDIX C. 5.3.3. Chart 3.3c.

The a/b, c and d mean score %, standard deviation %, t and p values in the six groups for Category A sentences in Tasks 1 - 6 inclusive.

CATEGORY A SENTENCES.

	TASK 1			TASK 2			TASK 3			TASK 4			TASK 5		TASK 6		
	a/b	c	d	a/b	c	d	a/b	c	d	a/b	c	d	a/b	c	a/b	c	d
Mean Score %	98.3	98.3	93.3	98.3	100	100	80	76.6	65.0	95	81.6	81.6	53.33	42.85	93.0	77.7	85
Standard Deviation %	3.73	10.67	11.05	3.4	0	0	5.77	9.43	9.57	5	10.67	13.43	18.85	16.65	7.45	14.14	11.05
t	t .984 p .25	t .728 p .25		t .901 p .25	t - p -		t .687 p .25	t1.939 p .10		t2.543 p .02	t.078 p.25		t .929 p .25		t2.140 p .05	t .909 p .25	
		t .964 p .25			t .910 p .25			t 3.00 p .01			t 2.690 p .02					t 1.342 p .25	

APPENDIX C. 5.3.3. Chart 3.3d.

The a/b, c and d mean score %, standard deviation %, t and p values in the six groups for Category B sentences in Tasks 1 - 6 inclusive.

CATEGORY B SENTENCES.

	TASK 1			TASK 2			TASK 3			TASK 4			TASK 5		TASK 6		
	a/b	c	d	a/b	c	d	a/b	c	d	a/b	c	d	a/b	c	a/b	c	d
Mean Score %	88	71.6	73.3	100	96.6	95.5	85	63.3	53.3	91.66	66.6	81.66	53.33	33.33	91.0	72.2	93.0
Standard deviation %	10.67	17.50	15.98	0	4.92	5.0	7.63	15.98	4.72	6.87	11.05	10.67	18.85	22.11	8.97	10.34	7.45
	t 1.856 p .10	t .15C p>.25		t 1.160 p>.25	t .620 p>.25		t 2.948 p .02	t1.342 p .25		t 4.307 p .001	t2.192 p .05		t 1.539 p.10-.25		t 2.89 p .01-.02	t 3.1 p .01	
	t 1.911 p.10-.05			t .986 p>.25			t 7.899 p .001			t 1.962 p .10					t .383 p>.25		

APPENDIX C. 5.3.3. Chart 3.3e.

The a/b, c and d mean score %, standard deviation %, t and p values in the six groups for Category C sentences in Tasks 1 - 6 inclusive.

CATEGORY C SENTENCES.

	TASK 1			TASK 2			TASK 3			TASK 4			TASK 5		TASK 6		
	a/b	c	d	a/b	c	d	a/b	c	d	a/b	c	d	a/b	c	a/b	c	d
Mean Score %	51.1	55.5	44.4	78.33	80.6	80.6	47.3	44.3	34.3	53.88	53.88	46.11	20	26	83.0	75.0	80.1
Standard deviation %	6.57	10.30	1C.82	12.13	6.5	8.9	11.92	12.12	5.98	12.53	10.43	7.55	12.58	14.04	9.97	20.72	16.17
	t .805 p>.25	t 1.661 p .10		t .368 p>.25	t .040 p>.25		t .394 p>.25	t 1.854 p .10		t .127 p>.25	t1.349 p .25		t .711 p>.25		t .778 p>.25	t .425 p>.25	
		t 1.183 p .25			t .337 p .25			t 2.1803 p .05			t 1.187 p .25					t .353 p>.25	

APPENDIX 5.3.4.

Chart 3.4a.

Summary of Analysis of Variance

Score/Type of Task in combined A, B and C Categories.

Source of Variation	Sum of Squares	of	Mean Squares	Variance Ratio
Treatments	11011.3333	5	2202.2667	26.636 **
Groups	926.6667	5	185.3333	2.242
Residual	2067.0000	25	82.6800	
Total	14005.0000	35		

** indicates significant differences at 0.01 levels.

APPENDIX 5.3.4.

Chart 3.4a.

Summary of Analysis of Variance

Score/Type of Task in C Category only.

Source of Variation	Sum of Squares	of	Mean Squares	Variance Ratio
Treatments	12555.2222	5	2511.0444	14.738 **
Groups	829.5556	5	165.9111	0.974
Residual	4259.4444	25	170.3778	
Total	17644.2222	35		

** indicates significant differences at 0.01 levels.

APPENDIX C. 5.3.5.

Chart 3.5a.

The mean time (in minutes), standard deviation, t and p values in the six groups according to the type of task for Category A sentences.

Category A Sentences	TYPE OF TASK					
	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5 *-d	TASK 6
Mean Time	21.3	18.0	32.9	23.4	26.9	41.9
Standard Deviation	5.93	3.25	8.68	3.00	0.176	8.57

t 1.092 p .25

t 3.602 p .002-1

t2.318 p .05

2.472 p .02-.05

2.735 p.02

t4.428, p .001

t5.843, p .001

t1.653 p .10

t4.566 p .001

Chart 3.5b.

The mean time (in minutes), standard deviation t and p values in the six groups according to type of task, with d (semantic distortion) sentences excluded for the Category A sentences.

Category A Sentences	TYPE OF TASK					
	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5	TASK 6
Mean time (-d)	14.1	13.3	21.4	17.3	26.9	29.3
Standard deviation (-d)	3.56	2.43	4.59	2.70	0.176	4.50

t 8.050, p .001

t 12.477, p .001

t 2.679, p .02

t 7.953, p.001

t 1.184 p .25

APPENDIX C. 5.3.5.

Chart 3.5c.

The mean time (in minutes,) standard deviation, t and p values in the six groups according to the type of task for Category B sentences.

Category B Setences	TYPE OF TASK					
	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5	TASK 6
Mean Time	37.3	30.6	52.5	36.5	39.9	69.2
Standard deviation	10.906	5.122	13.404	4.726	4.654	10.784

t1.246 p .25

t3.420 p .01

t 2.623 p .02

t 1.971 p.10

t1.897 p.10

t 4.661, p.001

t 7.247, p.001

t 2.175, p.05

t 6.225, p.001

Chart 35d.

The mean time (in minutes), standard deviation, t and p values in the six groups according to the type of task, with d (semantic distortion) sentences excluded for the Category B sentences.

Category B Setences	TYPE OF TASK					
	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5	TASK 6
Mean time (-d)	23.6	20.3	36.4	25.6	39.9	49.4
Standard deviation (-d)	6.862	4.307	11.015	3.169	4.654	13.538

t=4.406

t=2.241 p .05

t=6.928 p .001

p .25

t=5.697, p.001

APPENDIX C. 5.3.5.

Chart 3.5e.

The mean time (in minutes), standard deviation, t and p values in the six groups according to the type of task for Category C sentences.

Category C Sentences	TYPE OF TASK					
	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5	TASK 6
Mean time	79.7	71.05	90.7	77.9	61.8	103.6
Standard deviation	20.09	13.54	17.73	17.89	10.82	22.21

t .799
p .25

t1.973
p .10

t1.139
p .25

t .919, p .25

t .684, p .25

t1.788, p .10

t2.804, p .02

t1.016, p .25

t2.019, p .05

Chart 3.5f.

The mean time (in minutes), standard deviation, t and p values in the six groups according to the type of task, with d (semantic distortion) sentences excluded for the Category C sentences.

Category C Sentences	TYPE OF TASK					
	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5	TASK 6
Mean time (-d)	47.2	42.2	56.7	48.3	61.8	67.0
Standard deviation (-d)	18.80	8.60	13.65	10.05	10.82	13.35

t 1.901, p.25

t 0.677
p .25

t 3.17, p.01

t 0.668, p.25

t 2.063, p.05

APPENDIX C. 5.3.5.

Chart 3.5g.

Summary of Analysis of Variance

Time/Type of Task.

Source of Variation	Sum of Squares	df	Mean Squares	Variance Ratio	
Treatments	22447.4722	5	4489.4944	15.676 **	** indicates significant differences at 0.01 levels.
Groups	7082.8056	5	1416.5611	3.946	
Residual	7160.0278	25	286.4011		
Total	36690.3056	35			

Appendix D. UNIT 7.

Experiment 5. The Pilot Study

7.3. The questionnaires, Pretraining immediately, Post Training and 3 months Post Training.

7.4.3. The raw Item scores for the experimental population in Sessions 1, 3 and 4.

7.4.5. The raw Time scores for the experimental population in Sessions 1, 3 and 4.

APPENDIX D, Unit 7.

7.3. Experiment 5.

CHART 3a.

QUESTIONNAIRE (PRE) EXPERIMENT

1. Name

2. School

3. Age

4. Advanced Level Subjects

5. 1st, 2nd or 3rd year?

6. Grade obtained at '0' level in 'A' level subjects?

7. Grade obtained at '0' level in English

8. Grade obtained at '0' level in other languages?

9. Assess yourself in your Advanced level subjects as follows:-

   v. good good credit satisfactory poor

10. What were the term grades in your Advanced level subjects in the last two years?

11. Enumerate your methods of preparation for a broad essay type of task.

12. Enumerate the techniques you generally use to summarize a fairly complex piece of knowledge.

13. Select from the following list the techniques most useful for any summarizing activity.

    1. Look chiefly for details
    2. Write out lists of authors or terms

3. Try to understand the meaning of each sentence.
4. Memorize items such as rules, steps in a process, descriptions.
5. Look chiefly for the main points.
6. Start with an exploratory read.
7. Organize related paragraphs into groups.
8. Write out selected samples, such as definitions, outstanding facts, major concepts.
9. Re-read difficult sentences slowly.
10. Review the text and attempt to recall relevant data under sub-headings.
11. Review parts of the text difficult to recall, not long before summarising.
12. Make detailed notes.
13. Spend most of the time on part of the material which is unfamiliar.
14. Carefully read the text through several times.
15. Skim over the text to get the outline only.

14\. Enumerate which of these techniques (if any) you have used in the last year.

Experiment 5.

CHART 3b.

QUESTIONNAIRE (POST) EXPERIMENT (IMMEDIATE)

1. Name

2. School

3. In your last summarizing activity, did you use any of the techniques offered to you during the learning sessions?

4. If so, list the techniques you used and comment briefly on their relative value to you.

5. Did you find the last summarizing activity easier, the same, or more difficult than the first? Give details.

6. Do you <u>think</u> you have written a better summary?

7. Do you think you will use this training for future activities demanding an interpretive activity?

8. Any other comments?

Experiment 5.

CHART 3c.

READING AS A LEARNING SKILL

QUESTIONNAIRE - POST 4 MONTHS

1. Name

2. One of your responses to the immediate post training questionnaire affirmed your intention of using what you had learned. Have you done so during the last four months?

   (If 'no' omit questions 3 and 4)

3. Of the various techniques learned during the training session which do you remember and practise most?

   1.

   2.

   3.

4. List the particular learning activities for which you now find yourself using these techniques.

5. Can you describe in some detail the various techniques explained to you during your training?

6. If you can't remember all of them, can you suggest why you may have forgotten them.

7. Comment in your own words on whether your work has improved

a) in your own opinion

b) in terms of your teachers' assessment

8. Would you welcome a longer period of supervised training to improve your learning?

9. Have you become more aware of how you learn?

10. Do you find yourself using any new techniques or approaches to learning which you have developed for yourself?

11. Have you, as a result, stopped using any old methods?

12. Do you think you would benefit from further systematic information about learning as a process?

13. Which of the following statements best apply to you:-

a) I now learn quite differently and much more effectively.

b) I now learn more effectively.

c) The training session was quite useful.

d) I derived some benefit from the training session.

e) The training session was a complete waste of time.

APPENDIX D, Unit 7 Experiment 5.

7.4.3. CHART 4.3a.

INDIVIDUAL SCORES IN TEXT A (GROUP A) AND TEXT B (GROUP B)

IN PHASE 1.

TEXT A (114)					TEXT B (101)				
SUBJECT	Category Items			Total	SUBJECT	Category Items			Total
	$\dddot{44}$	$\ddot{44}$	$\dot{26}$	114		$\dddot{44}$	$\ddot{34}$	$\dot{23}$	101
1	27	19	6	52	7	22	18	15	55
2	38	40	20	98	8	29	15	8	52
3	8	9	9	26	9	34	24	18	76
4	31	20	6	57	10	34	16	6	56
5	14	17	10	41	11	35	32	18	85
6	21	23	13	57	12	14	13	9	36

7.4.3. Chart 4.3b. Experiment 5.

I.DIVIDUAL SCORES IN THE TRAINING TEXT (GENETIC CODE) FOR 12 SUBJECTS IN PHASE THREE.

SUBJECT	CATEGORY ITEMS			TOTAL
	... 52	.. 16	. 22	90
1	52	3	2	57
2	46	8	6	60
3	34	10	12	56
4	47	4	2	53
5	48	6	2	56
6	51	8	2	61
7	45	7	1	53
8	47	1	0	48
9	44	4	4	52
10	51	3	1	55
11	41	9	5	55
12	44	4	3	51

APPENDIX D. UNIT 7.

7.4.3. CHART 4.3c. Experiment 5.

INDIVIDUAL SCORES IN TEXT B (GROUP B) AND TEXT A (GROUP A) IN PHASE 4.

TEXT B (101)					TEXT A (114)				
SUBJECT	Category Items			TOTAL	SUBJECT	Category Items			TOTAL
	... 44	.. 34	. 23	101		... 44	.. 44	. 26	114
1	36	10	2	48	7	34	14	4	52
2	35	14	7	56	8	35	9	1	45
3	22	17	13	52	9	35	11	7	53
4	38	8	2	48	10	41	11	3	55
5	31	16	7	54	11	32	18	12	62
6	30	14	4	48	12	32	16	3	51

APPENDIX D. UNIT 7.

7.4.5. CHART 4.5a.

Experiment 5.

Individual Input and Output times in minutes for the six subjects of GROUP A (TEXT A), in the four phases of experiment five.

SUBJECT	PHASE 1 INPUT	SUMMARY OUTPUT (mins.)	PHASE 2 INPUT AND OUTPUT	PHASE 3 INPUT	SUMMARY OUTPUT (mins.)	PHASE 4 INPUT	SUMMARY OUTPUT (mins.)
1	108.4 min.	47	77.3 min.	185.2 min.	34	117.8 min.	45
2	308 min.	89	90.6 min.	35[illegible] min.	45	2[illegible]7 min.	55
3	38.3 min.	17	92.4 min.	307.5 min.	51	226. min.	54
4	121.1 min.	58	70.6 min.	154.1 min.	25	109.9 min.	35
5	1hr. 79.6min.	25	66.8 min.	434.6 min.	50	152.5 min.	35
6	53.3 min.	48	93 min.	409.2 min.	69	1[illegible]2.8 min.	52

APPENDIX D, UNIT 7.

7.4.5. CHART 4.5b.

Experiment 5.

Individual Input and Output times in minutes, for the six subjects of GROUP B (TEXT B), in the four phases of experiment 5.

SUBJECT	PHASE 1 INPUT	SUMMARY OUTPUT (mins.)	PHASE 2 INPUT & OUTPUT	PHASE 3 INPUT	SUMMARY OUTPUT (mins)	PHASE 4 INPUT	SUMMARY OUTPUT (mins)
7	105 min.	40	75.3 min.	207 min.	52	147 min.	42
8	93 min.	46	93.3 min.	116 min.	21	111 min.	28
9	213 min.	64	93.5 min.	318 min.	45	294. min.	48
10	97.9 min.	77	127 min.	219.7 min.	41	183.7 min.	50
11	250.4 min.	65	102 min.	418.2 min.	50	284.5 min.	60
12	83 min.	31	77 min.	290. min.	48	205. min.	45

READING STRATEGIES AND LEARNING OUTCOMES

Thesis submitted for the

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-by-

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A B S T R A C T

The project was concerned with action research aimed at improving the range and effectiveness of reading-to-learn. Students (Advanced Level and Undergraduates) report reading-to-learn problems but they are only vaguely aware of the cognitive organisation (intuitive tactics and strategy) which underlies and structures their reading behaviour. The research emphasis was therefore primarily learner orientated.

2. This approach clarified such issues as:

(i) Learner interpretation of instructional directives to learn for specific tasks.

(ii) Learner methods of translating the task definition into an operational plan for reading.

(iii) The systematic relationship between the tactics and strategies of reading (the time-structure of reading behaviour), and the variety of reading outcomes, within sentence, paragraph and chapter sized texts.

(iv) Training procedures (incorporating feedback of performance) by which a student can explore new tactics of reading-for-learning.

3. This approach has required the development of three new techniques:

a) A method for recording reading behaviour.

b) A method by which the 'structure of a text' can be systematically described.

c) A system of training procedures for encouraging students to develop more effective methods of reading-for-learning.

4. The empirical data showed that there were two related aspects in developing more effective reading-for-learning; the first was to develop a clearer definition of instructional directives and the second was the ability to translate these into effective operational plans. As a result of individual differences in cognitive structure and skill, students differ in their operational task definition in relation to specific learning outcomes. The plans of a 'beginner' or an 'expert' may bring about the same outcome but they differ considerably. Students also differ in their training needs within a training procedure for reading-to-learn effectively. This emphasises the need to develop a hierarchically organised learner-

controlled programme of self-diagnosis and training.

5. The theoretical outcome of the research was a tentative model of the student learning by reading. This model is based on the concept of a dynamic interaction between the learner's cognitive structure and skill, the learner's task definition and how this becomes operational, and the syntactic and semantic structure of the text. The model can be considered as a hierarchically organised multi-level description of the reading process. The reading strategy formed of the tactics, and the learning outcome, represent the observables of this interaction. The model was influenced by the theories of J. Bruner, G. Miller, N. Chomsky and R. Gagné.

6. The research was directed towards the identification of strategies and outcomes of reading-to-learn, with the double aim of investigating these areas and training students to increase their skill; both these aims were in line with endeavours to increase self-organisation and individual autonomy in learning.

7. Whilst the goals of the research were largely achieved, the results have illuminated a number of practical and theoretical issues that need further investigation.

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To the Memory of

my Mother, Elizabeth Jane

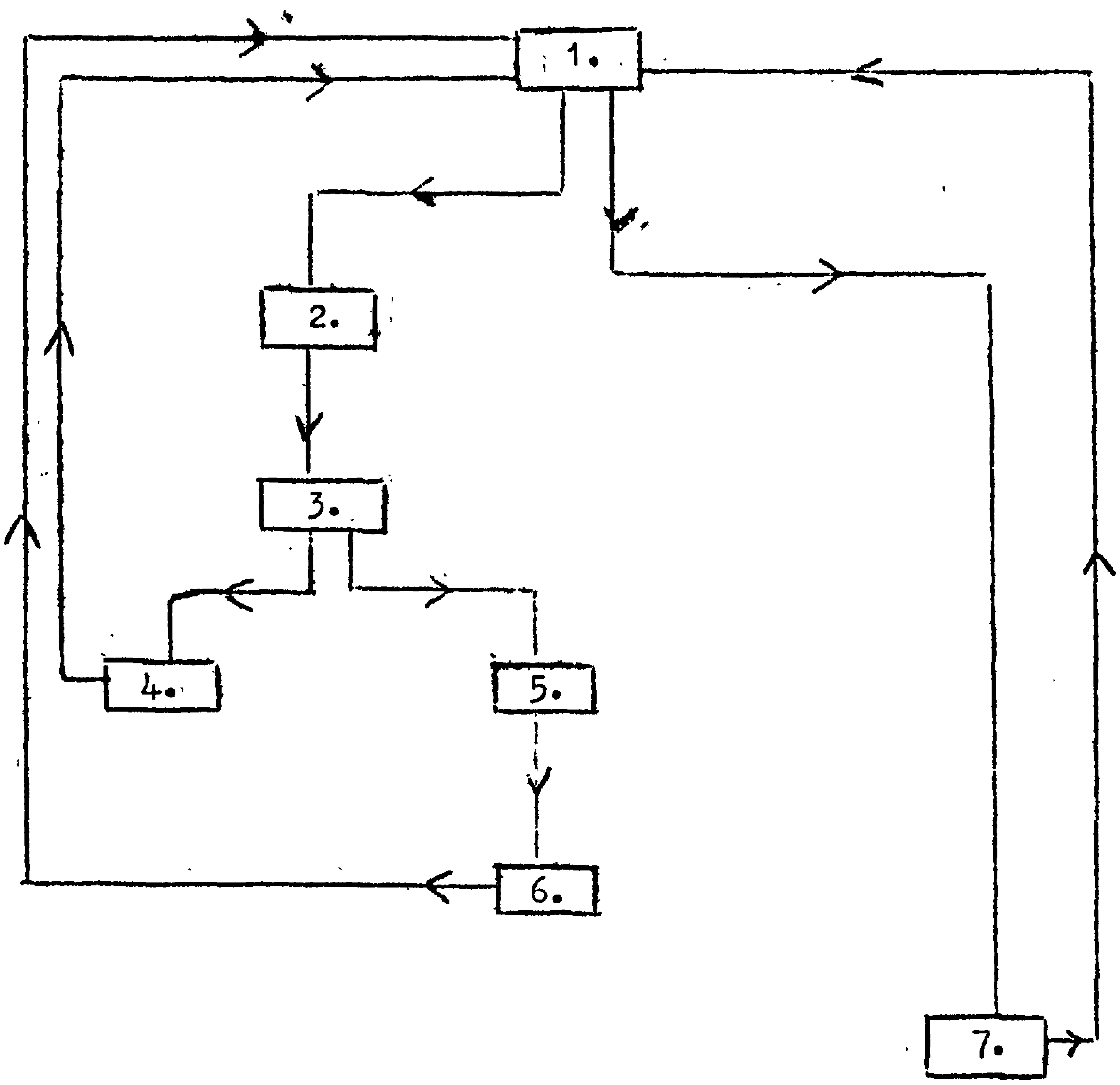
and

my Father, Emrys John Harris

'Why can't you draw what you see?' is the immemorial cry of the teacher to the student looking down the microscope for the first time at some quite familiar preparation he is called upon to draw. The teacher has forgotten and the student himself will soon forget, that what he sees conveys no information until he knows beforehand the kind of thing he is expected to see.

P.B. Medawar, 1967

A structured flow diagram of the Preface.



The numbers in the blocks indicate the paragraphs.

THE PREFACE

1. This preface is intended as a preliminary accessing device. It introduces the accessing system, of which it itself is a part. It explains the distribution of descriptors within the dissertation and contains a glossary of the key descriptors. (Squires 1970, Vickery 1968).

2. The empirical studies reported, which deal with the search behaviour of students, in order to retrieve information within a learning context, through the medium of the printed word, have also served to emphasise the importance of accessing devices, which faciliate this search. In practical terms this means paying much more attention to this information store in relation to its retrieval. This depends upon the provision of accessing devices which faciliate retrieval.

3. The accessing devices made available in this dissertation are of two kinds; those in the text and those outside it. Within the text the devices which are provided include: the spatial division of information in large chunks, paragraphs, headings and sub-headings, cross reference to the appendices, to other parts of the text and to the bibliography, and many key terms or definitions have been underlined. Outside the text the accessing devices provided include: the table of contents, which represents a sequential description of the information dealt with, a new accessing system, the structured flow diagram, which represents the interrelations between the main descriptors, and the glossary.

4. The rationale governing the sequence of the table of contents is explained in the general introduction in Unit 1.

Following the plan outlined by Marquis (1948), the programme design was sequenced into seven phases; the problem formulation, the review of existing knowledge, preliminary observations, model or theory construction, the formulation of a series of experimental studies, the application of the revised model to the educational problem, and a final assessment of the theoretical outcome.

5. The rationale governing the development of a new accessing system, the structured flow diagram, is summarized as follows. In textual materials, the only relation always made explicit is a linear progressive one; there is assumed to be some rationale behind the sequencing of material described in the table of contents. However, various types of logical relationships exist in written material, which a reader can manipulate according to his needs or queries. These do not necessarily coincide with the order of the table of contents or descriptor headings in each chapter. The structured flow diagram, presented as an accessing device, within this dissertation, represents an attempt to describe one other relationship, namely that of the generic relationship between the main units in the table of contents and between paragraphs within these units. Structured flow diagrams were developed and used within the empirical studies reported, and their (what is believed to be) novel use as an accessing device, grew out of the findings of these reported studies.

6. The structured flow diagrams, which aim to express the generic relationship between the main units or paragraphs are of two kinds;

I. An abstract of the generalisations dealt with in the text, is printed in each block of the diagram. This type of flow diagram is presented in Unit One, at the ~~beginning~~ end of the literature review.

II. No abstract of the generalisations dealt with in the text is presented in the flow diagram. The reader has to construct these abstracts, in order to evaluate the generic relationships implied by the diagram. Examples of this type of flow diagram are found at the beginning of this preface, ~~after~~ before the table of Contents, and at the beginning of each theoretical Unit (4,6 and 8).

Type I provides the reader with a more detailed organizer (Ausubel 1960) for information retrieval, than Type II. The purpose of Type I and II is to encourage greater active participation in reading, within a guided framework.

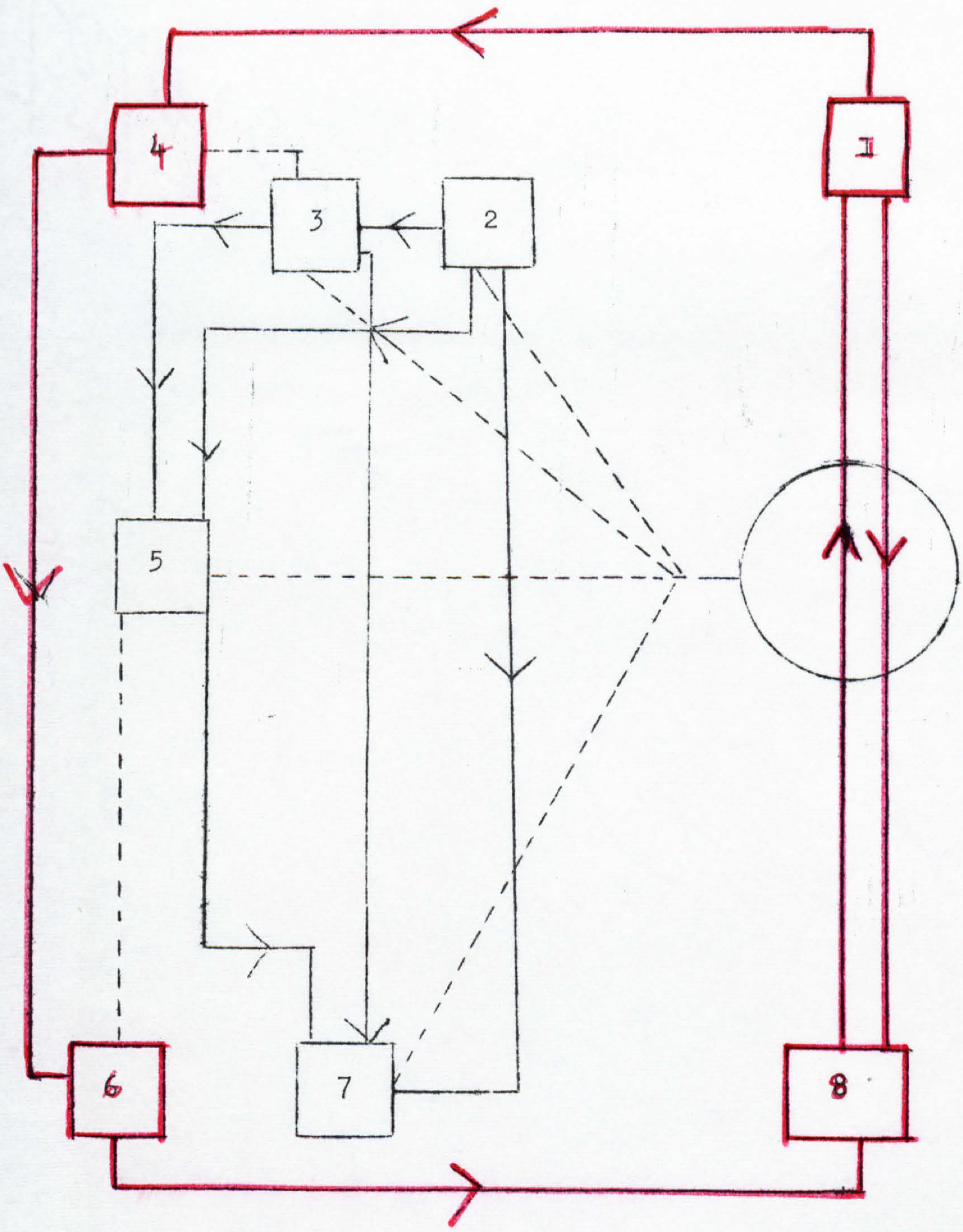
7. The Rationale of the Glossary.

Psychology acts upon and is acted upon by other disciplines. Its terminology, unlike most other sciences, is not entirely the result of a systematic reappraisal; it gathers its terms and concepts from an untidy area of related disciplines. Some of the outstanding terms, which are used as descriptions within the text are glossed in an attempt to explain their usage within the semantic environment dealt with. The function of this glossary is seen as a mediating device, between the possible meanings already available to the reader and the meaning which governed the usage of the terms, within the context of this dissertation.

The main descriptor terms are:

the Stimulus Situation	(block 1)
the Terminal Response	(block 2)
the Learner	(block 3)
the Reading Process	(block 4)
the Levels of Behaviour	(block 5)
the Instructional Procedure	(block 6)

A STRUCTURED FLOW DIAGRAM OF THE TABLE OF CONTENTS



This is a plan of the thesis. The numbers of the units indicate the order in which they appear. The solid black lines indicate the progression of the experimental aspects of the thesis. The solid red lines indicate the progression of the theoretical aspects of the thesis. The dotted lines indicate a relationship between the experimental and theoretical aspects of the thesis.

C O N T E N T S

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UNIT 1. The Problem Formulation and Review of Existing Knowledge.

1.1 General Introduction

The research project here reported forms part of a larger research programme at the "Centre for the Study of Human Learning" which is part of the School of Social Sciences at Brunel University. This programme is planned as an integrated set of projects, focused on the central problem of student learning and staff teaching. The ultimate aim of the research programme is to help students and staff to develop an effective repertoire of learning and teaching skills. Such skills include: listening in lectures, seminars, tutorials and informal group discussion; writing for personal notes, essays, examinations and research reports; talking formally in lectures, seminars and informally in tutorials; manual dexterity in practical work and reading from books, charts, the blackboard, films and teaching machines.

The broad aim of the research strategy reported was to probe into student learning processes, through the medium of reading, in an attempt to extend both the range and effectiveness of reading skills. One of the central learning skills demanded of a student is that he or she learn by reading: books have always been a main source of information for learning. Today the proliferation of books and printed matter brought about by the information explosion confronts the student population with much more reading material than it can digest. In addition, the new technology of learning has greatly extended the range of such educational devices as teaching machines, programmed texts, programmed text books, and textbooks with elaborate information retrieval devices. This information explosion and technological revolution in education further emphasises the predominance of the written word. Reading is therefore considered as a major learning skill.

At the research frontier of any given field, the pursuit of knowledge can be dominated by either the 'pure' conception that 'truth' for its own sake justifies the means, or the 'applied' conception that the valuation of 'truth' lies in its usefulness. Often the orientation of research is not wholly 'pure' or 'applied' and, to a large extent, the apparent antithetical conception is artificial rather than real. The formulation of a practical problem is often only perceived in the context of a theoretical conception, and the verification of a theory often throws up practical problems. According to modern scientific philosophy, the final test of a theoretical formulation is its predictiveness in terms of real situations. Medawar (1969a) has pointed out that in the 'hypothetico-deductive' conception of modern science, the two apparently contradictory conceptions are reconciled. The 'pure' and 'applied' conceptions can be regarded as "two successive and complementary episodes of thought, that occur in every advance of scientific understanding." In other words, any research project depends upon a complex dynamic relationship between the so called 'pure' imaginative creative phase and the so called 'applied' critical evaluative phase, for its successful operation.

The specialists at the frontier of educational research are not all agreed on the relationship between pure and applied research in a given research programme. Ebel (1969) and others James (1913), Estes (1960) argue in favour of a direct applied approach designed to yield information immediately useful in the solution of contemporary educational problems. In their view experience not experiment, discussion, reasoning and consensus not rigorously tested theories should form the basis of research. This view is diametrically opposed to that recently expressed by Cronbach (1966) who argues that efforts to improve education at the technological level would be largely futile and that significant improvement could ~~not~~ come from a fundamental understanding of the basic elements of education, such as learning and motivation. Of the educational research workers whose contributions are referred to in this project, most share this latter view. The author accepts, however, that this opinion rests more on faith and hope than on evidence and logic. However, an underlying assumption of this project has been the concept that a deep understanding of <u>the learner</u> is essential for the development of an effective teaching procedure. Hence, pure research with its emphasis on the establishment of a system of concepts and relations has formed the foundation of the research strategy. The ultimate goal was, however ~~therefore~~, applied and as a result the research strategy was seen essentially as action research relating to the specific educational problem of developing an instructional procedure to encourage students to improve the range and effectiveness of their methods of reading. The outcome of this approach has been a dynamic mix between the pure and applied conceptions of research.

The project was planned as an integrated set of experimental studies, focused on the central educational problem of the student as a learner of complex verbal material, through the medium of the written word. It represents an attempt to broaden and lengthen the scope of a research entity so that its merits can be verified.

Following the plan outlined by Marquis (1948), the project was sequenced into seven phases. The temporal sequence of the phases was not fixed, although there was a natural order of approach. The seven phases are listed as follows:-

1. <u>The Problem Formulation</u>

UNIT 1

From the existing theoretical hypothesis concerned with learning, basic assumptions and a general experimental approach was adopted which provided the vocabulary and conceptual framework for interpreting the problems of student verbal learning.

UNIT 1.

2. Review of Existing Knowledge

This took the form of an extensive literature review and participation in formal and informal discussion, with research colleagues. The culmination of this activity was the establishment of a basic approach to the problem of the student as a learner of intellectually complex matter.

UNIT 2. and UNIT 3.

3. Preliminary Observations

This involved testing techniques, exploring the 'problem' and testing the basic assumptions.

UNIT 4.

4. Model or Theory Construction

This involved the formulation of a preliminary model, which represents a systematic interpretation of the student as a learner of intellectually complex matter. This model formed the basis of subsequent testing.

UNIT 5. and UNIT 6.

5. Formulation of an Empirical Study

This study was planned for testing the model and for its further development in order to increase its usefulness.

UNIT 7.

6. Application of the Model or Theory

This represented the final test of the model in that its degree of usefulness was tested in the practical educational problem of the learning situation.

UNIT 8.

7. An Assessment of the Practical and Theoretical Outcome

This was an attempt at analysis and synthesis. It involved a critical reappraisal of the model developed, with suggestions for further investigations.

In 'pure' research in its strictest sense, phase six is not involved, since the final goal is that all postulates should be tested by making deductions from them, which are experimentally testable. With the exception of Skinner, psychological thinking within learning theory has tended to emphasise the 'pure' or theoretical over the 'applied' or practical issues. Theories have often developed from logical argument and tested by making deductions which are experimentally testable, without any reference to the practical problem of the real learning situation. Such theories, divorced from practical problems, have subsequently been found inadequate, since they fail to produce solutions to these problems. In 'applied' research the overall goal is the application of the model to the practical problem. However, in the present state of the growing field of learning psychology, any conceived model rarely predicts directly the complex uncontrolled conditions of the everyday situation. The application of a model demands a degree of 'psychological engineering' which has become the province of the educator. Whether the research programme is 'pure' or 'applied' in orientation, the cycle is rarely completed, since the achievement of the final stages in either opens up new theoretical and practical problems, which initiate the cycle again. In other words any research entity is reiterative.

1.1.1. Statement of the Problem

Students often experience difficulty in reading new subject matter in order to 'learn' it. Some report that they find it difficult to read through the text and that they often fail to maintain attention beyond five or ten minutes; others report that even though they have read the text and thought that they 'understood' it, they cannot apply the information adequately in any kind of performance testing situation. Students also report that, several readings of the same text reveal different 'meanings.' Many of them appear not to have developed the skills of selection and self-organisation needed for rapid and effective learning.

Most students say that they can read, but they are not aware of precisely how they do it. They are only vaguely aware of the cognitive and emotional organisation which underlies and structures their reading behaviour. Part of the problem is, therefore, how to increase students' awareness of their own intuitive tactics and strategies for information retrieval and storage. The other part of the problem is how can they be encouraged to increase the range and effectiveness of their reading skills?

According to De Cecco (1969a), we have passed through a whole era of educational research on teaching methods that makes global comparisons of old and new instructional techniques, especially in connection with television, the film, the lecture, discussions, programmed instructions and the text book, with little understanding of the basic variables and with little control over extraneous influences. Such research has had few theoretical or practical results. De Cecco points out, that at most such research has had a propagandistic and commercial value. There is a broad jump from fundamental psycholinguistic research on the grapheme/phomeme stage of early reading skill and the complex and essentially unanalysed problem of instruction, in the higher skills of reading. The problem of instruction in reading skills is fundamental. To solve it, in spite of the work of Bruner, Miller, Piaget and others, no psycholinguistic model which could form the basis of an instructional procedure, has been developed.

1.1.2. The Experimental Approach

It is difficult to assess to what degree learning characteristics (as reflected in reading characteristics) are innate or acquired. However, the impetus of modern developments in the field of cognition serve to emphasise the importance of the ecology of learning and opens up the interesting possibilities of the influence of cognitive development through systematic intervention. Again, it is felt there is a need for the definition of specific dimensions of an area within the schemata of modern theories of learning rather than the establishment of further generalisations such as Harlow's learning sets and Piaget's conservation and centralisation.

Within this framework of thinking experiments were designed to:

(i) Identify methods (strategies and tactics), of reading and to relate these to the effectiveness of learning, bearing in mind such factors as the variety of conditions within the learner the structure of the written material and the type of learning task set.

(ii) Plan and develop retraining schemes to suit each learner (i.e. to attempt to influence qualitatively the efficiency of learning), and to evaluate techniques of self-diagnosis and control at various levels of organisation in reading for learning.

(iii) Reshape or develop further a model of learning which takes the above into account.

1.1.3. Some Basic Assumptions

1. Learning is concerned with the use of language by reading in order to perform certain tasks. A hierarchical order of levels of learning in relation to reading is set out below (Gagné 1965) :-

recognition of the major principles of highest level of abstraction of the text.
recognition of the concepts of groups of words, phrases and clauses.
recognition of the concept of word meanings and the textual organisation as a whole.
recognition of the ORDER of sentence, paragraphs etc.

	recognition of the nouns, verbs, prepositions, i.e. syntactic structure.
III Reading	recognition of printed word.
II Printed word	a prerequisite to reading.
I Language	a prerequisite to verbal skill.

2. Reading is treated as a generative tracking task in which the reader is continually predicting the content at various levels of meaning and uses his eyes to check how these meanings match to the printed structure of the text (Thomas L.F. 1969).

3. Intellectual growth depends upon an interplay of an internal capacity genetically inherited and of the external social skills of a given culture. the efficiency of the 'cognitive map' can, therefore, be enhanced by the development and practice of techniques for coding verbal information according to its meaning structure. The explicit exercise of this technique could extend the cognitive potential of a person so that a more efficient 'map' can operate as a referent for the matching of external information in order for it to be understood (Bruner J. 1964).

4. The written word is not linear in meaning. Sequential statements differ in that they may deal with specific and relatively concrete or more complex and relatively abstract data (De Leeuw 1965). The reader exerts a selective filter on the text (Broadbent 1958), and while ordinarily the information is evaluated implicitly, difficulties arise if the text is not understood. The exercise of information classification can serve as a method of explicit evaluation so that the

organisation and interrelation of the various components of the communication can be better understood.

5. If training to read is to be effectual, it should be related to a learning theory which seeks consistently to account for 'insight'. (Bayles 1952). Procedural emphasis thus shifts from mere repetition, which is the outcome of traditional behaviourism, to conceptualisation which is the outcome of the cognitive approach. Insight is here defined as a 'sense of pattern' which is not to be equated with Gestalt, but with the neo-connectionist - cognitive viewpoint, that it consists of an integration of external information which is organised into higher order ensembles making possible the use of larger units of information for the solution of problems. Both the component parts and the whole pattern behave under similar laws, but since the parts are integrated into an organised unit, it means that there are characteristics of the whole that do not apply to the parts (Miller, Galanter and Pribram 1960).

6. The growth of 'insight' in the learning process is considered as an open system with inputs and outputs operating in a dynamic equilibrium, so that the equilibrium of the learner is changed to a more complex level of equilibrium. When the equilibrium is disturbed, as when a learner encounters new concepts, it is restored when the new concepts have been incorporated into the new pattern (Piaget 1950, 1957).

7. Learning is usually measured against criteria predetermined by the experimenter in the laboratory or the tutor in the classroom. The empirical studies which follow aim to investigate the process of learning by reading or input activity, and to establish relationships between this and the output which is achieved. In brief, the investigations are learner oriented. (Jahoda & Thomas 1966: Kelly 1955).

8. Learner participation in the learning process initiates and maintains motivation and increases morale provided that he operates within

a control system, so that any confusion or disorganisation in the learning can be detected and compensated. (Thomas 1968).

9. Accepting the need for communication between the learner and the instructor, it is essential to develop a common language. Gagné (1965) argues for a language which is based on controlled experimentation, basic research with emphasis on a deep understanding of such basic elements of education as learning, motivation and instruction. The outcome of this approach to educational research is to relate and to examine the relationship between educational objectives and human performance. Gagné argues that this relationship should be operationally linked: the objectives should be considered in increasing levels of detail in relation to a specific task, and the performance should be analysed and linked to the task.

1.2 Literature Review

1.2.1. Theoretical versus Practical Problems: Molar versus Molecular Models.

1. Theoretical systems have developed in parallel with experimental studies of learning. However, their interrelationship has not always been constant. Early in the history of verbal learning psychology, the empirical work concentrated on practical problems with a bias to education, but with the growth of knowledge and ideas a theoretical involvement of empirical work became more marked, with the result that original practical problems were in danger of being ignored. Ideally, the applied psychology of learning should be of importance not only as a way of putting theory into practice, but as a way of evaluating further the boundary conditions of the theory. When the theoretical model is inadequately developed, (which is the accepted situation of learning psychology at the present time), applied psychology has to concentrate upon the practical aspects of the learning problem with a longer term goal, that inferences from such studies are of relevance within a

a theoretical model building framework. The general tendency in the last decade has been to emphasise theoretical differences to the exclusion of the reality of the basic learning problems, which have become magnified as a result of the educational explosion catalysed by the technological revolution. Such theoretical differences mark a necessary phase in the development of a rapidly growing subject. However, there is a danger that an individual researcher takes a stance, which becomes too involved with the theoretical issues of the day and, as a consequence, any ensuing programme becomes divorced from the realities of the learning situation, in relation to education. Another factor, which must be borne in perspective, is that hopes for an all embracing "Newtonian" formal theory of learning of "Hullian" dimensions have rapidly become a diminished goal as a result of the realisation of the immensity of the problems involved. The tendency is, therefore, to emphasise miniature model systems of molecular rather than molar proportions, so that research programmes are related to specific dimensions within a more restrictive theoretical boundary. Jenkins (1954) distinguishes three levels of psychological theory: level one contains the relatively raw 'immediately apprehended', 'specific' data; level two contains concepts and laws which are summaries of their observed relations to level one; level three contains a formal mathematical or logical system which explains the laws of level two, which in turn explain the events of level one. At present, the models of learning theory are sets of level two concepts and laws and are, therefore, of molecular rather than molar dimensions.

2. Within this differential of theory and practise, and of molar and molecular model building, the author has taken the standpoint that a research programme on human verbal learning should first and foremost be realistically based on the specific problems apparent; on the other

hand, an overall view of the present state of learning theory is accepted as essential if the results are to be not only applicable to that specific problem, but to be taken into account within a framework of theoretical formulation of molecular dimensions. Whether or not this molecular theoretical system becomes knitted into one of molar dimensions (which is the utopian goal of any researcher), depends upon further verification or refutation within a larger research policy geared to a formal and all-embracing theory of learning, from which accurate predictions about all aspects of learning can be made. The action research reported in this dissertation is concerned with problems of short-term learning of intellectually complex matter through the medium of reading, with the ultimate aim of developing a theoretical model of molecular dimensions within which predictions can be made for the systematic intervention of the process in order to remedy it at the individual level.

3. This literature survey concerns itself with two theoretical aspects: a review of knowledge of the connectionist and cognitive theories of learning, and a review of knowledge of the practical aspects of the educational problem of the student as a learner of intellectually complex matter through the medium of reading.

1.2.2. Review of the Theoretical Problem.

1. Accepting that the operational aspect of the research is essentially applied, the basic assumptions which underly the orientation of the research strategy stem, however, from a consideration of interpretations of learning, in particular whether a connectionist or cognitive viewpoint is most adequent in accounting for learning. The shifting positions represented by the neo-behaviourists and cognitive theorists is considered by Kendler (1964) to emphasise that original basic differences in the psychological dilemma as epitomised in Skinner's and Miller's extreme connectionist and cognitive approach to

verbal learning, have become more apparent than real. The apparent differences reflect "personal preference for models and language systems adopted to represent behaviour instead of fundamental theoretical assumptions." Within this melting pot of neo-connectionist - cognitive ideas, the tradition of the natural sciences has emphasised the importance of public observation and public evidence, of cause and effect relationships; of the linear logic relationship of information; the concept of a hierarchical organisation of component parts and the use of performance models. The emerging connectionist - cognitive interpretation of complex verbal learning behaviour uses the hypothetical constructs of the cognitive theorist or the intervening variables of the connectionist theorist to explain Stimulus-Response relations.

2. In the mediational hypothesis of Osgood (1952) and Kendler (1964), a rapprochement between cognitive and behaviouristic theories has taken place. These mediational hypothesis explain the role of stimulus producing responses as mediating responses between the initiating stimulus and the terminating response. If responses are considered as providing cues, which consist of complex verbal cues, the ensuing inferences relate to a connectionist-cognitive theory within which the cognitive theorist statements such as Lewin's life space (1935), Tolman's sign gestalt expectations and cognitive maps (1932), Miller's images (1960), Ausubel's cognitive structures (1960), Bruner's cognitive strategies (1956), and Piaget's cognitive schemata (1937), are accepted and reinterpreted as stimuli produced by the individual's own responses. Within the connectionist tradition, the 'inferred elements' of internal stimuli and responses of Guthrie (1952), the habit strength, drive and incentive motivation, mediating processes of Hull (1943), and Spence (1956), the compound habit family hierarchies of Maltzman (1955), and Staats (1963), the one factor sign-learning mediating process of Mowrer (1960), show that a single Stimulus-Response association corporealised in

the reflex arc is inadequate to account for the complexities of learning behaviour. The internal stimulus and response, mediation hypothesis of Osgood (1952), and Kendler (1963), has formed a realistic bridge between traditional connectionist and cognitive conceptions of learning.

3. Another offshoot of a neo-connectionist - cognitive approach to complex verbal learning is cybernetics (1948). Like a connectionist theory these feedback models are concerned with informational connections between stimuli and responses. Stimuli serve as the input, responses as the output and the individual as the system. Negative feedback is the process by which stimuli control responses. The feedback model is, like cognitive theories, concerned with ways in which purposive behaviour is maintained by a flexible control system that takes the structure of the environment into account. Valuable aspect of this approach is that it emphasises the continuous control of sequences of behaviour, and in so doing, combines a precise molecular analysis with a flexible purposive view of molar analysis.

Another valuable aspect of these feedback models are the role of negative feedback in the performance with the output being fed back to control the operation. An analysis of the explicit value of this feedback in a specific learning event could be made use of in any instruction designed to intervene systematically in the learning process. Yet another valuable aspect of the feedback model is that learning can be interpreted as a change in feedback mechanisms - i.e. a change in the way the system deals with deviation, which is possibly related to the trying out of different responses until one of them is successful. Behaviour is thus not merely a collection of stimulus response units in traditional connectionist terms, but a continuously ongoing process.

4. To the extent that a theoretical system has conditioned the design goals and interpretation of the research strategy, this neo-connectionist - cognitive conception orientated towards cybernetics has

provided the guiding principles. Essentially the system can be considered as follows:-

neo-cognitive neo-connectionist system	Learning Behaviour		
cybernetic system	Input System	Finite Automata Complex Storage Systems and Control	Output System
neo-connectionist system	Independent variables - external stimuli which set up the mediating responses and which can be manipulated and controlled by the experimenter.	Intervening variables - mediating covert responses - the cue value of stimulus producing responses.	Dependent variables - terminating overt responses which can be observed and measured.
neo-cognitive system		Inner states - schemas, images, life space, sign gestalt expectation, cognitive maps, personal constructs cognitive style	

In this reported research strategy, the <u>independent variables</u> of **the input** system consisted of the <u>written information</u> provided on the reading recorder and the <u>instructional directives</u>. The <u>dependent variables</u> which were observed and measured consisted of the <u>written overt output</u> which took the form of a summary or response to Objective tests. The reading recorder provided a technical device for detecting and measuring the mediating responses or change in negative feedback at the molar level in terms of the lines of the text and textual organisation as a whole. This provided the reading strategy. In most reports of empirical work in verbal learning psychology, these mediating responses are inferred rather than observed. The experimental approach is considered as original and novel and results are considered to be of particular relevance to the model-building approach of mediating processes at the molar level. The design of this aspect of the research strategy was largely influenced by Kelly (1955), who emphasised the importance of making public the private construings or mediating phase between stimulus and response. A comparable study at a different level is the selection strategies of Bruner and his associates (Bruner, Goodnow and Austin, 1956). They describe ways in which individuals can learn concepts. Selection strategies control the order in which examples and non-examples appear. They have three purposes; they maximise the opportunity to obtain useful information about the concept; they reduce the strain of assimilating and keeping track of information and they regulate the amount of risk taken in reaching a solution. The difference between these selection strategies and a reading strategy, as observed by means of the recorder, is seen to be related to levels of learning. In selection strategies the nature of the concept (conjunctive, disjunctive or related), is known before learning takes place, and the information concerning the attributes and values of the concept to be learnt is immediately available as displayed on the 81 cards. In reading to learn, many kinds of concepts of varying attributes and values may be involved and the linear order of the written information precludes all information being available at one time. The nature of the concept is also not fully apparent. The text must first be explored for its conceptual information before the concepts can be learnt. In comparison with selection strategies, reading strategies are seen to represent two levels of learning.

5. Three questions are of central importance within a theoretical formulation of mediating processes in relation to verbal conceptual learning; how language is acquired, how it develops through ages and stages and how it relates to thought?

1.2.2.1. The Mediation Process and Verbal Learning

6. The study of verbal learning and verbal behaviour begins with the connectionist approach of Ebbinghaus (1913), with his studies of memorisation of verbal lists. Up to the present time, it is a matter of considerable debate as to what verbal responses are learnt, letters, syllables, phonemes, morphemes, words, phrases, sentences or transformational rules and how these external stimuli, which became internally represented, are linked to meaning. In this area the psychological dilemma between cognitive and connectionist theories remains acute, although a closer union of the two approaches is realistic if the cue function of words, as external stimuli, that mediate internal processes, is taken into account.

7. To the traditional cognitive theorist, thought has been experimentally linked to perception as well as to learning, although the necessity of learning in the development of thought is acknowledged. A background to the study of thought in the cognitive tradition begins with the early gestalt psychology. In the gestalt tradition, as reflected in the studies of Wertheimer (1945), Kohler (1925), Koffka (1935) and Katona (1940), learning takes the form of insight which is defined as a suddenly occurring reorganisation of the field of experience. However, this viewpoint of insight does not take into account the transfer from previous learning experiences as epitomized by Harlow's studies of learning set (1959). Lewin's studies of motivation and personality in the gestalt tradition accounts for learning and thought within his concept of life space (1935).

This represents the totality of factors which determine behaviour at a given time, phenomenological space contains the individual, the goals he is seeking, the barriers that restrict his movements and the paths he must follow. Learning involves a change within the life space, but in his theorising this aspect of how life space is changed by external events is not developed in detail. As a result, Lewin's theoretical system is useful for stating the results of certain kinds of learning, but of little value in predicting what learning will occur under what conditions. The first efforts in combining the advantages of a cognitive and connectionist approach to learning was Tolman's sign-gestalt theory (1932). Drawing from Watson's behaviourism (of stimulus and response associations) to Lewin's gestalt psychology of life space, he constructs a purposive behaviouristic theory of learning, which deals with goal directed whole acts of the organism. What is learnt is 'sign significate expectations' and not responses as such. The relationship between the sign and the significate (an early and later stimulus), is established in accord with contiguity and this established relation is the expectation. At the molar level, this expectation becomes the goal, and a given goal may be approached by a variety of different acts. To account for this he takes the individual's cognition or 'perception and beliefs' into account. This corresponds to Lewin's life space. It is within the intervening variables represented by sign-significate expectations that a union of connectionist and cognitive approaches was initiated. Other contemporary cognitive theorists have described the intervening variables in terms of the organisation of thought into internal hierarchies. Thought is described in terms of internal hierarchies and there exists a sub and super-ordinate organisation of knowledge and of behaviour. Such terms as 'subsumption' used by Ausubel (1960) and schemata used by Piaget (1937), strategy used by Bruner (1956), and plans used by Miller and Pribram (1960), imply a

hierarchical organisation.
To Ausubel, the acquisition of new meaning is the subsumption of new material under more inclusive ideas already existing in the cognitive structure. Piaget (1937) conceives development of intellectual processes of children as a continuous interaction of the child with the environment. As the child continues to cope with the environment his mental processes become more complex. This coping requires more than the simple habitual responses which he has termed assimilation and which are of equivalence to Skinner's operant behaviour. Instead the child must reorganise his thinking and this develops new patterns of responses which Piaget called 'schemata.' The child in learning must change old into new more complex schemata and this process he has termed accommodation. This process of reorganisation takes place in sub-stages and stages. Bruner (1964), interprets cognitive growth from the 'outside in' as well as from the 'inside out'. Growth from the 'outside in' depends upon the mastery of skills transmitted by the culture, language being a prime example. This ties up with anthropological evidence and implies that changes in man have been alloplastic - he has changed by linking himself with novel external implementation systems. Man's behaviour is a product of the dynamic interaction of an inherent biological capacity with external implements which amplify his ratiocinative capacities as exemplified by language, myth, theory and explanation. This depends upon an internal representation of the complex environment in which he lives and an integration whereby information is organised into higher order ensembles which can be used for the solution of problems. Bruner distinguishes three modes of representation, enactive (through motor responses), iconic (through visual responses) and symbolic (through verbal responses). Their appearance in the life of a child is in that order, each depending on the previous one for its development, yet each remains as an intact entity throughout life. It is in the growth of symbolic representation that the greatest thicket of psychological problems is found. As a result

of its acquisition the productive elements of the mind become apparent. Bruner's concern is for productive thinking. He describes 'hypothetical modes' and 'cumulative constructionism' to describe typical patterns of student thought. He emphasises the learner's need for active engagement in what he learns and to organise information within hierarchical levels, into cognitive structures which are meaningful to him. Intellectual capacities are developed and intellectual competence achieved when an individual is allowed freedom of search and discovery. Bruner (1956) describes selection strategies which represent intellectual processes (as mediating processes) through which concepts are acquired. These represent ways of handling and processing information. Miller, Galanter and Pribram (1960), assume that behaviour is organised into hierarchies. These hierarchies are totally different in conception to the habit family hierarchies of Hull and Maltzman which refer to the ordering of responses in terms of response strength. Their hierarchies are defined as levels of internal representations. These hierarchies are concerned not only with the organisation of knowledge, but with how knowledge becomes action. In this, these researchers have bridged the gap between thought and action, and this is their conception of the Plan. Tolman went no further than the conception of thought, and he has been criticised by many connectionist theorists for leaving his rats thinking in the maze. A plan is any hierarchical process in the organism that can control the order in which a sequence of operations can be performed. Image is the term given to organised knowledge and is equivalent to Bruner's cognitive structure and Piaget's schemata. These authors stress their cognitive approach and draw up similarities between William James' concept of the 'will' (1890), and their definition of plan. They refer to Bartlett's schemata (1932) as ways of organising our past experience for recall and use, and the similarity of Lewin's concept of intention, and their own description of thought and action is emphasised. Within this hierarchical conception of thought, Chomsky's theory of transformational Grammar (1957) and the complex organisation of thought that this implies can be accepted.

8. To the traditional connectionist, thought is the product of learning and the study of thought is pursued by systematically manipulating the environmental stimuli that control learning. Guthrie's connectionist theory (1952) which is an offshoot of Watsonian theory (1913), reduces all learning to a simple associative rule; any combination or totality of stimuli which has accompanied a movement will be followed by that movement when the combination occurs again. Complete learning thus occurs on the first occasion on which a stimulus is paired with a response. Guthrie is concerned with stimuli and responses at a molecular level and viewed in this detail no total stimulus pattern nor response pattern is ever exactly like another. Generalisation is considered as gross stimuli consisting of overlapping pools of minute stimuli. Motivation and reward have no main status in this system. Thorndike (1932) and Skinner (1957a) represent similar contemporary viewpoints which emphasises reinforcement as a basic factor in learning in the connectionist tradition. Like Tolman, they tend to deal with acts at the molar level. Their studies are essentially practically biased to the problems of education rather than to establishing a theoretical system of learning. Skinner, however, regards the two paradigms, conditioning and instrumental learning as representing different kinds of learning. Hull's deductive connectionist system (1943), which stems from Watson and Thorndike, represents the most ambitious attempt to develop a formal theory of learning. The system consists of 9 basic sets of postulates from which levels of learning may be deduced in quantitative form. The two notions of habit strength and drive deduction are at the centre of their system and can be regarded as intervening variables. Habits are formed and increase in strength as a function of the number of reinforcements and the amount of drive deduction. Drive has an activational role through its multiplicative

relation with habit strength and in addition, exercises a stimulus role. Emphasis of this stimulus role permits Hull to explain experiments which otherwise would be classed as cognitions and has led to challenging ideas on generalisation gradients and discriminative characteristics of drives. In the tradition of Hull, Maltzman describes thinking as intervening variables. His basic concept is habit family hierarchy which operates as a convergent or divergent mechanism (1955). To account for the changes in habit family hierarchy, Maltzman utilises knowledge of conditioning and mediated generalisation. Maltzman's conceptualisation of thinking epitomises the mechanistic connectionist viewpoint of learning. His hierarchical conception of thought is of an entirely different one to that of the cognitive theorists. Maltzman's conception explains reproductive thought rather than novel productive thinking. While the cognitive approach concentrates more on the internal states or intervening variables, and the connectionist approach concentrates on the external states or independent and dependent variables, the connectionist-cognitive approach takes both aspects into account; the external stimuli, the mediational process or covert response which is triggered off as a result of exposure to these stimuli, and the overt responses which become associated with these.

9. The mediating hypotheses of Osgood (1952), Mowrer (1960), Kendler (1963) and the hierarchical vertical and horizontal conceptions of Gagné (1965) can be considered as a rapprochement between the cognitive and connective schools. The knowledge hierarchies of Gagné explain within a connectionist-cognitive language of independent, intervening and dependent variables, how the range of human learning from simple response learning to problem solving takes place. Gagné's description of types of human learning includes horizontal response chains and vertical hierarchies of concepts and principles. He distinguishes 8 types of human learning from verbal associate learning consisting of chaining

of two or more previously learned stimulus-response behaviours, multiple discrimination of specific stimulus response patterns, concept and principle learning, which is critically dependent upon internal neural processes of representation, which in man, language plays a very determined role and problem solving, which implies the combination of concepts and principles learnt into a greater variety of novel higher order principles.

10. To distinguish a number of learning types is not a novel idea in the history of learning psychology. One of the most widely accepted distinction is that learning consists of the classical Pavlovian conditioned response and trial and error learning as typified by Harlow's learning sets. Skinner considers it to be a basic and essential distinction (1957). Hull, in his major formal connectionist theory considered the distinction to be one of different experimental conditions rather than of different underlying mechanisms. Skinner distinguished chaining as an identifiable form of learning and used this principle in his systematic shaping of operant behaviour, the technique by which he trained animals to perform complex acts that are outside their normal range. Hull, in his account of habit family hierarchies accepted the principle of chaining as well as of conditioning, and trial and error learning. Tolman, in his theory of purposive behaviourism distinguishes 6 kinds of learning of the molar level (1949). Within this conception Tolman attempted to account for the considerations of Freud on the psychoanalytical theory of motivation (1935); Guthrie on the stimulus-response connections learned by contiguity (1952), Lewin's paths and barriers of life spaces (1935), and Skinner's conditioned reinforcements (1957). However, within this cognitive framework of interpreting the mediational process of learning, he failed to provide detailed laws of Skinnerian dimensions nor general principles of Guthrian dimensions. His system cannot, therefore, be applied in practical learning situations.

Another modern psychologist in the neo-connectionist-cognitive framework, Mowrer (1960) discusses multiple discrimination learning and concept learning as well as the simpler kinds of learning.

11. These attempts to categorise learning types in the connectionist, cognitive and neo-connectionist-cognitive systems, represent a revolt against other psychologists within these systems who contend that all learning is basically the same. Watson and Guthrie in the early connectionist tradition, and Thorndike, as well as Miller and Mowrer in the later connectionist tradition, maintained this.

12. Gagné describes 8 varieties of learning that are distinguishable from each other in terms of the conditions required to bring them about. His criteria of classification are essentially practically based on simple observation, but the implication is that there are 8 corresponding kinds of changes in the mediating processes or internal states of the nervous system which need to be identified and accounted for. Whether these changes are structually different or energetically different, remains to be seen, but these changes are clearly distinguishable outside the human organism in terms of the conditions that must prevail for each to occur. Gagné accepts the possibility that as research continues new formulations of these conditions might be necessary. The analysis of Bloom (1956), based upon instructional objectives of learning in which verbal learning is categorised into the acquisition of knowledge and 5 other skills, comprehension, problem solving, synthesis, analysis and evaluation, may well have to be taken into account in this respect. How these identifiable abilities and skills relate to Gagné's learning types requires evaluation. In brief, the varieties of learning which have been currently distinguished by Gagné are:

Type 1 Signal Learning	The individual learns to make a general response to a signal. This is the classical conditioning response of Pavlov.

Type 2.	<u>Stimulus-Response Learning</u>	The learner acquires a precise response to a discriminated stimulus. What is learned is a connection (Thorndike) or an instrumental response. (Skinner)
Type 3.	<u>Chaining</u>	What is acquired is a chain of two or more stimulus-response connections.
Type 4.	<u>Verbal Association</u>	The learning of chains that are verbal. Basically, this is similar to Type 3. However, the use of language in the human makes this a special type because internal links may be selected from the individual's previously learned repertoire of language.
Type 5.	<u>Multiple Discrimination</u>	The individual learns to make different identifying responses to as many different stimuli, which may resemble each other in physical appearance. Although the learning of each stimulus-response connection is a simple type 2 occurrence, the connections tend to interfere with each other's retention.

Type 6. <u>Concept Learning</u>	The learner acquires a capability of making a common response to a class of stimuli, that may differ from each other widely in physical appearance. He is able to make a response that identifies an entire class of objects or events.
Type 7. <u>Principle Learning</u>	In simplest terms, a principle is a chain of two or more concepts. It functions to control behaviour in the manner suggested by a verbalised rule of the form, "If A then B", where A and B are concepts.
Type 8. <u>Problem Solving</u>	Problem solving is a kind of learning that requires the internal events usually called thinking. Two or more previously acquired principles are somehow combined to produce a new capability that can be shown to depend on a "higher order" principle.

Each type of learning begins with a different state of the organism and ends with a different capability of performance. It is, therefore, implied that the differences among the varieties of learning outweigh their similarities. Since the most important condition that distinguishes one from another is its prerequisites, Gagné has constructed a vertical hierarchical organisation of learning types in which the prerequisite of a more complex type depends upon the accomplishment of a simpler learning type. This hierarchical organisation can be represented as follows:-

Type 8	Problem Solving
Type 7	Principles
Type 6	Concepts
Type 5	Multiple discriminations
Type 3 and 4	Verbal associations or other chains
Type 2	Stimulus - response connections

Concepts

13. A consideration of the theoretical interpretations of verbal learning focuses attention on concept formation and utilisation. In the In the neo-connectionist-cognitive framework of interpretation this represents the central issue of the role of mediational processes or intervening variables in learning behaviour. The studies of Harlow has shown how concepts formation can be non-verbal (1959), However, the reports of Livblinskya (1957) and Luria (1959) shows that the use of verbal language greatly facilitates concept formation. Luria considers that through the symbolic properties of language, children learn a much more complex adaptation to the environment than they would otherwise. This is because through the use of language they are able to manipulate whole groups of concepts in complex ways so as to set up rules by which they regulate their behaviour. Jensen (1966) has proposed a theory to account for the development of the organisation of verbal behaviour. He describes various types of verbal learning which develop within various age groups. In the final stages of verbal learning, internal verbal utterances (V), represent a mediational process between the stimulus (S) and the response (R). This development of S-V-R learning distinguishes between animal and human behaviour according to Jensen. This development of verbal behaviour eventually reaches the level of the formation

of conceptual hierarchies. On the other hand, Carroll (1965) interprets all concept formation as preverbal. He conceives of words, meanings and concepts as three relatively independent series with complex interrelations. Carroll describes concepts as "classes of mental experiences learned by organisms in the course of their life histories." The formation of particular concepts depends on experiences with positive and negative examples of these concepts. These are the necessary conditions. The sufficient conditions include set, reinforcement of responses and sequencing of positive and negative examples. The viewpoints of Piaget, Bruner and Miller emphasises the dynamic aspects of concept formation and utilisation.

14. Attempts have been made by Shannon and Weaver (1949), to relate concept formation to information theory. Utilising information theory, there has been growing interest in the study of complex human behaviour through simulation by computers. Computer research in thinking is illustrated in the study by Newell, Shaw and Simon (1958). They assume a number of storage centres (memory), processes that use the stored information and a set of rules for combining these processes into programmes of information processing. They reject the traditional connectionist conception of the nervous system as a passive photographic plate because this overlooks the importance of the system's responding to complex and selective ways to simple stimulation. The neurophisiology of the neo-connectionist is more sophisticated with Hebb and his theory of reverberating circuits (1949). The big question of their interpretation is whether they are studying operation of the computer rather than human thought and problem solving? The brain as the control of human behaviour is a vastly complicated system. Analogies between the nervous system and a telephone exchange system have had their uses. Similarly, the concept of computers through finite automata (McCulloch & Pitts 1943), is useful in understanding the nervous system. A machine

which is capable of learning not merely by utilising what has been built into it, but also by acquiring information to which the machine is exposed, and using this information predictively. Such a machine must possess a built-in capacity to learn. Through finite automata or an information theoretical model, it is possible to conceive of the computer any way we like. According to George, (F.H. George 1961), the principles of classification stachastic storage, conditional probabilities, generalisation and built-in systems, are involved in finite automata. Feedback is taken to be implied by the organisation, which is essentially an elaboration of an input/output system with complex storage and with modification of response tendencies, through experience. At the highest level, there is the problem of symbolic representation of input-output events. This problem of how language is stored and used represents one of the big challenges of the future. This can be related to the problems of information theory. This theory can be regarded from at least three levels, syntactic, semantic and pragmatic (Carnap, 1958). Syntax is a formal set of signs that have certain grammatical properties; they follow rules that allow a certain set of combinations to occur and not others. Signs in the syntactical model relate to objects and relations which is concerned with semantics. The behavioural effects of language in social interaction is pragmatic. The study of human verbal learning encorporates all three levels of information theory.

15. General behaviour systems theory incorporates most aspects of information theory and also deals with the transmission of both information and energy, and with the relationships between information and energy transfer. In living systems the process of coding which makes possible for energy exchange to be information exchange, is basically of two kinds, innate or learnt, although the distinction is often not distinct. In the former, the information is encoded on the complicated DNA molecule as specific sequences of the 4 specific purine and pyrimidine bases. The

The question at the neurological and chemical level, therefore, is how the learnt behaviour is encoded? Since DNA codes its information to the cell in its control of the synthesis of specific protein molecule, it is possible that stimuli in the environment codes information within the central nervous system in the form of specific protein molecules. Some amino acids specific to the brain cells have been isolated, such as, amino butyric acid. The relationship between information and matter has a reality in empiricism. The law of entropy, the second law of thermodynamics, points to the specific relationship between energy (E) and entropy (S). Einstein's theory of relativity includes the basic equation $E = MC^2$; Weiner and Shannon have written equations which correct the notion of entropy with the negative of information

$$S = - H$$

a combination of the above equations:

$$E = MC^2$$
$$I$$
$$S = - H$$

demonstrates that there is a highly complex but to a degree, quantifiable relation between mass (matter or energy) and information. In other words, the Platonian metaphysical conceptualisations of the relationship of form and matter has a reality in empiricism. According to James Miller (1955), this implies a basic role of information theory in science. Information which can be measured in bits, or larger units, can convey qualitative or formal structural aspects to any system. It can describe the non-random relationships in which energy is organised. Information and energy co-exist as companionate aspects of every system. According to Miller, this fact should lead to a better understanding of the system known as the brain and the messages or information conveyed or stored in it.

16. Medawar, however, points to the error of equating in antithesis biological organisation and information theory, thermodynamic order and

non-randomness. He emphasises that a theory of order which represents the complex functional and structural integration of living organisms remains to be developed. It must be borne in perspective that the concepts of entropy and thermodynamic order are appropriate when dealing with energetics; of information theory when studying how messages are sent and acted upon, and of probability when dealing with phenomena that have a random element. Lacking the theoretical equipment it remains to be seen whether the solution lies within the confines of general behaviour systems theory in which the parts and the wholes behave according to similar laws, or within the Gestalt concepts which represent the opposite pole to empiricism and analysis, in which the laws of the whole are not connected and do not apply to the parts.

17. Sir Charles Sherrington (1906), the pioneer of research in the nervous system,reached the conclusion that energy and mind are phenomena of two categories, with the brain as an organ of liaison between them. Sir Cyril Hinshelwood, presiding at the British Association (1968) said "what remains utterly incomprehensible is how the brain becomes the vehicle of consciousness." At the edge of Biology, we meet the chasm between what science describes and what the mind experiences. Certainly, the crucial question of whether we do, or do not (within our present theoretical systems) understand the principle of life,is being reconsidered by a small group of prominent contemporary scientists. Professor C.H. Waddington (1969) and a small group of mathematicians and physicists (the Serbelloni group) agree that a major upheaval in present ideas is imminent. They argue that neo-Darwiniam and information theory cannot account for all the phenomena of life. Recently, Professor David Bohm suggested that rather than the parts of a living structure determining the whole, the whole may be determining the parts. René Tomo (1950), draws an 'topology' to describe the development of living forms.

He maintains that in Biology there exists formal structures - geometric entities which determine the forms of living matter. At this research frontier it is very much an open question whether a mentalistic cognitive approach in the traditional gestaltian sense, or a neo-connectionist-cognitive mechanistic approach to learning will finally lead to an adequate theoretical system to predict learning. Miller's psycho-linguistic conception (1965), that the meaning of an utterance is not a linear sum of the meanings of the words that comprise it, is of particular relevance in this context. This implies that the studies of the meanings of isolated words is of limited value, and that attempts to predict meaning of word compounds by weighted averages of the meanings of their components cannot be successful. In gestalt terminology, Miller claims that "the whole is greater than (or at least different from) the sum of the parts."

1.2.2.2. How language is acquired

18. Concerning the first of the three issues relating to verbal learning, namely how language is acquired, two major and contrasting connectionist and cognitive viewpoints which are in current vogue, emphasise the lack of a generally accepted theory.

19. In Skinner's functional analysis of verbal behaviour, only external conditions are relevant (1957b). His system does not account for the contribution of the organism to verbal behaviour. For Skinner, verbal behaviour is that behaviour we observe in everyday life. Although he insists on empirical explanations of verbal behaviour, his own analysis of linguistic behaviour rests on a speculative extension of his experimental analysis of animal behaviour.

20. Chomsky (1959) objects to Skinner's analysis of verbal behaviour in that he seeks to observe the causes without considering the neurological make-up of the speaker and what the speaker contributes to

learning and performance. Chomsky stresses the central importance of the speaker's ability to generalise, hypothesise and process information. Learning theory must explain according to Chomsky that, "all normal children acquire essentially comparable grammars of great complexity with remarkable rapidity." The transformational grammar of Chomsky assumes that lnaguage is a system of rules which can be variously arranged to form and understand new sentences. Knowledge of a language is thus based upon an intuitive mastery of the rules. The two essential concepts of transformational grammar are the Kernel sentence and transforms (1957). Chomsky defines the Kernel sentence as the underlying structure which expresses all the syntactical relations and functions that appear in any sentence. Postal (1964) has used the concept of phrase makers to describe underlying linguistic structure. Phrase makers describe the parts of the subject-predicate structure and how this structure becomes grouped into specific sequences of a sentence. The transformations represent a combined product of linguistic structure and psychological processes within the speaker. Miller (1962) has used Chomsky's transformational rules as a basis for psycholinguistic research. He has investigated the encoding decoding process which he describes as the "combinatorial power" to arrange grammatical rules to form new sentences. He is particularly concerned with the relationship between memory and syntactic structure, and with the relationship between the various syntactic structures and understanding. Miller points out that as a result of his studies there must be far more to 'meaning' than reference, in terms of an arbitrary association between some 'referent' and a 'thing', and then reducing the reference to a simpler matter of conditioning. Miller (1965) points to the major shortcoming of Skinner's approach as ignoring the syntax of the sentence and the distinction between the language and the user and the biological sub-structure necessary for speach. Skinner, and more recently Broadbent (1970), points out that the fact that grammar has rules need not imply that language is learnt by means of these rules. He argues in analogy: the fact that a person extends his arm and body in a skilled manner to catch a ball, does not imply that he has learnt this movement by means of the rules of biochemical muscle contraction and physics. It still remains to be seen whether the more cognitive studies of sentences and phrase makers will reveal more about the nature of language and thought than the connectionist studies of single words and syllables.

21. If Chomsky on the one hand, and Skinner on the other, could accept the cue function of words as external stimuli which mediate internal responses, and the possibility of behaviour chains capable of horizontal and vertical arrangements, this would result in a rapprochement between them. This approach is epitomised in the hierarchical theory of Gagné.

1.2.2.3. The Development of Language through Ages and Stages

22. Concerning the development of language through ages and stages, there exist two separate schools of thought. According to Sigel (1964), the basic issue which differentiates the two schools of thought is thus: Does development always follow the same pattern so that there is a fixed order of ages and stages, or is development a product of learning experiences which differentiate ability, knowledge and skill for each individual? As in the case of the controversy between connectionist and cognitive theories on the nature of learning, the issue may be a product of the tradition of research rather than the product of contrary assumptions. The former European school epitomises a basically 'pure' or theoretical approach within a system called the age-dependent theory and the latter American school epitomises the experimental approach. In the new experimental vigor of Piaget and in the increasing developmental interests of American experimental psychologists, it is possible to

envisage a rapprochement. This would consist of accepting the conception that the development of learning depends upon the acquisition of the necessary prerequisites in the terms of Gagné. This is dependent on the time-span of the developmental intellectual life of the individual. The process of reorganisation of the cognitive schemata of Piaget during development, takes place in ages and stages as shown by Erwin - Tripp (1960) would thus be dependent upon the acquisition of the necessary prerequisites. Within the theoretical environment of this rapprochement, Erwin-Tripp and Miller (1962), have shown how the study of linguistics relates to the acquisition of language. The child must learn the sound system, (phonology) and grammar (linguistic) when acquiring language. After the one and later two word stage of utterances, the 'marked grammatical system' appears when markers such as 'the' before a noun and the introduction of verbs after 'can' and before 'ing' are practised. This appears to be a simplified model of the adults' language. Erwin-Tripp and Miller take the view that 'transformational rules' may well explain the mechanism of the acquisition. Werner and Kaplan (1950), have investigated the acquisition and generalisation of meaning in relation to language. Related terms, which in adulthood are differentiated in meaning, are often confused in children. During development, children use sentence contextual clues to discriminate and generalise meaning. Asch and Nerlove (1960), have used terms with double syntactical functions to compare the linguistic behaviour of children of different ages. The results show that the recognition of multiple meanings is not the result of discrimination. The same term is first used in different contextual situations without the recognition of similarity of syntax. Recognition of the multiple function comes later with practise and is an individual rather than age-group attribute. De Cecco (1969b) points out that in learning words have multiple rather than single meanings, the child demonstrates an innate hierarchical organisation of thought. Brown and Berko (1960) deal with <u>syntactic categories</u> and <u>function</u> as distinct aspects of a language. Their studies show the close correspondence between the developmental curves of both aspects which emphasises the <u>genetic interdependence of meaning and structure</u>. The question remains whether the meaning and the structure is learnt together as a whole, or became associated through contexual practise? The adoption of a comprehensive system of education has focused attention on the relationship between <u>social class language and meaning</u>. Bernstein (1961) has shown social class differences in the use of language. He has formulated linguistic differences as elaborated and restricted codes in the middle and lower social classes, respectively. The <u>elaborated codes</u> are similar to Chomsky's description of syntax and the failure of lower classes to learn the elaborated code represents the failure to master the syntax of their own language. The characteristics of <u>elaborated</u> and <u>restricted codes</u> give a direction to the <u>organisation</u> of thought. The implications of this on learning are of crucial educational relevance. The syntactical make-up of a subject must be taken into account as one of the independent variables.

1.2.2.4 <u>Two Approaches to Meaning</u>

23. There remains the crucial question at the research frontier of psychological learning theory, <u>what is the meaning of meaning</u>? The cognitive theorist asserts an <u>indirect</u> relationship between the physical world and cognition. Words become meaningful when they recall images that are copies of the objects they name and when they are incorporated with other words in the cognitive structure of the individual. To the <u>connective theorist meaning</u> is reduced to a function of specific variables, such as <u>word frequency</u>. Word frequency is a measure of the frequency with which individuals are <u>exposed</u> to words.

24. Ogden and Richards (1953), take a cognitive standpoint and they make the crucial distinction between the symbol (word) and the referent (thing). The relationship between the two is 'imputed'. Meaning does not adhere in the direct word-object relationship. Chase (1931) points out that the absence of a direct relation has allowed certain men to probate the expertise of word games and deception.

25. Noble's (1952) connectionist approach identifies meaning with associational strength, which is a different concept to that of the habit strength described by Hull and Maltzman. Meaning as such is not discussed within the Hullian system, although a connectionist interpretation of meaning could be made in terms of habit strength. Noble defines meaning as the mean number of continued written responses given within a one-minute period to a particular word. This is a strictly functional concept, although in his definition of complex meaning, which is considered as a product of certain responses producing stimuli, that in turn give rise to a host of new responses; these stimuli are internal or proprioceptive and have some similarity to Osgood's mediating stimulus. Noble's associative strength appears to be an important component of meaning, but other components of meaning, such as, the syntactical relation words have to one another and to sentences, the ability of individuals to choose between alternative meanings and the relation of the acquisition of meaning to previously acquired meaning and to the influences of culture are obviously also important.

26. Osgood's neo-connectionist-cognitive approach (1952) emphasises the importance of 'mediational processes' to account for the difference in responses elicited by words and the objects which they represent. He observes that words elicit only part of the responses which the associated object elicits. The word response is referred to as rm (which is an abbreviation for mediating reaction), this produces a

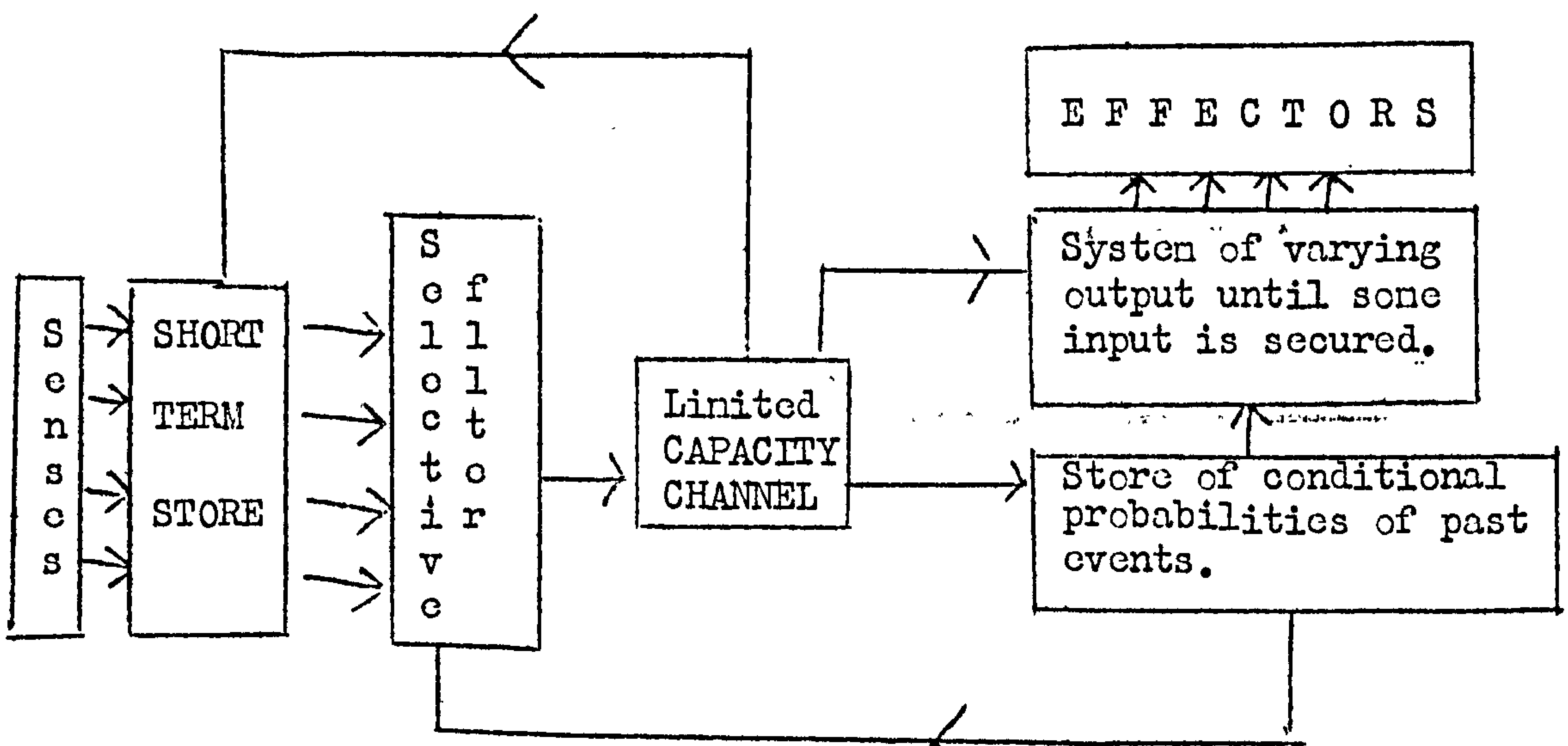
mediating stimulus Sm, that in turn may result in a variety of overt responses. Osgood offers his theory in a connectionist stimulus-response context, but the mediational process he describes is not accessible to observation and is inferred in a cognitive context. Osgood and his associates have studied mediating responses in terms of the dimensions of meaning. They developed a technique known as semantic differential where pairs of words were selected which define a dimension of meaning, such as hard-soft. They claim that ultimately it is possible to determine how many dimensions are required in order to describe the meanings of all words. Each of these separate dimensions would be equivalent to each separate mediating response. The several different mediating responses occurring at the same time with different intensities in response to the stimulus word would determine the meaning of that word. Dimensions which they have evaluated include 'evaluative', 'strong-weak' and 'active-passive' dimensions. The semantic differential technique has been shown to have limitations owing to the difficulty of ranking certain 'concrete' or specific words. However, its development represents an interesting approach to the quantitative understanding of meaning. Erwin-Tripp (1960) has pointed out that the factors found by Osgood in the semantic differential studies may be the referents for the several terms which are used as synonyms prior to differentiation of finer distinctions between attributes. Katz and Fodor (1963), have attempted to describe the characteristics required by a semantic theory of language. They distinguish between grammatical and semantical theory of language. The semantic theory should account for the individual's ability to interpret the sentences of his language. According to these researchers, the acquisition of transformational grammar, does not complete the explanation of why the native speaker is able to use and understand new sentences. Sentences of different syntactical structure can have identical meaning, sentences of similar syntactical structure can have different meaning. A semantic theory should account for the semantic relations between morphemes in a sentence. It should predict cases in which the sense of a morpheme or string of morphemes in a sentence restricts the range of meaning of other morphemes in the sentence. A semantic theory must possess 'projection rules' as one of its components. The effect of the projection rules must be to select the appropriate sense of each morpheme in a sentence in order to provide the correct readings for each distinct grammatical structure of that sentence. These projection rules need to be evaluated in detail for the formulation of a formal system which can be computerised. In order to interpret meaning in its fullest sense, the 'combinational power' of Miller, which results in the transformation of syntactical structures and the 'projection rules' of Katz and Fodor' which result in semantic as distinct from syntactic conceptions, must be taken into account. Whether these conceptions represent two aspects of the same phenomenon, or whether they represent two entities interrelated in a complex and dynamic way remains to be established.

1.2.2.5 The Mediation Process and Levels of Theory

27. Stemming from the concept of the mediating process of the neo-connectionist-cognitive theorist, from Osgood to Bruner and Pribram and the hardwear/softwear computer language of the cybernetician, the emergence of a new all-embracing theory of learning seems conceivable. Any model/theory for behaviour must be at many levels, and these must be compatible and closely integrated. Ultimately, it must be possible to describe behaviour at the psychological, neurophysiological and biochemical level. This literature survey is concerned with the molar psychological level of theory. The assumptions that underlie it however relate to all other levels. The conceptualisation of Pribram extend from neurophysical

to psychological levels (Pribram 1960). He has rejected the classical concept of the reflex arc as the fundamental pattern for the organisation of all behaviour, and maintains that a description of behaviour must be made at molar and molecular levels simultaneously since the former are made up of the latter. His theory of behaviour is implicit and intuitive and inferred from observations of linguists and ethologists. Behaviour is hierarchically organised, i.e. it is organised simultaneously at several levels of complexity. At all levels, behaviour is considered as a servo-operation and one which suggests graded responses in organisation. In human verbal behaviour phonemes are organised into morphemes; morphemes are strung together to give words and phrases, phrases in a proper sequence form sentences and a string of sentences make an utterance. A complete description of an utterance involves all levels. The hierarchical organisation of verbal behaviour or plan must relate to an internal storage or representation in the cerebral cortex, to form Images or Cognitive Structures. A Plan must comprise part of the Image since otherwise it could not form a basis for behaviour. Changes in the Image can be affected only by executing a Plan for selecting, storing or transforming information. Changes in the Plan can be affected only by information drawn from the Image. According to Pribram the transformation of Images into Plans in human verbal behaviour is a verbal trick. Images and Plans are inferences which can be described in cybernetic terms as storage centres and programmes or hardwear and softwear.

28. To translate the conceptual idea of hardwear and softwear into neurophysiological terms is a fertile and much discussed area of study. Broadbent's hypothetical constructs of the nervous system based on cybernetic principles is shown on the following page (Broadbent 1958).



A tentative information-flow diagram for the organism, as conceived at the present time by Broadbent. This diagram contains many of the views of recent workers; it covers Brown's research on immediate memory, Deutsch's and Uttley's on learning and the work on anticipation and refractioness as well as that on noise, multichannel listening and prolonged performance.

This information theory model allows future contact with physiology, but does not assume physiological detail. The model is developed from detailed evidence about behaviour and assumes the plausibility of causality between observeables and unobserveables which allows valid inferences to be drawn about events in the brain. Broadbent stresses the need to issue in experiments which involve observeables. The use of cybernetic language has four main advantages according to Broadbent (Broadbent 1958).

1. It allows Stimulus and Responses to be kept as observeables.
2. It allows a servo-operation conceptualisation of the Stimulus-Response transformation, rather than the reflex arc open chain model whichrefers to a peripheralisation which is not always justified.

3. It allows for the combatibility of the description of the integrative action of the nervous system in terms of information flow and physiological knowledge as it becomes available.

4. It emphasises the relationship between stimulus now present and others which might have been present, but are not. This appears repeatedly in the study of skill and of perception generally as a matter of primary importance.

29. The research programme of this reported dissertation is concerned with the theoretical problem of relating reading-to-learn Strategies or Plans to a miniature (molecular) psychological model of the student as a learner of written information, and ultimately to a molar theory which can describe the nervous system.

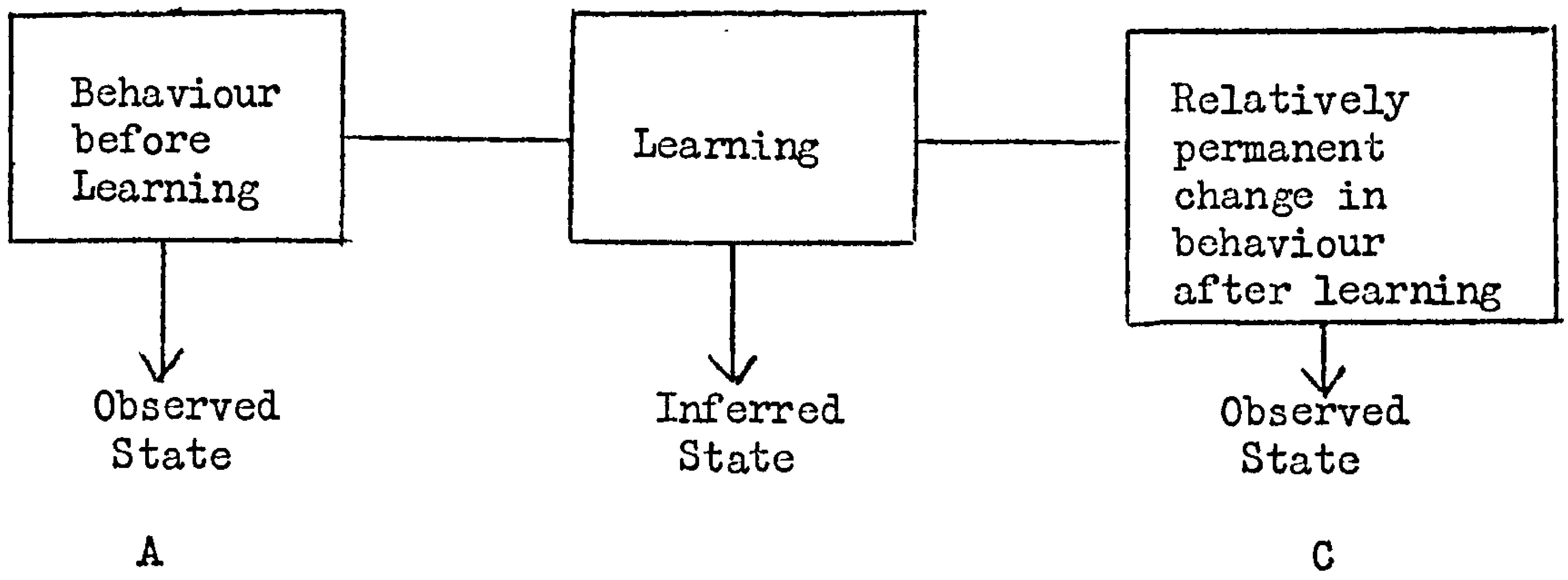
1.2.3. Review of the Practical (Educational) Problem

1. There is ample evidence to show that in employing written information as a medium for learning, most students operate well below their potential reading efficiency. Reading is considered to be one of the most complex skilled performances of which human beings are capable (McLaughlin, 1968), and yet paradoxically within our educational system, it has been commonly assumed, that once an individual has been taught to translate 'strings of letters' into words, no further instruction in the skill of reading is needed. There is a large gap between grapheme/phoneme instruction on the one hand, and the complex appreciation of meanings, central to the study of science and literature on the other hand. Another factor contributing to the inefficiency of reading is that the school learning experience of most students has tended to be tightly circumscribed and monitored. This has meant that success can best be achieved by accepting the structure and standards offered by the teaching staff. Personal responsibility of learning is abdicated for all but the lowest level of self-organisation within their own learning activity, including reading (Thomas, L. 1969). Many students appear not to have developed the skills of selection and self-organisation needed for efficient reading-to-learn. They can point in the direction of difficulties, but can seldom put their finger on the problem. They can report reading problems only as vague areas of unease, and they are only vaguely aware of the cognitive and emotional organisation which underlies the structure of their reading behaviour. The practical problem hinges on a central issue, namely, is it possible to intervene systematically in the process of reading-to-learn in order to encourage students to be more effective learners? To answer the question, it is essential to evaluate in explicit terms the process of reading-to-learn, and to evaluate the learning outcome, in other words, when a student

is engaged in verbal 'learning' through the medium of the written word, what precisely does his behaviour involve? To do this it is necessary to assess which factors determine what will be learnt and how rapidly it will be learnt? In other words, it is necessary to consider what learning is. This problem needs to be examined at several levels and along several dimensions. For this purpose, an assessment of definitions of learning and of the elements which make up a learning event is useful.

2. No one definition of learning appears to be acceptable to all psychologists. However, it is possible to agree on certain phenomena to which the term is not applicable. Hill (1964a) points out that what is learnt need not be correct or adaptive, need not be conscious or deliberate and need not involve any direct overt act. Learning has survival value in the process of Natural Selection, since it can be adaptive and can lead to self-sufficiency in relation to the environment. Learnt behaviour in contrast to innate behaviour frees the individual and the species from evolutionary time. Behaviour which is learnt, can be unlearnt, modified, discriminated and generalised; innate behaviour is stereotyped and inflexible. Learnt behaviour is transmitted through the culture, which is itself changed as a result of the emergence of new patterns of learnt behaviour. For the purpose of this research programme, such conceptions about what learning is or is not, are not directly relevant. It is necessary to define learning more closely. Selection from the definitions available, presents difficulties, because they reduce the total concept of the process. In this reductive process, something is lost, so that the choice of definition must reflect the predisposition and purpose of the user. The author has selected the definitions of Kimble and Gomezy (De Cecco 1968f) and Gagné (1965) as being most useful. Kimble and Gomezy define learning as a relatively

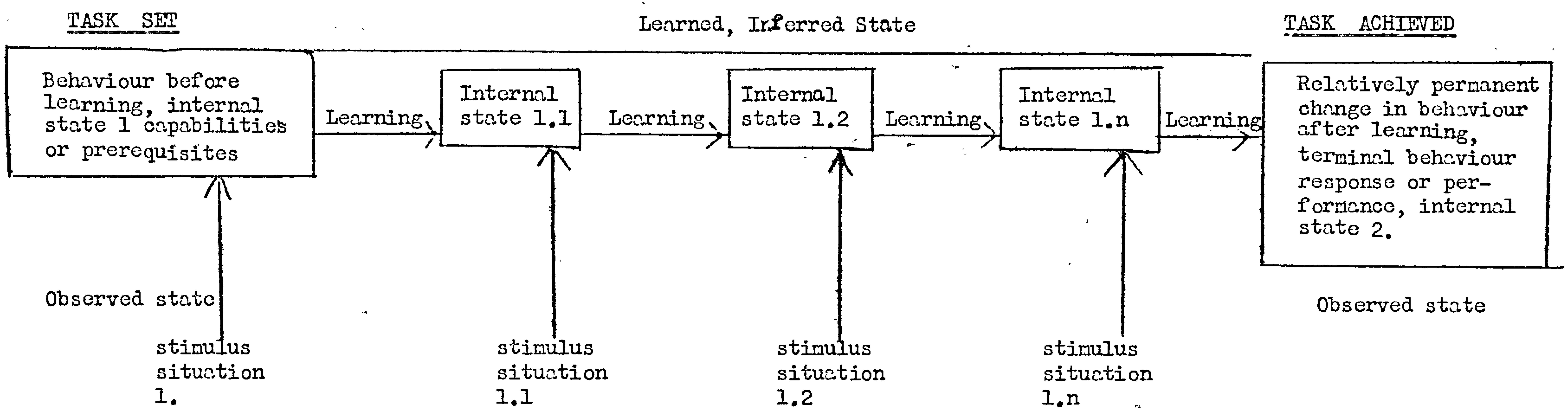
permanent change in a behavioural tendency (which they equate with performance), and is the result of reinforcement. Learning is an inferred state of the organism and as such is distinguishable from performance, which is an observable state of the organism. This concept of learning can be reproduced as follows:-



A and C represent different observeable states.

The nature of the relatively permanent change in a behavioural tendency after learning depends on the stimulus situation, which is related to the purpose of learning or the set task. An analysis of a complex learning task, identifies several sub-tasks, which must be learnt in the process of learning the task proper. The terminal behaviour or response of the overall task and the responses of the sub-task, may fall into different categories of observed behaviour and, therefore, require different learning conditions. According to Gagné (1965), the factors which comprise the different learning conditions are represented by the capabilities of the learner (pre-requisites) and the stimulus situation outside the learner. Each set of conditions distinguishes one variety of learning. Within the definition of Kimble and Gomezy and Gagné, the author interprets a complex learning task as seen overleaf:-

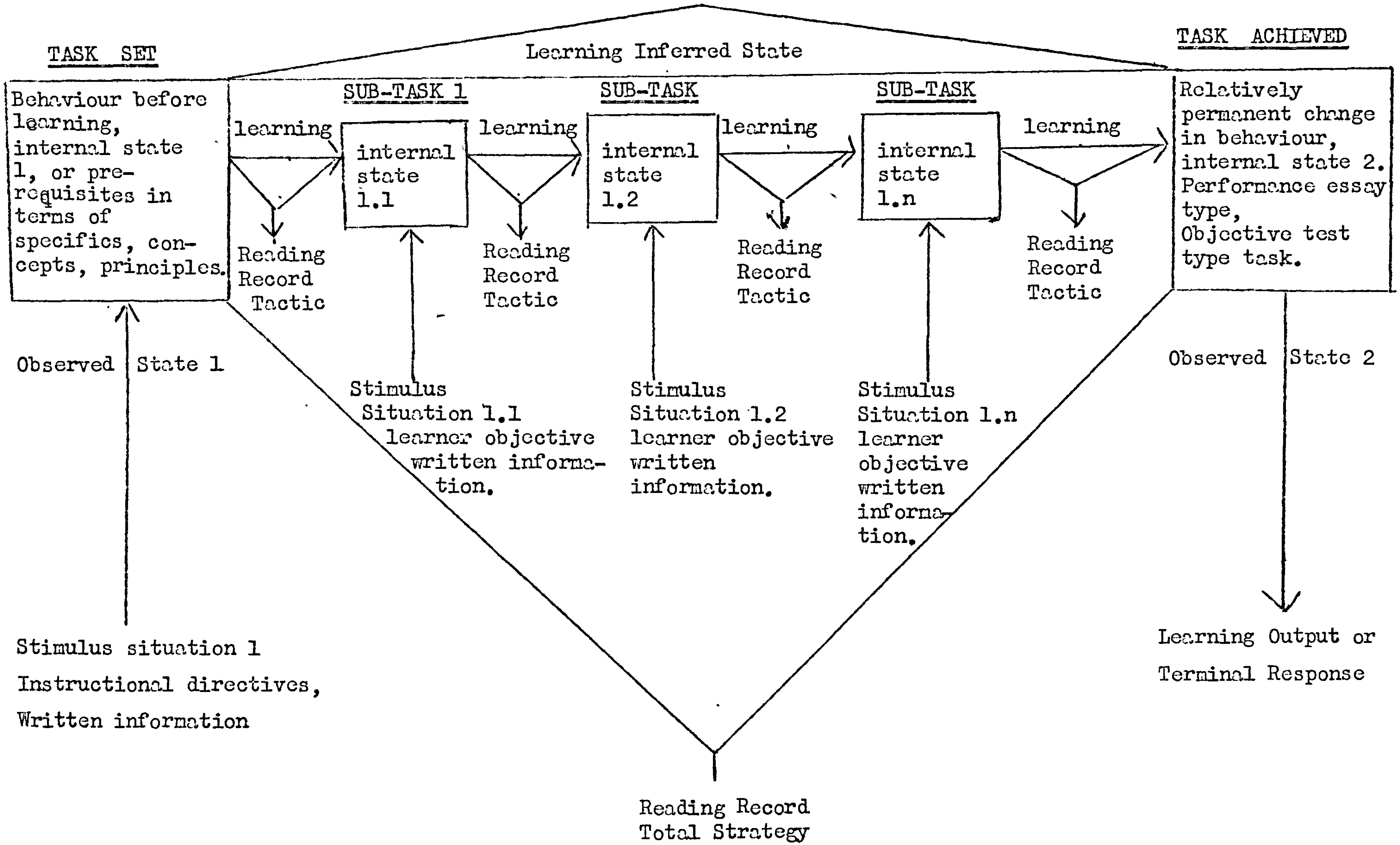
THE AUTHOR'S INTERPRETATION OF THE CONCEPT OF A COMPLEX LEARNING TASK DERIVED FROM KIMBLE, GOMEZY AND GAGNÉ



The interaction between the stimulus situation and the internal state represents one facet of the learning situation. During this interaction between the stimulus situation and the internal state of the learner, an S - R relationship is set up. The nature of the connection cannot be directly observed (in organismic behavioural terms), although it is assumed that some day studies of nervous system functioning may provide a much greater understanding of the mechanism involved, than is now available (Broadbent "Moon Mountains", 1958). However, in observing the interaction between the internal state and external stimulus situation, which represents the conditions of learning for each type of learning (Gagné's 8 learning types), it is possible to describe the requirements for the S - R relationship. During learning, there must be a transformation between the Stimulus (S) and the Response (R) within the learner. The requirements of the observed transformation (in organismic behavioural terms) between S-R represents one aspect of the transformation within the learner (in neurological, biochemical terms). From the observed transformation, it is possible to make some inference about the kind of transformation that takes place within the learner. As discussed in the theoretical review (1.5 2), Gagné interprets these transformations from simpler to complex learning types as a vertical and horizontal hierarchical organisation.

.3. Within this conception of the learning process, the experimental studies on student learning through the medium of reading, reported in this dissertation can be understood as follows:-

STUDENT LEARNING THROUGH THE MEDIUM OF READING



3. The reading records obtained by means of the reading recorder Unit 2, 2.4), thus represent an observeable measure of the interaction between the stimulus situation and the internal state of the learner; in other words, they represent one aspect of the inferred transformation between the interim and overall stimulus and response situation. Part of the aim of the study can thus be expressed as the quest for the identification of the sub-tasks within an overall task, as interpreted by the learner. This identification is inferred from the reading record and how this relates to the outcome of learning. The interim stages of each successfully performed task can thus be explicitly recorded in terms of the learner. This stage of the research programme is seen as a pre-requisite for the larger aim of instruction in reading to learn. The analysis of the sub-tasks and the inferred requirements for their performance as inferred from the reading record can be used as feedback in the instructional process. What makes reading to learn such a highly complex skill is that during reading, the stimulus situation is under the control of the learner, in other words, the learner selects from the potential stimulus situation of the written material the stimuli which interact with his internal state at each stage in the ongoing process of learning to perform a complex highly skilled task. The learner defines the instructional directives in his own terms which more or less reflect the objectives intended by the directives, and this aspect of the stimulus situation is also under his control. The degree to which it is under his control depends on the degree to which he can explicitly define the task in operational terms. Inefficient reading-to-learn can thus be understood to be the inability to set up an optimal stimulus search behaviour to meet the internal capabilities, at each stage of the ongoing process. An explicit analysis of the learning conditions (comprising internal capability and stimulus situation) which make up

a complex learning task, used as feedback to increase the awareness of the learner to the learning situation, would, under this assumption, improve his learning efficiency.

4. The author also considers the learner orientated definition of Jahoda and Thomas (1966) as useful. Jahoda M. and Thomas L.F. have suggested that difficulties in assessing the kind of learning that takes place have arisen because the terminal performance is often judged against criteria determined by the instructor. They suggest that the learner's interpretation of the terminal performance may differ from that of the instructor. His inferences concerning his learning will relate to his own definition of the task, and his terminal performance will differ from that expected. It is implied that the differences in interpretation of the terminal performance originates from the lack of a language to describe the explicit nature of the learning conditions necessary for successful performance of a particular task. Jahoda and Thomas have identified three types of learning. From the above, it will be apparent that these types are not, however, considered in the same category as Gagné's 8 learning types, which were inferred from the 8 distinguishable conditions for learning. Implicit in Jahoda and Thomas' interpretation of learning is the conception that, since learning is an inference from behaviour, differences in learning relate to differences in interpretation of the terminal performance. Learning Type A is measured by comparing the learner's terminal behaviour with the purpose of the instructor; Type B is measured by evaluating changes in terminal behaviour against purposes which are expressed by the learner, and Type C is measured retrospectively by the learner by evaluating changes in terminal behaviour that only become clear to him during or after the learning activity. Learning Type B and C are learner as opposed to instructor orientated, while Learning Type A is instructor orientated. Learning Type B is a special

type of Type C where ideally the learner is under complete explicit control of his activity. Jahoda and Thomas stress that much of the controversy in education derives from different views of the process of learning. Value systems are differentiated according to the different emphasis on each type of learning.

5. A recognition of the importance of the learner's definition of the learning task, within the Psychology Department of Brunel has markedly influenced the design and goals of this empirical work, on learning by reading. Studies have been designed to take into account the behavioural patterns which are observed <u>during</u> learning as well as the change in behaviour after learning. The research emphasis is <u>learner orientated</u>.

6. This approach to the learning problem is concerned with an analysis of the factors which determine <u>what</u> is learnt and <u>how</u> it is learnt? This implies that the internal capabilities or 'conditions' within the learner, which in Gagné's terms represent the prerequisites for learning, need to be evaluated. The behavioural observation of the process of reading-to-learn recorded by means of the <u>reading device</u>, which represents one aspect of the transformation between stimulus and terminal response, can in the language of the <u>neo-connectionist-cognitive theoretical system</u>, be related to one aspect of the <u>mediational process</u>. In accepting this very important comparison, the theoretical problem of model construction and the practical problem of educational application became very intimately interrelated. The theoretical goal and part of the practical goal, which determine the research programme became equated. The practical goal extends to the application of the theoretical inferences about learning, in an attempt to encourage students to increase their efficiency.

7. It is recognised that Gagné's interpretation of <u>internal conditions</u> necessary for learning as <u>internal capabilities</u> forming a

prerequisite for each learning type is one aspect of the total conditions involved. Motivation, attitudes and values also determine learning. Such human dispositions as these are of tremendous importance in the learning process, but this research programme, which is defined within specific dimensions already outlined and related to molecular rather than molar model building, does not attempt to deal with this aspect except in a tangential sense. The scope of the research programme is restricted, to what may be termed the intellectual 'subject matter' content and skill, that leads to improvement in learning.

8. The issues of what is learnt and how it is learnt also relates to an assessment of all the elements in a situation essential for learning. Gagné (1965) identifies three basic elements making up the learning event.

1. The learner (human being or animal). For the purpose of describing the learning event, the most important parts of the learner are his senses, control nervous system and muscles.

2. The events that stimulate the learner's control of his senses, spoken of as the stimulus situation.

3. The action that results from stimulation and subsequent nervous activity which is called a response. Responses may be described specifically at three levels, biochemical, physiological and behavioural.

A learning event takes place when the stimulation situation affects the learner in such a way that his responses change from a time before in that situation to a time after it. The change in responses is what leads to the conclusion that learning has occurred. In learner interaction with the environment the conditions, or internal state at that given time, determine his selection of responses through his motor system. These conditions or mediating processes are centred in the cerebral cortex and are inferred from the behaviour of the learner. They relate to his previous learning history.

9. The experimental design and interpretations of this reported research programme attempted to take into account the inferred 'conditions' within the learner, the stimulus situation and the response at the behavioural level. In this approach to the study of learning intellectually complex matter, through the medium of reading, new techniques and equipment had to be developed. These are described in detail in UNIT 2, 'General Experimental Procedures.' Essentially, these consisted of the Reading Recorder which measured the behavioural responses during learning, a semantic evaluation of the structure of the written material, which was used to manipulate the stimulus situation and measure the response situation and instructional procedures which were developed to control the stimulus situation and influence the response situation.

1.2.3.1. 10. The Rationale for the Development of the Reading Recorder.

Few research programmes take into account the measurement of interim behavioural activity during learning. Most reports on learning are based on measurement of the independent and dependent variables (before and after conditions) from which the process of learning is inferred. Bruner's selection strategies (1956), however, describe methods in which individuals learn concepts. He used an array of 81 cards representing the various combinations of four attributes, each with three values. The subject was asked to select a set of cards, which share a certain set of attribute values. He was told to select one at a time and he obtained feedback as to whether the card is a positive or negative example of the concept. This card assortment method could have been adopted for measuring reading by assigning one sentence or 'item of information', on each card. Early reading studies at the Centre were based on this technique. However, the number of cards required in 'chapter' reading is so great as to make this method cumbersome in the extreme. The measurement of eye movements during reading was also considered as a method of obtaining a record of the process. Many workers are currently exploring this technique - Levyschoen (1969, Lesevre (1964), Cunitz, R.J. and Steinman, R.M. (1969), Derek Fender (1964), Shackel (1958, 1960) and Kamiya (1968). Large eye motions can be recorded by photographing the reflection of a light from the corneal surface. Another method relies on the fact that the eyeball has a small electric charge and its slow movements can, therefore, be measured by electrodes placed around the eye socket. Gosta Dohlman (1925) attached a mirror to a subject's eye with a rubber suction-cup so that a beam of light reflected from the mirror would trace the movements of the eyeball. In more recent adaptations of this technique, the mirror is mounted on a contact lens. Such a mirror together with a simple projection system and a photographic plate, provides a rough record of how the eye examines a scene. This method has much to recommend it as regards precision, but for many reasons, did not meet the varieties of demands imposed by the research programme. The delicate and complicated procedure locating apparatus on the eyes, the necessity of fixing the head in a stationary position, and the problems of being restricted to the measurement of a small amount of the text, as well as the economically costly and very experimental stage of the technique, conditioned further considerations of methods of measuring reading. The reading recorder which was developed as a result is robust, mobile, comparatively inexpensive and efficient in locating reading within two or three lines of the text. The device is described in detail in UNIT 2 ('General Experimental Procedure').

1.2.3.2 11. <u>The Rationale for the Description of the Text</u>

Various ways have been devised to assess the "readability" of prose. One is to use one of the several formulas that have been developed, dependent usually on measures of the grammatical complexity and vocabulary level of the material. Bjornsson (1968) has developed a readability index on this basis. His lix system is based on two of the twelve grammatical criteria he originally considered. These two criteria are: the total length of a sentence and the percentage of long words. The method of analysis consisted of counting the total number of words in a sentence and to add up words with more than six letters. Random samples of 100 words and random samples of 10 sentences are selected from a text, the number of samples depending on the size of the text. The total value of the two criteria gives lix. The lix is compared against a lix table graded from easy to very difficult readability. Another method of describing the readability of a text is the "cloze" procedure developed by Wilson Taylor, whereby the deletion of every tenth word in a text, and an assessment of correct guesses by a panel of readers is made. This method is generally considered to be more successful than the first, for example, in detecting that the prose of Gertrude Stein is fairly difficult, despite her use of short words and sentences of moderate length (Carroll 1965). Neither of these procedures were capable of being adapted to the criterion of utility within the research programme. The criterion was that this description of the text could be used to arrive at:-

a) The construction and distribution of objective tests which represented one form of comprehension test.

b) An analysis of the informational item content and relevant selectivity of the "essay type" summaries which represented another form of comprehension test.

c) As a basis for inferring the "learning outcomes" likely to derive from a particular reading record.

d) To develop meaning flow diagrams of the text to be used subsequently in an instructional procedure with informational feedback in a learning situation; to encourage students to develop new tactics and strategies in reading.

Bloom's (1956) classification of educational objectives has been used extensively as a basis for developing objective test items, which test different types of learning abilities (American College Board Achievement Tests). A technique was developed by the author of assessing the 'informational' content of the text in terms of Knowledge items, according to Bloom's classification. This categorisation was explored by three or four independent experts (all teachers) in a particular Knowledge area, who formed a study group to discuss their descriptions. An "agreed subjective meaning structure" of the text was formulated. Bloom's approach to ways of ordering Knowledge, which influenced the development of this classification system, is based on the assumption that language has a structure. It has deep structure represented by kernels and transforms, and a more superficial structure in terms of the syntax and semantics of individual languages (Chomsky 1957). The semantics of a language represent the shared pool of 'meanings' which are representative of a particular culture. Bloom's semantic classification of knowledge is based on the distinction between items of knowledge, which represent Specifics, Ways and Means of dealing with Specifics and Universals and Abstractions. This technique is described in detail in Unit 2, "General Experimental Procedure - Task Evaluation Techniques", and the texts described according to this technique are presented in Appendix A.

1.2.3.3. 12. The Rationale of the Instructional Procedures

Several factors determine the design of instructional procedures. Instructional objectives should be made explicit in terms of specific terminal performances, which is the outcome of learning behaviour. Part of the aim of this research was to make instructional objectives (or instructional directives) explicit in terms of the interrelationship between strategies of behaviour during learning, and terminal behaviour after learning. This depends upon an analysis of the objective in terms of the stimulus situation, mediational phase or interim behavioural activities, and the terminal response or final performance. As discussed in the immediately preceding paragraphs, the reading device recorded the mediational phase, and the technique of using Bloom's knowledge objectives provided a yardstick for the control and measurement of the stimulus situation and terminal responses. The aim of such a task analysis is considered to be to help to determine the optimum learning conditions for the variety of learning tasks a student must learn to perform. These conditions of learning are both internal and external to the learner (Gagné 1965). The internal conditions relate to the level of the students entering behaviour - his present capabilities. The internal conditions which have major effects on verbal learning must relate to the level of meaningfulness (Noble 1952) or Cognitive Structure, (Bruner 1964), Cognitive Schemata (Piaget 1950), Image (Miller, Galanter and Pribram 1960), or Complexity of Learning Type (Gagné 1965). Individual differences in reading may depend upon the different "mix of specifics" and "universals and abstractions" in the person's Cognitive Structure. Several external conditions also influence verbal learning: (1) instructions to learn, (2) practise, (3) reinforcement, and (4) interference.

13. 1. Instructions to Learn

The problem in the learning situation is to focus attention on particular stimuli among the deluge of stimuli which are available. Postman (1946) distinguishes incidental learning from intentional learning: in incidental learning the instruction does not prepare the student for a test on the materials: in intentional learning the students are told before learning the materials that they will have a certain type of test. De Ceccfo (1968a) points out that there are two types of incidental learning: in Type A the student is exposed to materials, but given no instructions before given a surprise test. In Type B, the student is directed to learn a specific task but at the same time he is exposed to material not covered in the directives. The test he is given tries to uncover how much he learns of the tasks not covered by the direction. This was tested in Experiment 3, Unit 3. McLaughlin (1965) points out that incidental learning is usually a misnomer. No experimental situation supports the belief that a distinct learning process occurs without motive, self-instruction or instructions to learn. Either the learning is orientated to the instructions to learn or orientated to self-instruction. The former is related to the Type A learning of Thomas and Jahoda (1966), and the latter to their Type B learning. The problem is to provide an instructional objective (or instructional directives) with sufficient clarity or explicitness in relation to the terminal performance to enable the learner to orientate his personal strategy of learning effectively towards this set goal. That instructional directives do tend to influence the ways in which students study has been reported by George Meyer (1935). Objective and subjective attempts at analysis of methods of study (discussion and observation), indicated that at an overall macro-level, students tended to review differently for essay and objective tests. The differences consisted largely of number and combinations of methods used. Paul W. Terry(1933) reported that selections out of 67 standard methods of prediction for learning, made by 23 students which were judged to be best adapted for objective tests or essay tests, showed that in general methods for the former emphasised 'details', and methods for the latter emphasised 'generalisations.' No literature on this very important issue has appeared until the very recent report by Paul Torrance (1969) which confirmed some of the findings reported in Experiment 3, Unit 3, of this dissertation. Although his findings are complex and not altogether conclusive, evidence regarding differential effects of the "recognition type multiple choice test," and the "divergent production creative applications test" items in relation to students' learning, seems to be strongest and most consistent.

14. 2. Practise

The value of practise in verbal learning is subject to considerable theoretical and practical debate. Students and teachers question its value in knowledge acquisition. The longer a person works at learning the more he will learn (Underwood 1964). It can be interpreted and argued that the development of an internally hierarchical organisation of knowledge and skills - Cognitive Structure, Images, depends on practise. The conditions of practise poses problems for the instructor. Underwood (1957, 1961, 1964a) considers the value of massed or distributed practise in verbal learning; he concludes that the interval between practise must be shorter when error tendency is high than it must be when it is low. If the probability of forgetting is very high, massed practise should replace distributed practise. De Ceccho (1968b) emphasises that the value of either forms of practise diminishes in concept, principle and problem-solving learning if all other learning conditions are properly provided. Another valuable aspect of practise instruction is considered by the author to be part or whole practise. Since learning the parts are only of value when seen within the whole, the progressive part method (McGeoch 1942) which requires practising material, by combining several units into fewer units, is seen to be important. This method is time-consuming, but often effective. This is taken into account in evaluating instructional procedures in reading to learn effectively.

15. 3. Reinforcement and its nature

Reinforcement is a major condition for most learning. There are currently two trends in the interpretation of reinforcement. Hull, Mowrer, Miller, Lewin and Tolman have interpreted reinforcement as drive reduction. The other trend relates to the learner's own responses as goal, as interpreted by Spence (1956), Sheffield(1950) and Premack (1959). Both interpretations indicate the fundamental hedonism of the psychology of learning. Whereas the term reinforcement connotes the hedonic aspect of reward, in reinforcement as feedback the learner is given knowledge of his current responses, which stresses its informational aspect. There is no evidence of methods of separating the reward function from the information function of reinforcement. Reinforcement as informational feedback plays a crucial role in skill learning (Travers 1963, 1964). De Ceccio (1968c) emphasises that the importance of external reinforcement in feedback diminishes as the learner becomes more familiar with the skill: as the correct form of the class, relationships and solutions become clear to the student, he achieves scholarly independence when he can generate his own feedback to test the adequacy of his performance. There are two aspects of informational feedback in terms of relative effectiveness; namely, confirmation and prompting procedures. Prompts are cues to guide the student to a correct response, which is subsequently confirmed or corrected. Prompts can be regarded as supplementary conditional stimuli (classical conditioning). Confirmation can be regarded as reinforcing stimuli (operant conditioning). Kimble and Wulff (1953) showed that prompted instruction was superior to instruction with confirmation of results only on all items tested. Cook and Kendler (1956) found that instructional procedures which provide the learner with sufficient guidance to avoid mistakes is superior to procedures which only correct errors after they are made. De Ceccio (1968d) points out that the balance between prompting and confirmation is a very delicate state - too much prompting in programmed texts can lead to failure in the terminal test. Instructional procedure geared to encourage self-organised learning would enable the student to decide on the best 'mix' for him. In planning the levels of guide within the instructional procedure for reading-to-learn effectively within this reported strategy of research, both prompting and confirming feedback information was provided. The prompting information related to the distribution and number of relevant informational items necessary to complete the task, the confirmation related to the actual items in the text. This is explained in Unit 2, "General Experimental Procedures - The Training Techniques." One of the basic assumptions of this reported research strategy is that the provision of clear and adequate knowledge of results involving prompting and confirmation at the appropriate level in the total hierarchical description of the task enables the learner to be aware of the effects of his behaviour in terms of validating his terminal performance.

16. 4. Interference

Interference factors are conditions of forgetting rather than of learning and retention. Interference is the competition of old and new responses which results in forgetting. In retroactive inhibition what is learnt later in time interferes with the retention of what is learnt earlier. In proactive inhibition, what was learnt earlier in time interferes with the retention of what is learnt later. According to Underwood (1964b), proactive inhibition is the major cause of forgetting. This conclusion is at odds with the traditional belief that what was learnt subsequently rather than what was learnt previously was the chief source of forgetting. Concerning the amount of material presented in a learning situation, Miller(1956) presents evidence that the span of immediate or short-term memory is about 7 links (or bits of information). After 7 links, the information is recoded into larger chunks of information. Since the memory span is a fixed number of chunks, we can increase the amount of information retained by building larger chunks. Finally, the serial position effect (Jensen 1962), points the tendency to remember the material in the beginning and the end and to forget the material in the middle.

17. The Amount of Instruction

In evaluating an instructional procedure for learning, the amount of instructional guidance must be taken into account. Bernard Corman (1957) using Katona's matchstick problems (Katona 1940) studied the effects of various amounts of guidance on the learning, application and verbalisation of the principle and method required to solve the problem. He used three degrees of guidance; providing no information, some information and much information about the relevant principle and method. He obtained in general the following results: (1) as the amount of information about the principle increased, the successful learning (simple requisition) increased: (2) although the amount of information did not affect the verbalisation (writing) of the method, students who received information about the principle (either some or much), verbalised the principle better than did the students who received no information: (3) giving information was more effective than withholding it, as far as application of the principle was concerned. Bruner (1960) and Nedeesky (1967) recommend the use of three levels of guidance within a series of instructional procedures: at the first stage the learner is provided with detailed instruction relating to an analysis of the overall task, at the second stage more general instructions are provided, and at the third stage instructional objective is given. An assumption of this scheme is that during training, the overall goals became associated with the detailed instructions.

1.2.3.4 18. The Complex Skilled Behaviour of Reading-to-Learn

A consideration of these various aspects of the design of this research strategy emphasises the complex skilled behaviour of reading-to-learn. In complex skills the individual must keep track of several sources of information (stimuli), organise this information and control his responses (Fitts 1962). Skilled behaviour can be described as the organisation of S - R chains into larger response patterns. The more elaborate the skill the greater the number of individual S - R units and S - R chains which must be acquired (De Ceccio 1968c). Considerable evidence suggests that the smaller units of behaviour which make up complex skills, are hierarchically organised into larger complex patterns. In learning skills, particular S - R units (Type 2 learning - Gagné) and S - R chains (Type 3 learning - Gagné) must be learnt in a subordinate order before the skill can be performed. The skill is the total response pattern. In verbal learning skills the responses are either covert verbal or overt motor responses of utterance (Jensen 1966). In physical skills the responses are motor responses involving motion. Bryan and Harter (1899) observed that as students became more skilled in learning and using Morse Code, the students seemed to tap patterns of dots and dashes, dealing with whole words and subsequently with phrases. Book (1908) observed the same development of response patterns in students learning to type. The student tackles the learning of a new skill with a verbal plan or strategy (Miller, Galanter and Pribram 1960). According to these writers, the Plans of a beginner, and of the expert, may bring the same result, but they are different in nature. The expert's version of the Plan is involuntary, inflexible and implicit; it is so automatic that he is unable to explain the execution of his performance. The beginner's Plan is flexible, voluntary and communicable to a degree. Until the beginner's Plan becomes automatic, he is not free to work the skill into a larger more complex skill. This notion that complex skills (or plans) are the result of the learning of sub-skills (or plans) is consistent with the idea of hierarchically organised response patterns.

It is a notion of the author that creativity or open-ended problem-solving activity can largely be explained by integration of automatic skills into a larger complex of skills. The issue of creativity is tied up with level of internal organisation of acquired automatic skills. One aspect of creativity could be the controlled flexibility in the application of hierarchically related skills.

19. In the learning skills, three phases are identified (Fitts 1962); the cognitive, the fixation and the autonomous - through which the student passes in learning a complex skill. Moving from one phase to another is a continuous process. In the cognitive phase the students attempt to intellectualise the skill - i.e. the students develop plans which guide the execution of the skill. Essential to this, according to Fitts, is the analysis of the skill and a verbalisation of what is being learnt. Learning conditions essential to this phase are instructional procedures - knowledge of results (reinforcement), practise and the establishment of appropriate expectancies. In most cases of human skill learning this first phase is fairly short (Williams 1949),(Flexman 1950). In the fixation phase, the correct behaviour patterns are practised until the chance of making incorrect responses is reduced to zero. This stage takes longer than the cognitive phase. The student is learning to link together the units or chains into a hierarchically organised plan. Finally, the autonomous phase is characterised by increasing the speed of performance.

20. A complex skilled behaviour, such as reading, can be described and analysed as hierarchically organised verbal response patterns (Fowler, 1962). Such responses within the domain of reading relate to three main levels of structure:

Level 1 consists of the graphic code of the phonemic structure of words;

Level 2 the visual patterning of these word forms in sentence text sequences;and workers have been concerned with the physical aspects of reading, such as, ocular defects, perceptual defects (dyslexia), faulty habits, restrictions of the semantic environment, and adequacy of typography and lighting. Those research workers who have concentrated on a psycholinguistic orientation have been, in the majority, concerned with the acquisition of skill at the level of grapheme-phoneme correspondence. There is no evidence from the literature of an extensive investigation into the higher order skills of reading-to-learn. De Ceccio (1969c) emphasises that we have passed through a whole era of educational research on teaching methods that makes global comparisons of old and new techniques, with little understanding of the basic variables and with little control over extraneous influences. He stresses that most of the results obtained from this approach has, at the most, propoganda and commercial value. De Ceccio comments on the lamentable jump from research on grapheme-phoneme correspondence to the complex and essentially unanalysed problem of instruction in reading skill.

22. Grapheme-phoneme correspondence has been extensively studied by many psychologists. Gibson and his associates (1962) have attempted to discover rules of correspondence between spelling and sound - i.e. between written and spoken language. Gibson assumes that in skilful reading 'Superforms' or rules are mastered which define spelling to sound correspondence. The child is thus able to generate the reading of new words and sentences without single explicit instructions. A child's progress in reading depends upon an increasing mastery of superforms. The grapheme-phoneme correspondence is discovered with or without explicit instruction. Gibson's view of generative superforms is similar to that of Chomsky on generative transformational grammar. The initial teaching alphabet (i.t.a.) invented by Pitman is of considerable popularity, although no theoretical formulation of spelling transformations or of their

use in reading is made clear. Following Gibson, if the learning of superordinate rules which define grapheme-phoneme correspondence is an essential part of acquiring reading skill, then it is to be questioned whether the learning of additional rules, which are later discarded, is of value. Downing (1964) suggests that there is some evidence which indicates that learning reading through i.t.a. reduces the difficulty of the initial stages of conventional phoneme-grapheme correspondence.

23. Robinson and Hall (1941) have carried out some preliminary investigations in higher level reading abilities. They have shown that good reading ability in one field is not necessarily correlated with good reading ability in another field. Differences in reading are not only quantitative, (i.e. speed), but also in the levels of skill used. They distinguish three levels of reading skill. Word-by-word reading; flexible reading - with adjustments in speed for comprehension difficulty, and the use of phrases, sentences or groups of sentences in information retrieval; overdrive reading, with a degree of prediction of information to be read matching with a very good comprehension of reading. These researchers have also shown that matched groups reading two versions of the same text, one with access devices (headings, sub-headings), and the other without, showed no significant differences in comprehension tests. They stress the need for instruction in how to use access devices normally found in texts in order to increase efficiency of information retrieval, and distinguish between the external and internal accessing systems of a text.

24. Of considerable popularity has been the use of various teaching aids to promote more rapid readings. These can be divided into three main categories, tachistoscopes, films and pacers. The principal purpose of these aids is to force the reader to read faster, whereupon he may discover that he can 'take in' easy materials more rapidly than he believed

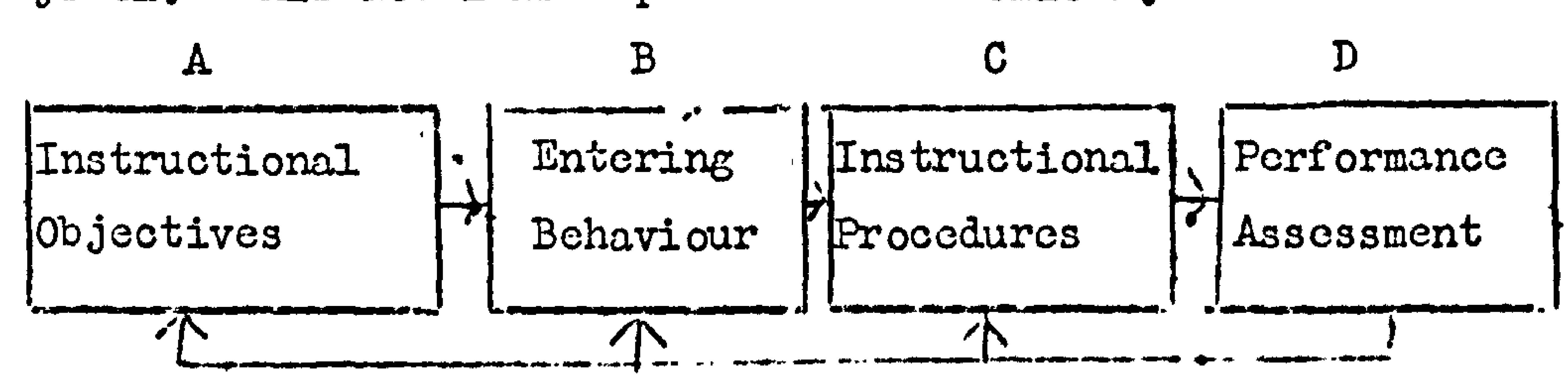
possible. While this discovery may be of high motivating value for reading, the instruction does nothing to increase the individual's rate of comprehension. There is also some doubts as to whether the increased efficiency in speed reading is maintained. Morton (1959) reports that trainees drawn from executive levels of the General Post Office Headquarters had lost 20% of their 50% improvement on average six months after training. Some individuals had returned to their original speed. Another approach in instruction to faster reading is training to widen the eye span. Amble (1966) has shown that this is possible. However, De Leeuw (1965) considers the major problem to be conceptual rather visual. He reasons that instruction should consist of techniques to develop comprehension skills rather than visual skills. Schlessinger (1966) has shown that individuals tend to read in phrases according to the grammatical structure of the material. He suggests that training to read in phrases would result in a widening of the eye span. Wales (1966) has shown that presenting sentences in phrase units results in better memorisation than when word groups are formed arbitrarily. Training of comprehension skills seems to be the key issue in efficient reading, but no empirical work has been reported on this aspect of reading instructions. It became clear that reading rapidly and reading efficiently are not necessarily synonymous. A reading course developed by De Leeuw (1965) offers higher order skills of reading, such as, scanning, skimming and skipping. They also recommend phased reading in the form of preview, fast read and review. The SQ_3R Method (McLaughlin 1968) recommends Scan, Question, Read, Recall, Revise, in that order. Such dynamic reading approaches stress the role of purpose, comprehension and methods of information assimilation. These techniques of higher order reading skill, which are currently very popular in commercial courses, belong to the same category as Pitman's Initial Teaching Alphabet, in that no clear theoretical formulation forms a basis for their use .

in reading instruction. De Leeuw (1965) stresses the need for the development of a psychology of reading, to test the validity of their instruction and to develop instruction further. None of the commercial courses available take into account a detailed analysis of instructional objectives, entering behaviour, instructional procedures and performance assessment, nor how these parts of a teaching model are interrelated.

25. At the present level of educational and psychological research, it can be said that while instruction to read at the grapheme/phoneme level of skill is paralleled with considerable psycholinguistic research efforts, the onus is on the individual to develop higher order skills for reading-to-learn. This partly explains why many intelligent adult readers operate well below their potential reading efficiency. Poulton (1963) points out that the ceiling to reading speed is set by the maximum rate at which information can be processed. The young child while receiving formal training in reading probably comes to read at a rate determined by his capacity for information processing at that time. The training ceases but the information processing capacity continues to develop. Therefore it is not uncommon to find adults with inappropriate reading habits, with under-developed skills for extracting information from written material, and with reading speeds scarcely adequate for the quantity of material requiring attention. Paulton, Morton, Tinker and Robinson have reported empirical findings on the speed of reading versus comprehension. Reading rate was not central to the goals of this research study and their findings are, therefore, not reviewed. However, any of their findings judged relevant to the results of the reported empirical work are discussed in the appropriate empirical units.

26. A review of the literature on instruction in higher reading skills emphasises that demand is far greater than knowledge of how to improve instruction. Enlightened instruction must rest on basic research

on behavioural processes. In the absence of sufficient knowledge on behavioural processes, Gagné (1963) and McDonald (1965) have constructed teaching models that have heuristic value for research on teaching. None of the models developed seem to include all the organismic, behavioural and cultural dimensions of teaching. Yet they are the most operational models available at present. A psychological model in the connectionist tradition of S-R learning theory has been shown to be inadequate in successful teaching techniques and programmed texts (De Cecco 1968f). Melton (1959) stresses that the problems of applying laboratory findings to educational settings should be resolved by research and not by 'heady extrapolation.' Reinforcement for example may be a fairly precise operation in the experimental chamber, but in the class-room it is a mixture of motivation, feedback and reward. There is a very real need for the construction of an elaborated psychological model of learning behaviour for the development of an efficient teaching model. In the opinion of the author the combined methodological rigor and cognitive rigor of the neo-connectionist-cognitive theoretical system provides the framework and impetus for the development of a suitable psychological teaching model. Robert Glaser (1962) has developed a 'stripped-down' teaching model which can be incorporated into the neo-connectionist-cognitive psychological system. This model is represented as follows:-



Instructional objectives are those a student should attain upon completion of a segment of instruction. Entering behaviour describes the student's level of attainment before he begins; it refers to his previous learning ability. Instructional procedures describe the teaching process. Proper management of this component results in those changes in student behaviour which is called learning. Procedures must vary with instructional objectives. Performance assessment consists of tests and observations used to determine how well the student has achieved the instructional objectives. There are various other psychological models of teaching, such as, Laurence Stolorow and Daniel Davis's computer based model (1965), John Carroll's school teaching model (1963) and Ned Flanders' interaction model (1960) as well as historical models such as, the Socratic model (Jordan 1963), the Jesuit model (Broudy 1963) and the American Personal Development model (Cremin 1964). However, although more complex in conception than the basic teaching model of Glaser, they include some, or each of its four components. What remains to be fully developed is an empirically tested theoretical formulation of each component and of the extent of the interrelationships between them. De Cecco (1968f) has shown the guide-lines which would be fruitful in such a research programme.

27. It is generally considered that instruction is at the heart of the educational process. A central purpose of instruction in education is considered to be that of knowledge generalisation or knowledge transfer, which is to be contrasted to the initial learning of knowledge (Gagné 1965). It is said that education should be concerned not simply with the acquisition of knowledge, but with the use and generalisation of knowledge in novel situations. Knowledge transfer cannot occur if knowledge itself has not been acquired. Beyond this there is the important question of what conditions of instruction are required to encourage transfer. Osgood (1949) has developed a model for the transfer of training. The amount of transfer from one task to another depends on similarity of stimulus and response. The model is partly based on the

mechanism of stimulus generalisation that may underlie transfer phenomena. If two tasks present similar stimuli and require the same responses, then what is learned in relation to the stimuli presented with one task will generalise to the related stimuli provided by the second task. Thus, what is learned in relation to the one task is to some degree, transferred to performance on the second task. Osgood's model is applicable to the learning of physical skills, but in cases of academic learning, there are many instances which indicate that it is not applicable. In the area of complex verbal learning, it appears that transfer is much more dependent on verbal mediating processes than on stimulus and response similarity. According to Ausubel (1963), transfer in complex learning situations takes place when an individual can code the information from two situations in the same way. This is dependent upon the acquisition of concepts and principles. The learning of conceptual principles represents the acquisition of mediating processes that faciliate related learning. According to De Cecco (1968g) the acquisition of concepts and principles can be thought of as learning how to solve a whole class of problems; when examples of the class of problems are presented, they can readily be solved. Gagné and Brown (1961) report the advantage of a guided discovery (G.D.) programme in bridging the events between concept learning and concept utilisation. They suggested that the G.D. Programme required a systematic reinstatement of learned concepts by the learner. Bruner (1961) has stressed the importance of learning through discovery. Bruner emphasises the learner's need to be actively involved in what he learns and to organise information into cognitive structures that are meaningful. Intellectual capacities are developed and intellectual competence achieved when the student is allowed the freedom of search and discovery. Thomas (1967) indicates the possible outcomes of the freedom of search and discovery to industrial training. If the learner is involved in his training, he not only becomes motivated, but also he is encouraged to act in self-organised ways. An individual becomes more adaptive and continues to learn after the specific training conditions have been removed. The instructional procedures developed within this reported research programme for encouraging effective reading-to-learn have depended on the assumption that the transfer of skill is related to two interrelated factors; verbal mediation, which accounts for the acquisition of concepts and principles; and the provision of freedom of search and discovery, which encourages intellectual potency.

28. The notion of giving a learner some control over his learning activities is not new. The Oxbridge tutorial system has traditionally provided students with some control over when and what they study. R.F. Mager (1963) has shown that when learners were provided with a store of training objectives they were better in skilled performance than learners tightly controlled within an instructional process. This encouragement of self-sufficiency is in accordance with considerable empirically reported and theoretical formulations of contemporary psychologists and educationalists. Learner participation has been shown to "maintain attention (Hebb 1958)", assist the processing of information in an internal store so that it is catalogued meaningfully (Broadbent 1966) for the effective retrieval of information in problem solving situations, Gagné and Brown (1961), and for higher skill learning Bruner (1961). Instruction in the skills of reading-to-learn should, therefore, proceed from an externally controlled to a learner controlled system. This might be achieved by developing a progressive system of diagnosis and instruction.

29. Within this reported research programme, the author has begun to explore the problems raised by the need to develop a hierarchically organised learner controlled programme of selective diagnosis and instruction, to meet individual needs. Instructional procedures

developed and applied within this reported research programme are seen <u>as a provisional phase</u> in the development of <u>a learner state of controlled flexibility</u>, in the learning process. This ultimate goal is seen to be attainable within <u>a succession of episodes or sub-goals</u> which serve to make the process of reading-to-learn explicit at sentence, paragraph and chapter level in terms of the learner. These episodes are not temporal, since they overlap, but there is to some extent a natural order of development. These sub -goals can be outlined as follows:-

(1) <u>The exploration of reading strategies</u>:

- (a) The relationship between reading, strategies and the varieties of outcomes of reading.
- (b) The role of reading strategies for inferring learning outcomes.

(2) <u>The exploration of the structure of the written material</u>:

- (a) As an assessment procedure for essay type summaries.
- (b) The construction of objective tests.
- (c) For describing the meaning flow relationships of the text to be used as feedback within an instructional procedure for reading-to-learn.

(3) <u>The exploration of task definition</u>:

- (a) The effect of task directives on the learner's definition of the task.
- (b) The identification of the learner's translation of his formulation of the learning task into an operational plan for reading.

(4) <u>The exploration of an instructional procedure in an attempt to systematically intervene with the process of reading-to-learn</u>:

- (a) To encourage students to interpret their own pattern of reading as it emerged from the recorder, so that the task directives could be explicitly operated.
- (b) To study the effect of the provision of 'knowledge of results' as feedback at different levels of detail and at different stages in relation to the learning task, the structure of the text and the reading strategy.
- (c) To develop interim tests or assessment procedures relating to each type of learning task.
- (d) To develop a technique of self-diagnosis (self-testing with informational feedback).
- (e) To develop a hierarchically organised learner control of his strategy in relation to the complexity of the task, the structure of the material and the learner's own internal capabilities.
- (f) To take into account the complexity of the learning tasks, the internal and external conditions necessary for learning and the phases of learning a complex skill.

1.2.4. The Aspects and Utility of a Psychological Model

1. Having developed an overview of the theories of learning and formulated the practical educational problems in the context of existing knowledge, the last step in this phase of the project was to establish the criteria which must be taken into account in a model building activity, of the student as a learner of verbal material by reading. This model must reflect two related aspects (Hill 1964b):-

a) it must provide a vocabulary and conceptual framework for interpreting examples of the problems of learning observed;

b) it must provide a conceptual framework within which practical solutions can be interpreted - i.e. the model directs attention to the variables that are crucial in finding a solution.

This model must be of value in four related ways (Hill 1964b):-

a) it must be testable empirically (i.e. it must generate meaningful predictions);

b) it must be reliable (i.e. it must generate consistent predictions);

c) it must be coherent (i.e. it must not be in conflict with itself);

d) it must be comprehensive (i.e. it must explain a variety of phenomena).

2. Finally, the model must encorporate the following behaviours:-

(1) the complexities of human symbolic verbal learning

(2) the cognitive flexibility of behaviour

(3) the cognitive rigidity of behaviour

(4) the practise of implicit and explicit learning skills

(5) the influence of earlier learning on later learning - knowledge transfer

(6) the detailed stimulus situation

(7) the dynamic structural relationship between the student's selection of specific stimuli in the verbal learning environment and the responses which follow

(8) the motivational (or any other) aspects of <u>feedback</u> and <u>reinforcement</u>

(9) the cognitive and emotional advantages of self-organised learning.

3. The major outcome of the theoretical aspect of the preceding literature survey is the formulation of a conceptual framework within which a model building activity of the student as a learner of verbal (symbolic) material by reading can be developed. The major outcome of the practical aspect of the preceding literature survey is the formulation of a set of goals which provide the rationale for the model building activity. In other words the pure and applied aspects of this research are intrinsically combined within one research effort. In summary the conceptual framework for such a model is presented overleaf.

CONCEPTUAL FRAMEWORK OF A MODEL OF THE STUDENT AS A LEARNER OF COMPLEX VERBAL MATTER

EXTERNAL WORLD STIMULI		INTERNAL WORLD		EXTERNAL WORLD RESPONSES
(i) Written verbal information. (ii) Instructional objectives for learning.	Selection of Stimuli: Input	Development of Internally represented aspects of the external world in vertical and horizontal hierarchical organisation to form a Cognitive Structure.	Selection of responses: Output	Interim and overall responses relating to the learning goal.

Explicit and Implicit Level of Awareness

life space, personal constructs, cognitive style

Independent variables	Intervening variables, mediating processes, meaning internal stimuli and responses, related to past conditions of learning and to body processes, learning represents adaptive change in negative feedback.	Dependent variables

Ongoing Process

Plan - a hierarchical process that controls the order in which sequences of operations is performed.

UNIT 2 - Preliminary Observations, Materials, Subjects, Methods.

2.1 General Experimental Method

In a particular 'reading-to-learn' situation, a sixth form or undergraduate student covers a large amount of print in terms of its topographical and semantic 'layout'. Specifically, the student progresses through the print syntactically in terms of the words, sentences, paragraphs, chapters and semantically in terms of the specific and relatively concrete to the more complex and relatively abstract data. In an attempt to approach the reading problem in as close a 'real student learning situation' as possible, it was necessary to choose material which was long enough to reflect these levels of structure and short enough for experimental purposes. It was considered that 'a chapter' represents a suitable unit as a basis for experimentation, since on average it contains the appropriate level of textual organisation and intellectual complexity.

The nature of the information contained in the unit depended upon the educational orientation of the experimental sample. As a rule of thumb, the learning material was aimed to extend the student's knowledge in an area in which he was already familiar. Overall, he would have sufficient prior knowledge of the specific terms so as not to hamper his progress through the text. The student's pre-experimental knowledge in a given area was assessed orally by discussion.

In Unit 5, 'the sentence' was used as the experimental unit and factors which determined the selection and analysis of this experimental unit are described in detail in that unit.

Attempting to study the reading problem systematically involved developing a method for:

(i) Recording a reader's progress through the material.

(ii) Describing the structure of written material.

(iii) Interfering with the reading process in order to improve it.

These techniques are outlined as follows:-

1) A reading recorder produces a graphical record of the reader's protocol. The written material is viewed through a transparent screen or 'window'. The operator can move the written material manually by turning a handle. An earlier version of the reading recorder, which depended upon several encoding and decoding stages proved to be too cumbersome. The later version of the recorder involved fewer recording stages and was more reliable and accurate. Both versions are described on pages 9 and 10.

2) A method for describing the structure of written information involved the compilation of a taxonomical index of the 'items' within the text. This was based on Bloom's Taxonomy of Educational Objectives (1956). This categorisation is carried out by three or four independent 'experts' in the content area, who compare descriptions to arrive at an "agreed subjective meaning structure" of the text.

This meaning structure was used to:-

a) Construct two objective tests (A and B) (Experiment 2 and 3).

b) Analyse the content and relevant selectivity of the 'essay type Summaries.

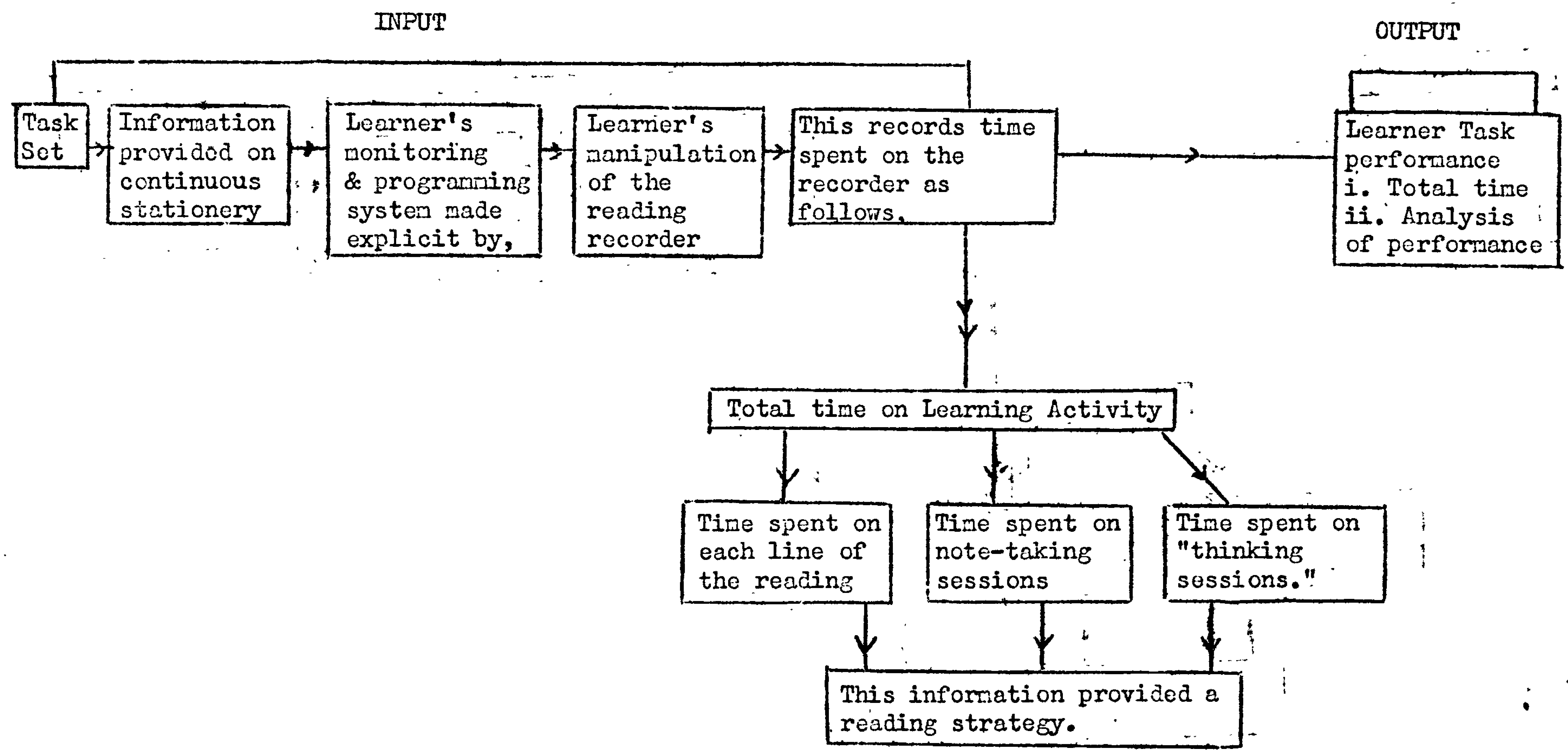
c) Infer the learning outcomes likely to derive from a particular reading record.

d) Develop flow diagrams of the meaning structure of the text. These were used as part of an instructional procedure, providing information feedback in the learning situation to encourage students to develop new tactics and strategies of reading.

3) A training procedure for extending the range and effectiveness of student reading for learning. This presented the learner with an opportunity to review his reading tactics. The procedural emphasis was to encourage the learner to shift the focus of learning control from the teacher to the learner.

Essentially the training procedure consisted of the provision of knowledge of results or feedback of information at different levels of detail in relation to the learning task, the meaning structure of the text and the reading strategy. The aim of the training was to make students more aware of their own reading behaviour by observing the patterns which emerged from the recorder. The training procedure helped students to interpret these records and thus to experiment constructively with alternative methods of reading. There appeared to be two related aspects in developing more effective reading. The first was to develop a clearer definition of the learning objectives, and the second was the ability to be able to translate these into effective operational plans (Miller, Pribram and Galanter, 1960).

An outline of the type of data obtained in the empirical studies reported in this dissertation is schematised below:-



2.2. The Subjects

The experimental population consisted of students from a Public School, Grammar School, Technical College, College of Further Education, University College and volunteers from a research establishment. Most were either pursuing or had completed the advanced level course in Biology. A few were advanced level students in other subjects who had a good basic knowledge of Biology. The subjects were given time to familiarise themselves with the reading recorder and difficulties or queries were sorted out in discussion with the experimenter. The students set their own time limit in each experiment and by pre-arrangement they were prepared to participate for 3 - 4 hours if necessary. The subjects worked individually in a silent room which was well lit and ventilated. Individual arrangements were made to participate in the morning, afternoon or evening. The subjects worked alone but could call upon the experimenter if help was required. In order to maximise ego involvement, subjects were informed that after all the data had been processed, their individual reading protocols and scores would be reported to them.

2.3. The Learning Material

Experiment 1.

Three sequential chapters from the "Origin of Species" were presented in a somewhat abbreviated form, with a range from approximately 3,000 words in the first text, 2,500 words in the second text, to 4,000 words in the last text. The chapters selected were - Chapter II, "Variations under Nature;" Chapter III "The Struggle for Existence", and Chapter IV "Natural Selection", in that order.

Experiment 2

The text used was a scientific treatise on 'Hearing' as expounded in the McGraw Hill Science Encyclopaedia, consisting of approximately 3,900 words.

Experiment 3

An article from "Scientific American", October 1966, Vol.215, No.4, entitled "The Genetic Code" by F.H.C. Crick, was presented in an abridged form of approximately 3,100 words.

Experiment 4

The 66 sentences which formed the substrate for this experiment were selected from a number of papers, which dealt with genetics. These papers were either reprints from "Scientific American" or from "Nature." These sentences are presented in Appendix A, 2.3.

Experiment 5

The Genetic Code above and two matched articles of approximately 3,450 and 3,800 words were selected from "Scientific American". Specifically these were, "The Role of Light in Photosynthesis" by D.R. Arnon, November 1960, and "The Mechanism of Immunity" by Sir MacFarlane Burnet, January 1961.

2.4. The Reading Recorder.

The reading recorder was developed at Brunel University under the supervision of L.F. Thomas (Reader, Psychology Department).

The purpose of the device

This apparatus was designed to record how a person reads written, typed or printed text. The aim was to produce a record which would:-

a) Show how long was spent on each part of the text,

b) show how the reader moved backwards and forwards through the text,

c) record to within an accuracy of 1 or 2 lines of the text.

The basic design.

The text to be studied was typed on to continuous stationery and viewed from behind a transparent screen adjusted to restrict the viewer to 5 lines of print at one given time. The operator could move the print in both directions manually by turning a handle, which was connected to the sprocket wheels on which the viewer was located directly via a spindle. To allow for peripheral vision, the number of words immediately visible in the window was in the range of 7 to 10 words horizontally and 5 lines vertically. Poulton (1962) reported a significant increase in read errors (misreadings and omissions) as the size of the window in training to read films was reduced beyond 7 - 10 words horizontally. Poulton suggested, that determination in reading occurs as soon as restrictions are placed on vision. Poulton's data applied to moving films. The movement of the print using the reading device was controlled by the operator and, therefore, the immediate field of vision may not be so critical.

The early version.

An electronic coding device was used to identify the position of the text in relation to the window. The reading record was produced via a series of recording and decoding stages, first as tones on a tape recorder, then as punched paper tape from a Sequential Event Timer and Recorder (S.E.T.A.R.) and finally through an Elliott 803 computer on to the X.Y. plotter. Two additional switches were attached to the recorde , one of which recorded note-taking and the other 'thinking' or non-reading activities. This proved to be a very cumbersome and unreliable method of recording and a simpler, more reliable version was subsequently developed.

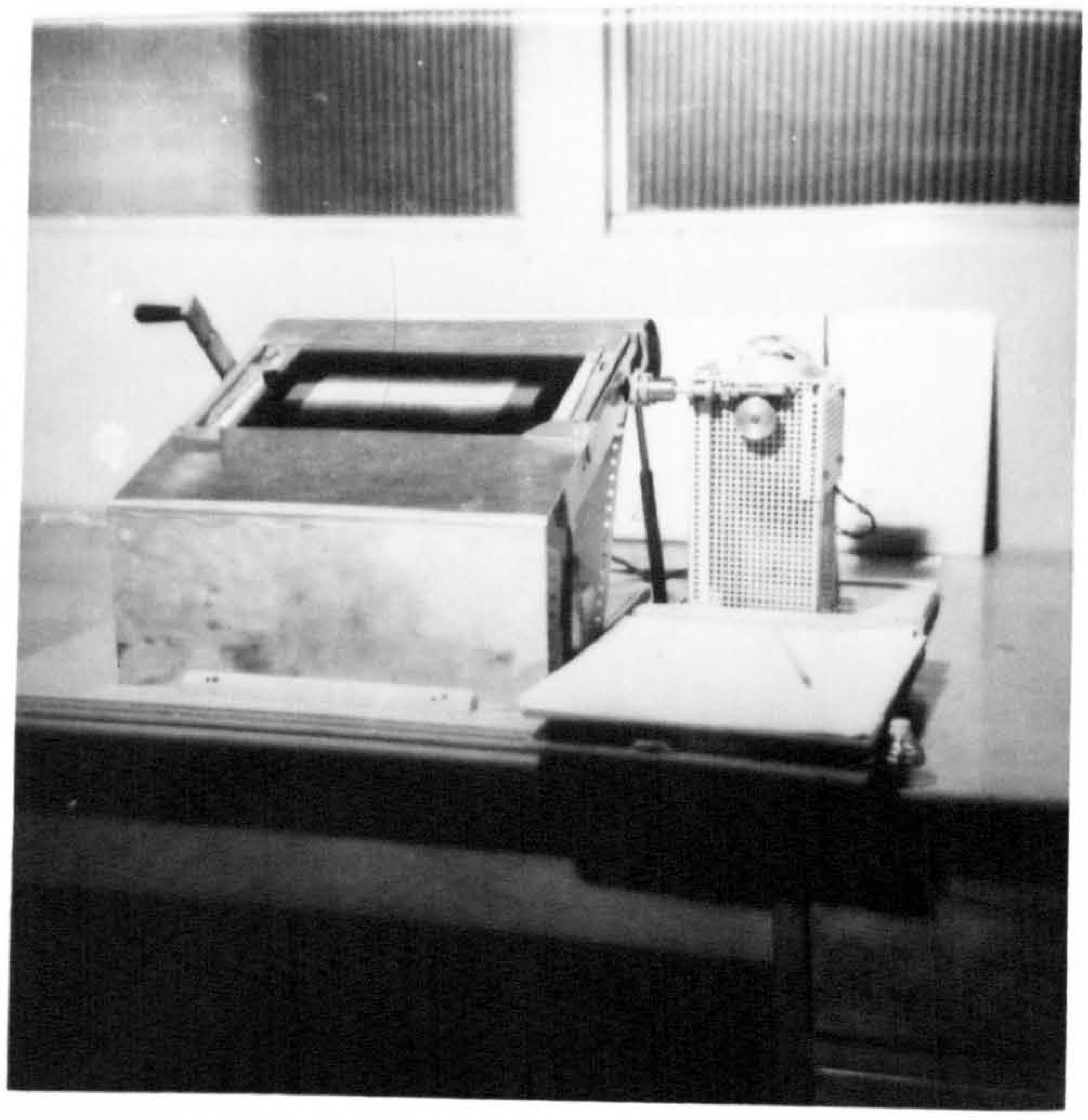
The later version.

This reading recorder has a spiral potentiometer connected to the axis of the sprocket wheels carrying the continuous stationery. This feeds directly into a servo-operated potentiometer pen recorder, producing an immediate record of the subject's reading behaviour. The loss of the numerical data from the S.E.T.A.R. proved less serious than the advantage of immediacy and reliability inherent in the improved technique. Again, separate event pens recorded note-taking and 'thinking' or non-reading sessions.

Once the zero position of the text had been established and synchronized with the zero position on the potentiometer, the voltage presented by the potentiometer at any given point is proportional to the position of the text.

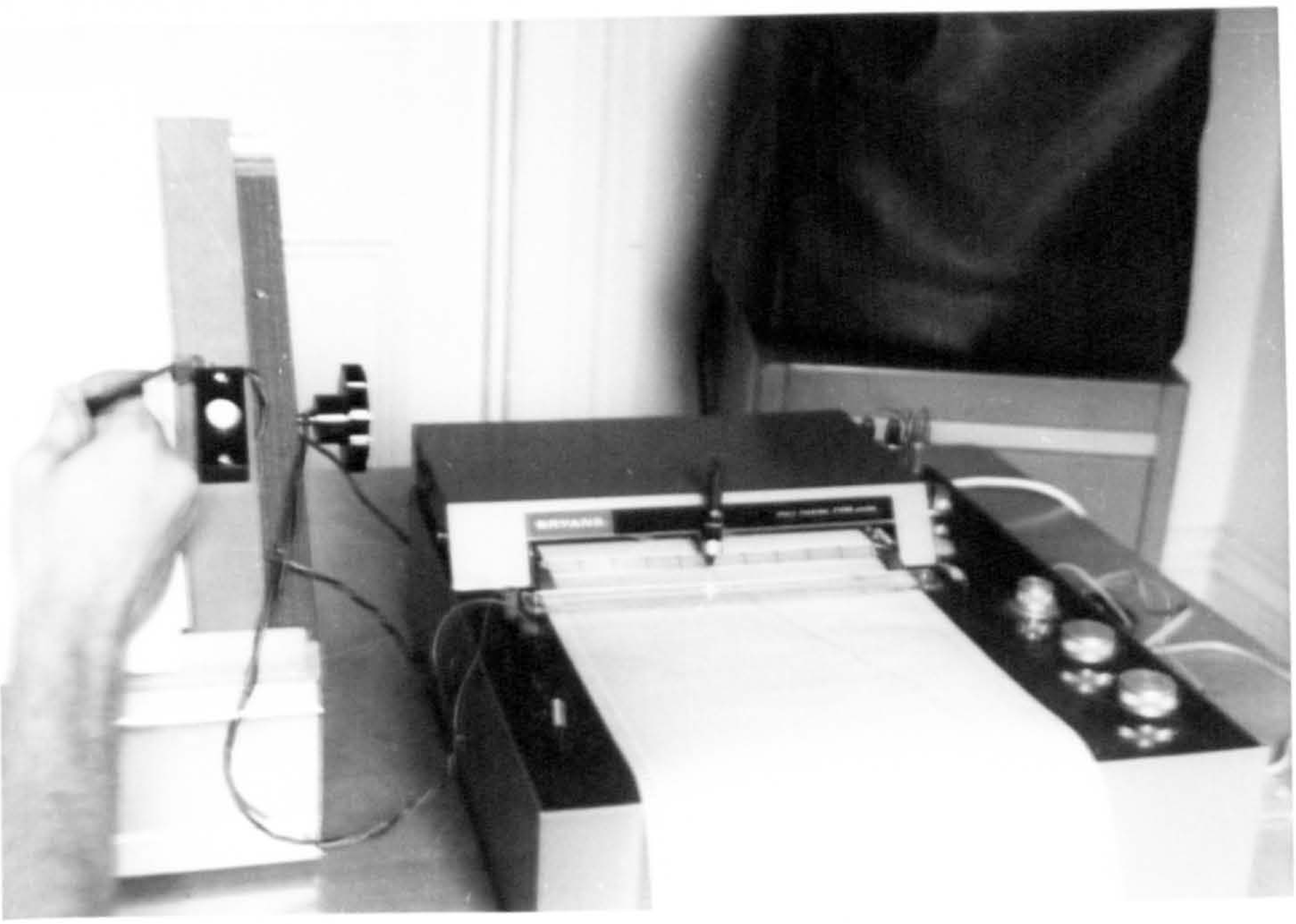
The case containing the reading recorder was designed to guide the continuous stationery evenly from one interleaved pile to another, movement being equally easy in either direction. Students reading on this machine very rapidly adapt to an automatic co-ordination of hand and eye.

A series of photographs of the reading recorder are shown in the following pages.

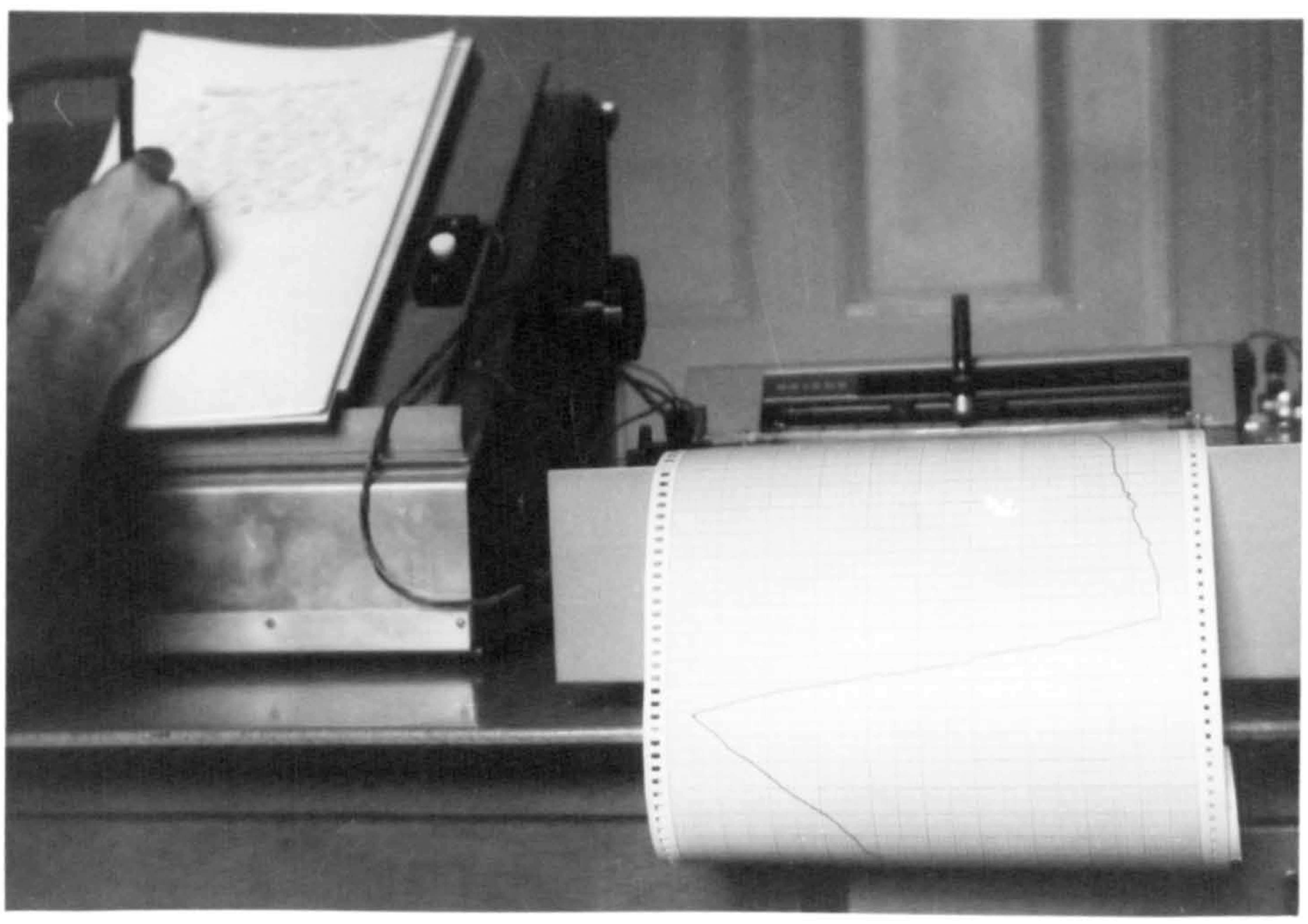


Photograph 1. The Reading Recorder, with viewing 'window' (early version).

Photograph 2. The Reading Recorder in action. (later version).



Photograph 3. The Servo-Operated Potentiometer Pen Recorder.



Photograph 4. The graphical record, note taking pad and 'thinking' switch.

2.4.1. Analysis of the Reading Records.

The graphical records provided by the servo-operated potentiometer pen recorder were analysed by means of the Sangamo Chart Reader. This reader enabled measurements to be made along 'x' and 'y' ordinates, fairly quickly, with a high degree of accuracy. The full width horizontal and vertical cursor scales, which were available with the Chart Reader were in inch or metric systems. The vertical line cursors for analysis of the read records were prepared especially for each experiment, in order to analyse the distribution of 'hesitations' and 'regressions' in the reads. These vertical line cursors were prepared by mapping data from 'control' read records onto transparent perspex sheets. The data consisted of 'hesitations' in the control read records, which marked the distribution of paragraphs, sentences, 'items of knowledge' (2.6.1), clauses and verb placements. A schema illustrating the type of vertical cursors used in each experiment is presented as follows:-

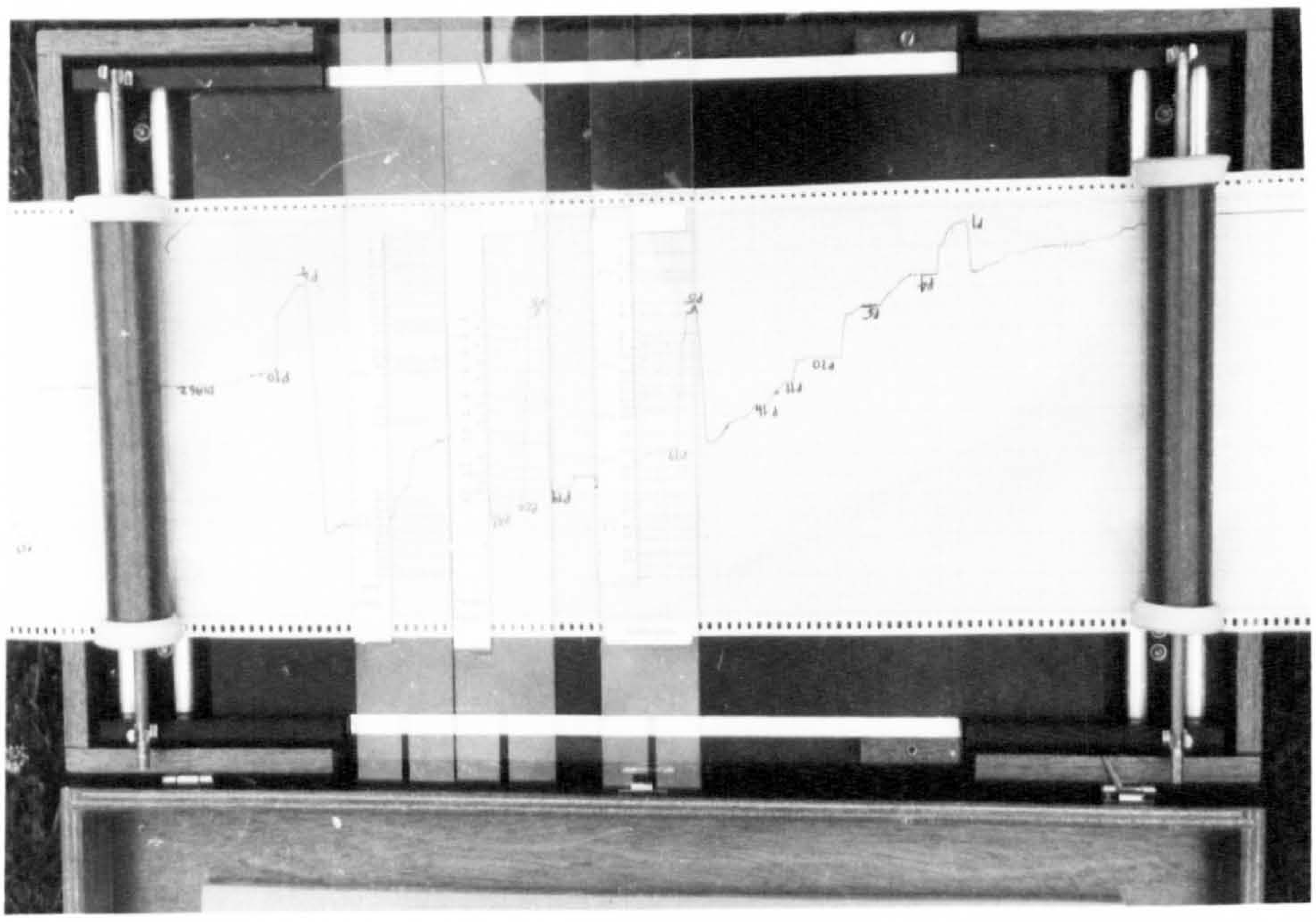
VERTICAL CURSOR SCALES

	Paragraphs	'Units of Knowledge' in the Text			'Units of Knowledge' for Objective Tests A and B		
		Specifics	Ways & Means of dealing with Specifics	Universals & Abstractions	Recall Simple	Recall Complex	Recognition.
Experiment 2.	-	-	-	-	✓	✓	✓
Experiment 3.	✓	✓	✓	✓	✓	✓	✓
Experiment 5.	✓	✓	✓	✓	—	—	—

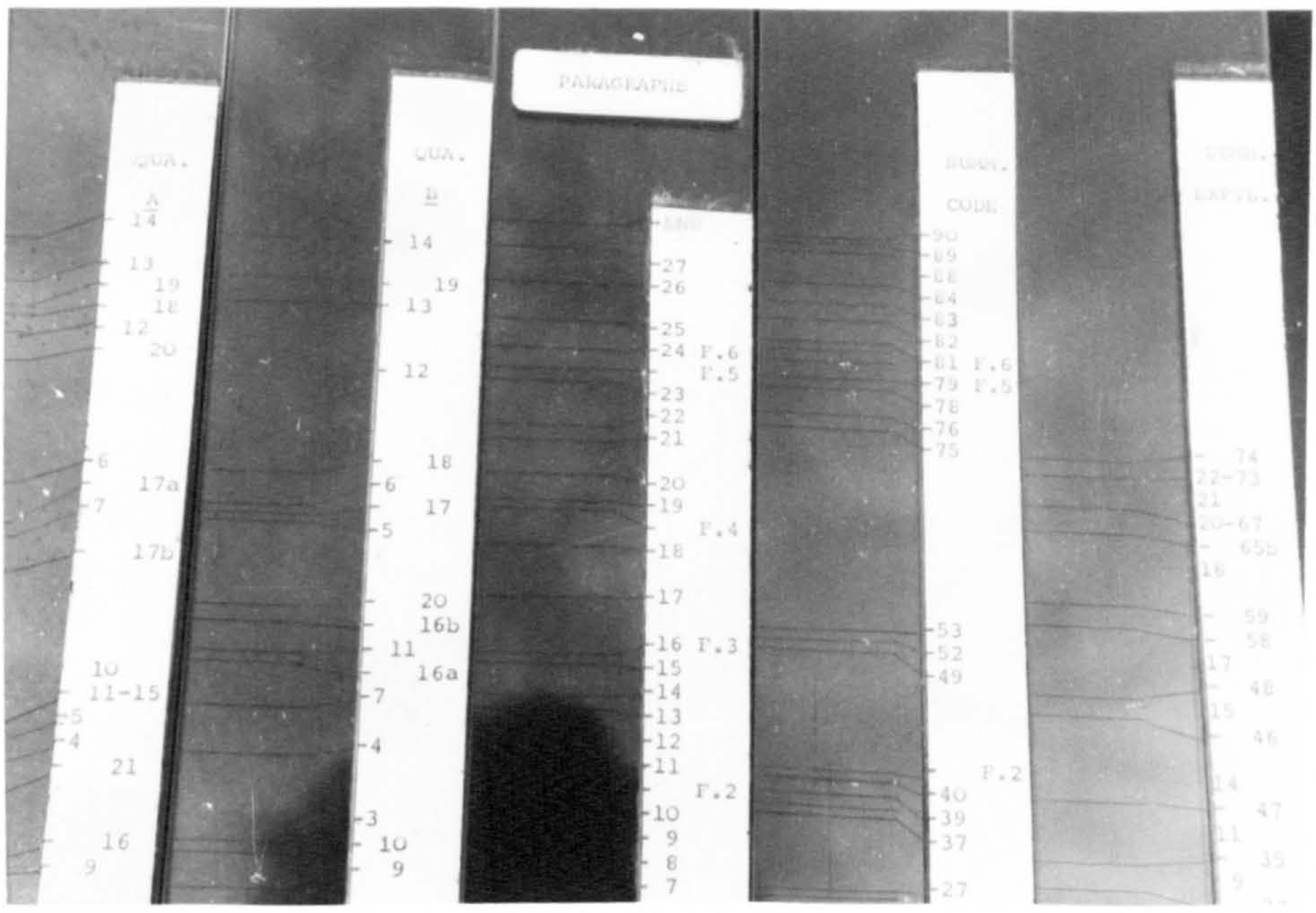
VERTICAL CURSOR SCALES

	Sentence	Clause	Words	Verbs.
Experiment 4.	✓	✓	✓	✓

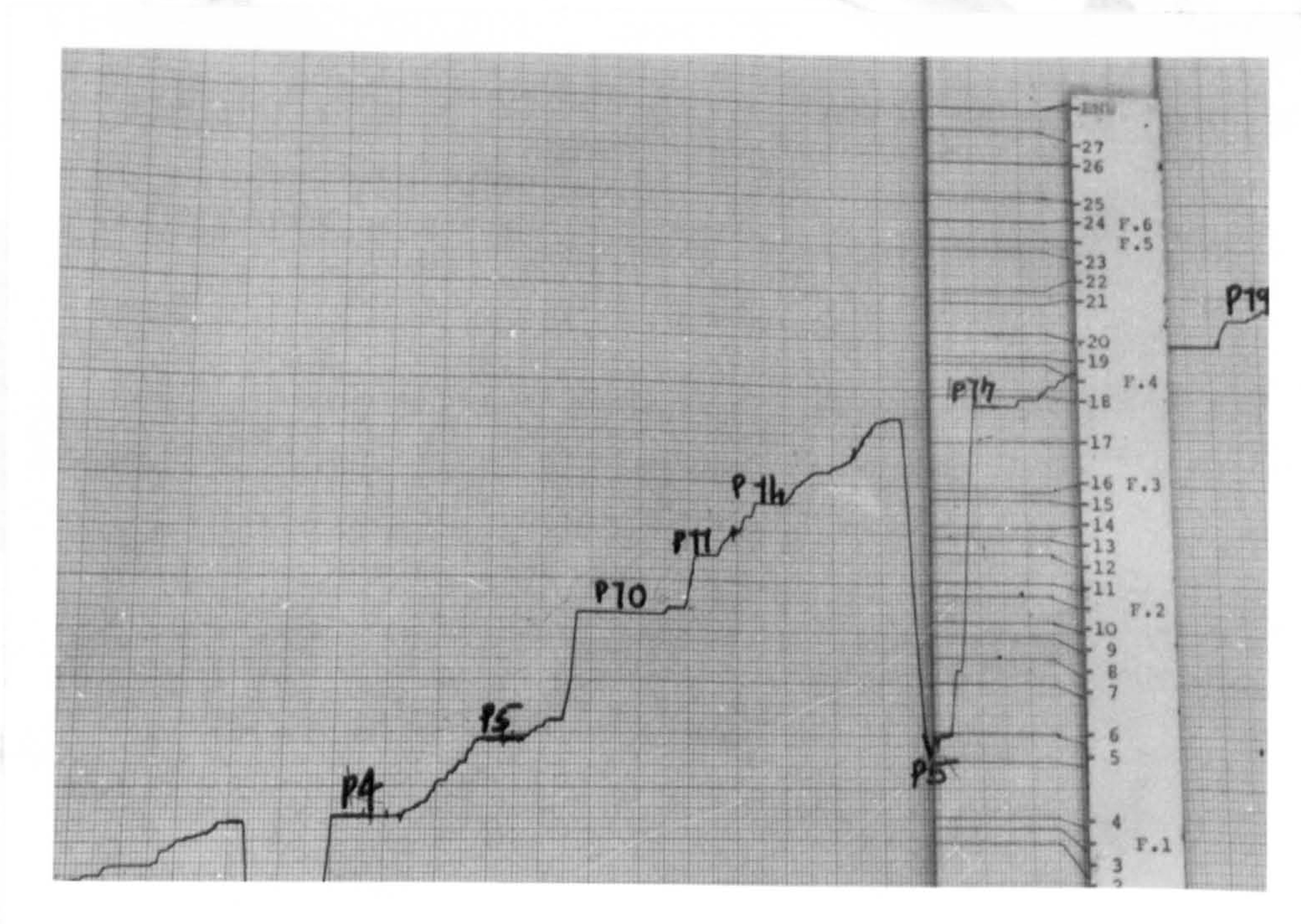
PHOTOGRAPHS OF THE SENGAMO CHART READER AND OF SOME OF THE VERTICAL CURSOR SCALES FOLLOW



The Sengamo Chart Recorder



The Cursor Scales Prepared for Use in Experiment 3 cont. over



P4
P5
P10
P11
P14
P17
P5
P19
27
26
25
24
F.6
F.5
23
22
21
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19
F.4
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17
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F.3
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14
13
12
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F.2
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9
8
7
6
5
4
F.1
3

Such a detailed analysis was not available for the reading records of Experiment 1. The earlier version of the recorder was used for this experiment. There were difficulties in obtaining highly accurate graphical records because of errors developed at the sound at S.E.T.A.R. stage of the recording.

2.5. The Tasks

Two kinds of tasks, namely the preparation of a summary and responses to objectively constructed tests were selected as the goals of learning in the empirical work.

Reasons for setting a Summary as a Learning Task.

1. A tool for analysis of performance

With reference to The Taxonomy the skill of summarisation falls largely within the first category of intellectual abilities and skills, namely comprehension. The specified skill can make demands, to some degree, on powers of Analysis, Synthesis and Evaluation as referred to in The Taxonomy. However, for the purpose of this analysis it was deemed sufficient to classify the skill solely as comprehension.

Specifically, a summarisation requires a background of knowledge and two types of comprehension behaviour, namely translation, which means that an individual can put a communication into another form of communication, (in this case, another verbal form) and interpretation, which involves dealing with a communication as a configuration of ideas, whose comprehension may require a reordering of the ideas into a new configuration in the mind of the individual. Hence it is possible to evaluate summaries using the guidelines of knowledge and comprehension as outlined in the Taxonomy.

2. Academic Interest

From the above, it is recognised that a summary demands a high level of intellectual abilities and skills, and for this very reason should provide an interesting representation of the learning process.

3. Present educational ideals.

Educational attitudes and goals in the 20th century place great emphasis on the ability to generalise and use generalised ways of attacking problems. This ability is closely related to the accepted psychological phenomenon of transfer. The importance of transfer in the learning process has been emphasised by J. Bruner and others who hold the view that 'massive transfer' of basic ideas and attitudes is at the root of the educational process. Virtually all the evidence of the last two decades on the nature of learning has indicated, that massive general transfer can be achieved by "appropriate" learning even to the degree that learning properly under optimum conditions leads one to learn how to learn. Individual protocols geared to summarisation might, therefore, shed light on the comparative efficiency of different methods of reading.

Reasons for setting Objective Tests as a Learning Task.

1. A tool for the analysis of performance.

Objective tests are of high merit as a measuring instrument of attainment, free from the variables which exist in the more traditional marking process of essay type questions. A number of intellectual abilities can be separately tested with a high degree of precision. Voluminous reports are available in the literature as guidance for their compilation (Nedelsky 1967, Ebel 1967, Gardener 1969). The Classification of abilities is clearly illustrated in the College Board Achievement Tests and Nuffield Project tests.

2. Academic interest

The bulk of education, for a variety of reasons, is concentrating on the use of objective tests, in order to assess the educational progress of an individual and in order to assess the final achievement, in a given subject. Little is known of the effect of this development on the learning process. The interesting question as to whether students prepare differently for objective tests and essay-type tests needs to be answered.

2.6. The Task Evaluation Techniques

Arbitrary scoring of summaries based upon an intuitive assessment was considered inadequate for the evaluation of a learner's performance. A grid for the construction of objective test items had to be developed. A literature survey emphasised the paucity of established techniques for the systematic description of material, (Unit 1, Review of the Practical (Educational) Problem, 1.2.3). A technique was developed, which was based on a classification of knowledge as outlined in The Taxonomy of Educational Objectives (Bloom, 1956). According to "The Taxonomy", knowledge can be classified from specific and relatively concrete to complex and relatively abstract data. The learning material was assessed by a panel (three to four members which formed a Study Group) in terms of the taxonomical classification.

2.6.1. Analysis of the Texts

The material was divided into "items of knowledge" and classified according to the categories described in "The Taxonomy". These categories are itemised in Table 1. This analysis of the written material provided a basis for the preparation of the objective test grid and for the systematic content analysis of each summary.

TABLE 1

CATEGORIES USED IN TEXT ANALYSIS

A. Knowledge - a prerequisite for all other intellectual abilities and skills and defined as the recall of material, representing the psychological process of remembering the facts and ideas stored in the mind.

A1. Memory of Specifics

A1-1 Terminology - memory of the referents for specific symbols and terms. The ability to distinguish the referents for words and to establish the limit within which a biological term may have a meaning.

A1-2 Specific Facts - knowledge of specific biological facts relating to an understanding of a theory.

A2. Knowledge of Ways and Means of Dealing with Specifics

A2-1 Knowledge of Trends and Sequences - directions of phenomena with respect to time - evolutionary progression of organisms.

A2-2 Knowledge of Classification and Categories - knowledge of the classes, divisions and arrangements which are regarded as fundamental or useful for a given subject, field, purpose, argument or problem.

Phylogenetic categories; groups of plants and animals.

Taxonomical categories; variety, species, genus, family, order and class.

A2-3 Knowledge of Methodology - knowledge of techniques and procedures employed in investigating a subject, field or a problem.

A2-4 Knowledge of Criteria - knowledge of criteria by which facts, principles, opinions and conduct are tested.

Darwin's criteria for distinguishing more variable species from less variable species.

Darwin's criteria for measuring the Struggle for Existence and Natural Selection.

A3. Knowledge of the Universals and Abstractions in a Field.

Knowledge of the major ideas, schemes and patterns by which phenomenon and ideas are organised.

These concepts bring together a large number of specific facts and ideas, describe the processes and interrelations between them and this enables the subject to organise the whole in a parsimonious form.

A3-1 Knowledge of Principles and Generalisations - knowledge of abstractions which summarise observations and phenomena.

Knowledge of important concepts which make up the evolutionary theory.

A3-2 Knowledge of Theories and Structures - knowledge of the body of principles and generalisations together with their interrelations which present a clear systematic view of a complex phenomenon. This category differs from A3-1 in that the emphasis is on a body of generalisations which are interrelated to form a theory, while in A3-2 the generalisations are treated as particulars which need not be related to each other.

Complete formulation of theory of evolution.

N.B. In the analysis, if an item from the text can be referred to more than one of the above categories, it is included in the highest level category.

Item analysis consisted of a labelling of each item in the text as a 'unit of knowledge'. Thus, the learning material (or text) was categorised into Specifics, Ways and Means of dealing with Specifics and Universals and Abstractions. Then a flow diagram was prepared of each text. This was constructed from a reconfiguration of the paragraphs of the texts in terms of its 'Universals and Abstractions' and each paragraph was related to all other paragraphs in a generic sequence. The detailed analysis of the learning material, as well as the relevant flow diagrams, are presented in Appendix A, 2.6.1.

When the texts used in Experiment 1 were first analysed, the analysing technique was not fully developed. 'Themes' were identified and each 'unit of knowledge' was related to a 'theme' (or generalisation). At this early stage the 'themes' were intuitively inferred. In the later experiments the categorisation of 'units' became more detailed and the identification of generalisations became more objective.

2.6.2. The Summary

When the learning test consisted of the preparation of a summary of the material provided, an evaluation of the summaries was undertaken, using the item analysis prepared, from the learning material. An item was scored, if it was recalled close to the original form or if it was recalled as a variant. A variant is defined as a translation of the original, (The Taxonomy Comprehension, 2.00, Translation 2.10). A comparison was made between each subject's record and the analysis and flow diagram of the original text in order to evaluate the degree of comprehension. Comprehension is referred to in terms of its classification in "The Taxonomy", as outlined in Table 2.

Table 2

CATEGORIES USED IN SUMMARY ANALYSIS

B. Comprehension - defined here as an ability which represents an understanding of the literal message of the text. In reaching such an understanding, the student may re-order the communication 'in his mind' to make it more meaningful. Two types of comprehensive behaviour are demanded by the task, namely:

B1. Translation - the ability to put a communication in other words, only possible if an individual can give the denoted meaning to each of the parts of the text.

B2. Interpretation - the ability to translate each of the major parts of a text and the ability to sort out the relative importance of the various parts, their interrelationships and their relevance to generalisations as described in the text.

B1 & B2 are assessed by referring the summary to the 'items' and a flow diagram of the text.

In this way an estimate could be made of each subject's assessment of the text, in terms of the instructional directives.

2.6.3. The Objective Test.

All objective test items were confined to the knowledge section of The Taxonomy. Accordingly, all items were planned to test the acquisition of knowledge only. Although somewhat more than rote learning is required for knowledge acquisition, the form of the question and the level of precision required in testing for knowledge should not be too different from the way in which the knowledge was originally learnt. This meant that items in the objective test questions were constructed at the level of discrimination found in the text, rather than at an entirely different level. It must, therefore, be stressed that objective test items geared to assess other intellectual abilities, namely Comprehension, Application, Analysis, Synthesis, and Evaluation, were not represented. Thus the test was deliberately designed to set a task very different from that of summary preparation; summarising activity relied not only upon the acquisition of knowledge, but also upon the intellectual ability of Comprehension. Two sources were consulted for the construction of objective test items, (Ebel 1965 and Wood 1961).

In Experiment 2, separate question papers, A and B were prepared, each composed of 16 questions. In both A and B the questions were structured as shown in Table 3.

TABLE 3.

QUESTION-NAIRE	1. RECOGNITION Multiple choice questions, recognition of facts, terms & concepts.	2. RECALL SIMPLE Remembering single words or phrases, specific facts, terms, classifications criteria, methodology.	3. RECALL COMPLEX Remembering Universals & Abstractions i.e. major concepts.
A	4	4	8
B	4	4	8

In Experiment 3, two separate questionnaires A and B were prepared each composed of 22 questions. In both A and B questions were structured as shown in Table 4.

TABLE 4.

QUESTION-NAIRE	RECOGNITION Multiple choice questions recognition of facts, terms & concepts.	RECALL SIMPLE Remembering single words or phrases, specific facts, terms, classifications criteria, methodology.	RECALL COMPLEX Remembering Universals and Abstractions i.e. major concepts.
A	8	7	7
B	8	7	7

The original question papers in Experiment 2 and 3 are included in Appendix A, 2.6.3.

All objective tests were scored by allocating one mark to each correctly answered question. No mark was allocated for a half correct answer.

The six types of tests or learning tasks used in Experiment 4 are described in detail in the Experimental Method of Unit 5, (The Tasks, 5.2.3). The tests are presented in Appendix A 2.6.3.

2.7. The Training Techniques (Instructional Procedure)

The development of a training technique for the improvement of reading skill depended upon an assessment of how strategies of reading relate to learning. Experiments 1-4 inclusive were designed to trace out this relationship at different levels. Implicit in this training was the expectation that if a learner be presented with an opportunity to be made aware of his reading protocol, this could form a basis for a more precise assessment of the outcome of his activity against self-defined purposes. Within this premise, students were encouraged to improve their strategies of reading for efficient learning.

The aim of the training studies was to develop the student's reading skill in two ways. Specifically, to develop new skills and apply these (1) in a variety of intellectual ability test situations, and (2) at all levels of textual organisation and complexity. Experiments 3 and 5 report empirical work, in which a specific attempt was made to encourage the development of new skills (or tactics), in order to improve the effectiveness of 'reading-to-learn.'

In considering what the training skill should offer, other than the two skills specified, the instructional principles of Jerome Bruner (1961), and Nedelsky (1967), were relevant. These authors suggest that any instruction should involve three levels of training. At the first stage the learner is provided with detailed instructions relating to the overall task, while at the second stage more general instructions are provided, and finally only the overall goal is given. Implicit within this scheme is the conception that during training the overall goal becomes associated with all the detailed instruction.

This system for categorising aims had value in providing a way to develop a schema for training. Hence, the details of training at the 'sentence' and 'chapter' level were organized in two dimensions. Table 5 illustrates the two dimensions of reading skill and level of instruction.

LEVEL OF INSTRUCTION

STAGES IN READING SUB-SKILLS
Relating to a particular learning task.

	1	2	3
1			
2			
3			
4			
5			

TABLE 5. Two-dimensional table of training to improve strategies of reading for efficient learning. Examples of how this was worked out can be found in UNIT 7 under Instructional Procedures (7.2.).

The development of a training technique which incorporates these dimensions was designed to take place in several stages, which can be summarised as follows:-

STAGE 1

In this initial stage an attempt was made to assess at the chapter level the relationship between strategies of reading and the type of learning which took place (Experiments 1, 2 and 3).

STAGE 2

In the second stage, students were offered visual guides to aid their reading for the purpose of composing a summary (Experiment 3, Group D).

a) They were shown how the pen recorder chart related to the detailed structure of their method of reading.

   The record which was provided as a guide could be used at two levels:-

   (i) A quick reference to it provided an indication of the number of 'main points' in the paragraphs (prompting reinforcement).

   (ii) A detailed comparison of the reader's record against the control record provided feedback as to exactly which item in the text being read was a higher order item of relevance to the summary (confirming reinforcemen).

b) They were shown a structured flow diagram of the text containing no words but numbered in a way that related directly to the paragraph numbers in the text. This diagram was prepared from the higher order items in each paragraph, which were then linked according to their semantic (generic) relationship (prompting reinforcement).

Use of these visual guides provided feedback against which a personal reassessment of the outcome of the learning activity in relation to the instructional directives was encouraged.

STAGE 3

At this stage an attempt was made to assess at the sentence level the relationship between strategies of reading and the type of learning which took place (Experiment 4).

STAGE 4.

In the fourth stage, the tactics or patterns of effective reading strategies which had been identified in Experiments 3 and 4 at the 'chapter' and 'sentence' level were presented as a feed-back. The reading strategies selected were those, which related to effective generalisation. In addition, each phase within the reading strategies was identified and described at three levels, the general, the specific and the detailed graphical record. The students were encouraged to make use of all three levels of instruction (UNIT 7, Experiment 5, The Pilot Study).

STAGE 5.

The empirical work reported in this thesis does not incorporate a detailed investigation of this final stage. However, the results of the empirical work haveled to a formulation of this final stage which is to be tested in the next phase of the longer term project. Students should be encouraged to use the training discriminately in order to operate at the level best suited for their individual 'conditions'. This depended upon a development of a model of the student as a learner operating on written material, so that various interacting factors could be taken into account and displayed to the student. A presentation of this model as well as further suggestions for this stage of the scheme, are contained in UNIT 8. It is to be expected, that ultimately a training scheme can be formulated, which encourages self-organized learning, so that the student takes over the control of his progress, in using reading as a learning skill.

UNIT 3 - An Empirical Study to Clarify the 'Problem' and to Test the Assumptions.

EXPERIMENT 1

Preliminary Exploration of the Instructional Directives, Learning Material, Task Definition, Reading Protocols and Learning Outcomes.

3.1 Introduction

The experiment was exploratory on a fairly broad front; to test the reading recorder, to develop the technique for content analysis of the learning material, to test the task evaluation technique, to evaluate ways in which subjects from a broad spectrum of the educational population differ in their reading strategies, to relate strategies of reading to learning outcomes and to evaluate the effect of increased familiarity with the knowledge area of the learning material on reading strategies and learning outcomes.

3.2 Experimental Method

Two groups of 20 subjects (Advanced Level students, Undergraduates and Graduates) participated in this experiment. Members of the experimental group read three chapters from Darwin's 'Origin of Species', one at each of three separate sessions. The control group read the last of the three chapters. All subjects were asked to produce a summary of each chapter after the reading. No time limit was set but it was made clear that once the summary had been commenced, no back reference to the learning material would be permitted. In the experimental group the interval between each session was not more than two weeks and not less than one week. For practical reasons this gap was inevitable. It was recognised that any long-term memory 'carry over' to each subsequent session could have been interfered with by more recent learning, especially if this was in any way related to the knowledge area of the text (Ceraso 1967).

The selection of the evolution texts as learning material

(Unit 2, 2.3, Appendix A.261) was considered appropriate to maximise involvement. The expectation was that since the 'Origin of Species' had profoundly influenced many Nineteenth Century scientists and philosophers, such as, Kant, Pisarev, Freud, Pavlov, Jackson, Edinger, Kappers and Herrick, all of whom had left a deep impact on the culture, the recognition of the importance of this original work would arouse interest in the task. On subsequent discussion it was found that while most participants were vaguely familiar with the evolution postulates of Darwin, very few had read the original book. Participants claimed that the three texts had interested them, and that they thought they had understood them, but many were uncertain concerning the quality of their summaries. There were no drop outs. The rationale governing the choice of the learning material is summarised in Pisarev's original words: "This brilliant thinker, whose knowledge is enormous took in all the life of nature in such a broad view and penetrated so deeply into all its scattered phenomena, that he discovered not an isolated fact but a whole series of laws, according to which all organic life on our planet is governed and he told of them so clearly, proves them so irrefutably and bases his arguments so logically, that any human uninitiated in science could be in a state of astonishment at not having thought out such conclusions long ago. Every educated person should make himself familiar with 'The Origin of Species', in it the reader will find the precision of an exact science, the breadth of philosophical generalisation and the irreplaceable beauty which is the mark of the aesthetic." The texts, therefore provided an interesting matrix for studying learning strategies geared to a summarising activity. The itemised analysis of the three texts is contained in Appendix A 2.6.1).

Each summary was analysed in terms of the number of items recorded and related to the flow diagram which presented identified themes or generalisations for each paragraph (Unit 2). The number of items recorded for each summary was converted to a percentage of the maximum possible. The maximum number of items was taken as the total number of items into which each text had been analysed. This produced a measure of the nature and amount of omissions (or selections) and the extent of the organisation of the summaries. The length of each summary (i.e. total number of words), and the time taken to write each summary were recorded. The input time (i.e. time spent on the reading recorder), and the patterns of reading within each read record or protocol were then related to the summaries. The experimental procedure is summarised in Table 1.

TABLE 1

GROUP	SUBJECTS			THE DARWIN TEXTS			NO. OF SUMMARIES PRODUCED	SUMMARY ANALYSIS				SCHEMA FOR ANALYSIS OF THE READING RECORDS		
	A.L.	Under-graduates	Graduates	1	2	3	Summary	Total no of items	Total no. of Themes	Summary length	Summary time	No. of Reads	Type of Read	Other Activities
Experimental Group SUBJECTS	6	7	7	20	20	20	20 20 20 60 Summaries	Total Items Text 1, 42 Text 2, 47 Text 3, 85	Total Themes Text 1, 3 Text 2, 3 Text 3, 4					
Control Group SUBJECTS	9	6	5			20	20	Total Items Text 3 85	Total Themes Text 3 4					
TOTAL SUBJECTS	16	13	11	20	20	40	80 Summaries							

Summary of the Experimental Procedure

3.3 Results and Discussion

3.3.1 Analysis of the Summary Score

The mean item scores of the experimental group for the first and third texts did not differ significantly ($p < 0.25$). Neither did the control group mean item score for text 3 differ significantly from that of the experimental group for text 3 ($p < 0.25$). The mean scores and standard deviation are shown in Table 2. The individual item scores t tests and probability levels are shown in Appendix B 3.3.1.

GROUP	TEXT	MEAN ITEM SCORE PERCENT	STANDARD DEVIATION
Experimental	1	50.0	23.75
	3	48.75	24.30
Control	3	47.65	21.79

TABLE 2

The mean item score percent for the Experimental and Control Groups in Texts 1 and 3.

Each experimental and control group subject was classified according to the position of their item score in the total distribution into:

High scorers (A)

Medium scorers (B)

Low scorers (C)

This distribution is shown in Tables 3 and 4.

TABLE 3

The score distribution for items (percent) and themes (number) in the Experimental Group for Texts 1, 2 and 3.

TEXT 1			TEXT 2			TEXT 3		
Experimental Group Subject	Item Score Percent	Total Themes = 3 no. of Themes	Experimental Group Subject	Item Score Percent	Total Themes = 3 no. of Themes	Experimental Group Subject	Item Score Percent	Total Themes = 4 no. of Themes
			HIGH SCORERS (A)					
5	86	3	5	87	3	6	95	4
3	86	3	7	85	3	7	89	4
1	81	3	1	85	3	1	86	4
4	79	2	6	83	3	2	77	4
6	79	2	3	81	3			
2	71	2	2	79	3			
7	69	2						
			MEDIUM SCORERS (B)					
17	52	3	4	55	3	5	58	4
18	50	2	16	55	1	3	56	4
19	43	1	12	53	1	17	48	3
12	43	1	17	53	2	4	47	4
20	40	1	18	51	3	18	45	3
13	38	0	15	45	1	14	42	2
16	38	0	19	43	2	19	42	3
15	31	0	20	43	2	20	42	4
14	29	0	14	38	2	12	41	1
			13	36	1	16	38	1
						13	38	0
						15	35	1

			LOW SCORERS (C)					
9 10 8 11	26 24 21 14	2 2 0 3	9 10 8 11	26 26 21 19	3 3 0 3	9 8 10 11	24 22 20 14	4 2 3 3

TABLE 3 (continued)

TABLE 4

The score distribution for items (percent) and themes (number) in the Experimental Group and Control Group for Text 3.

TEXT 3			TEXT 3		
Experimental Group Subject	Item Score Percent	Total Themes = 4 no. of Themes	Control Group Subject	Item Score Percent	Total Themes = 4 no. of Themes
		HIGH SCORERS (A)			
6	95	4	24	85	3
7	89	4	22	82	3
1	86	4	23	86	3
2	77	4	25	77	3
			21	75	3
		MEDIUM SCORERS (B)			
5	58	4	40	58	3
3	56	4	39	55	2
17	48	3	38	53	2
4	47	4	37	45	2
18	45	3	31	38	1
14	42	2	29	38	1
19	42	3	32	38	1
20	42	4	30	36	1
12	41	1	34	35	1
16	38	1	36	34	2
13	38	0	35	33	2
15	35	1	33	31	0
		LOW SCORERS (C)			
9	24	4	28	25	3
8	22	0	26	20	0
10	20	3	27	15	0
11	14	3			

Table 3 shows the high consistency of subject behaviour in terms of item score across the three texts. All medium and low scorers remained in their class. Four of the seven high scorers remained in their class, the remaining three changed their pattern of behaviour and became medium scorers. Table 4 shows that the distribution was more or less similar in the experimental and control groups, although differences in numbers of themes were evident. Tables 3 and 4 show that in all learning sessions high item scorers report a high number of themes; medium item scorers represent two sub-groups of high and low theme reporters; low item scorers represent two sub-groups of high and low theme reporters. Progression from the first to the third learning session in the experimental group affects the distribution of high, medium and low item scorers in relation to numbers of themes reported. The distribution of high, medium and low item scorers in relation to themes in the experimental and control group is different. The distribution of subjects into high, medium and low item scorers in relation to numbers of themes successfully reported, show significant differences in the experimental and control groups. (Appendix B. 3.3.1).

The data in Table 5 shows that the experimental group reported more themes than the control group.

GROUP	Total Theme Score	Mean Theme Score	Standard Deviation	t value	Level of Probability
Experimental	56	2.8	1.13	3.07	$p > 0.001$
Control	36	1.8	.857		< 0.002

TABLE 5

Theme Scores of Experimental and Control Group for Text 3

The theme score percent in the first and the third learning sessions of the experimental group and in the learning session of the control group is shown in Table 6.

GROUP	SUB-GROUP	Mean Theme Score Percent: Text 1	Mean Theme Score Percent: Text 3
Experi-mental	A	81	100
	B	25	63
	C	58	63
	Total Group	57	70
Control	A	-	75
	B	-	37
	C	-	25
	Total Group	-	45

TABLE 6

Theme Score Percent of Experimental and Control Groups

Inspection of Table 6 shows that all classes of subjects in the Experimental Group increase the number of themes as a result of increased familiarity with the learning material and with the task; It appears, therefore, that while most subjects remain consistent in their self-definition of the task across the three texts in terms of item score, they become more effective in numbers of themes reported. However, further inspection of Table 3 shows that not all medium and low scorers increase the number of themes reported. The high scoring subjects tended to increase the number of items reported from the first to the third learning sessions (a related t test was significant at p=.02, Appendix B, 3.3.4, as well as number of themes. The medium and low scoring subjects maintained the same number of items in the first and third learning sessions (Appendix B, 3.3.1), but some of these subjects increased the number of themes. The three high item scorers in Text 1 who redefined their task in Text 3 to become medium scorers maintained a high level of number of themes.

Table 7 shows the relationship between high, medium and low item scorers in the experimental and control groups and their levels of educational achievement.

	STUDENT	HIGH ITEM SCORE	MEDIUM ITEM SCORE	LOW ITEM SCORE
Experi-mental Group	Advanced level	2	4	0
	Undergraduates	2	4	1
	Graduates	0	4	3
Control Group	Advanced level	1	7	1
	Undergraduates	1	4	1
	Graduates	3	1	1

TABLE 7

The relationship between level of educational achievement and item score in Text 3.

Graduates are approximately equally divided between the three score groups. Undergraduates and Advanced Level students cluster at the medium score. In view of the relatively small population this result should be interpreted with extreme care.

3.3.2 Analysis of Input (Learning) Time, Output (Summary) Time and Summary Length.

The individual input times, summary times and summary lengths for the three texts are shown in Appendix B, 3.3.2.. Table 8 shows that no significant differences in input time, summary time nor summary length were apparent, for the experimental group as a whole between the first and the third learning sessions, although there was a tendency to decrease input time. The four high scorers who remained in their class for Text 1 and Text 3 showed a tendency to decrease their input time but increase their summary length. This tendency ties up with the significant increase in the number of items recorded, (p = .02, Appendix B,3.3.4.). The seven high scorers (made up of the four who remained in their class for Texts 1 and 3 and the three who changed their class from high scorers to medium scorers from Text 1 to Text 3) showed a significant decrease in input time and a tendency to decrease summary time. This significant difference in input time could reflect changes in reading-to-learn activity as a result of changes in task definition. This factor is evaluated later in this result section (3.3.3.). The nine medium scorers and the four low scorers showed no significant changes in input time, summary time, nor summary length. However, the large standard deviations indicate that the subjects in these sub-groups were not uniform in behaviour.

The mean input time, summary time and summary length in the first learning session of the experimental group (Text 1) and the learning session of the control group (Text 3) were not significantly different. Neither did the input time, summary time nor summary length differ in the third learning session of the experimental group (Text 3) and the learning session of the control group (Text 3). However, a comparison of the high, medium and low scorers in experimental and control groups showed that high scorers in the control group tended to take longer on

TABLE 8

KEY:
SUB-GROUP A(i) = the 4 subjects who were high scorers in Texts 1 and 3.
SUB-GROUP A(ii)= the 4 subjects who were high scorers in Texts 1 and 3 + the 3 subjects who were high scorers in Text 1 and medium Scorers in Text 3.

Experimental Group	INPUT TIME				SUMMARY TIME				SUMMARY LENGTH			
	Mins. per 15 lines of Text				Mins. per 15 lines of Text				Words per 15 lines of Text			
	(Text 1 - Text 3)		Related	Probability	(Text 1 - Text 3)		Related	Probability	(Text 1 - Text 3)		Related	Probability
	Mean Difference	Standard Deviation	t	p	Mean Difference	Standard Deviation	t	p	Mean Difference	Standard Deviation	t	p
Total Group(20)	+.447	1.25	1.558	0.10	+.1	.474	.735	0.25	+.3	5.95	.2198	0.25
SUB-GROUP A(i) 4 A(ii) 7	+.557 +1.305	.75 1.10	1.88 2.917	0.10 0.01	+.025 +.17	.387 .3089	.111 1.632	0.25 0.10	-4.5 +1.857	5.02 8.542	1.78 .5449	0.10 0.25
SUB-GROUP B (9)	-.122	.835	.4129	0.25	+.04	.622	.1818	0.25	-1.1	3.95	.787	0.25
SUB-GROUP C (4)	+.225	.442	.8817	0.25	+.04	.222	.312	0.25	+.75	2.277	.570	0.25

Analysis of INPUT TIME, SUMMARY TIME and SUMMARY LENGTH in the Experimental Group in first and third learning sessions (Texts 1 and 3).

their input time and summary time (p=0.10). The low scorers in the control group took longer on their input time than the low scorers of the experimental group (p=0.02). This data is shown in Appendix B, 3.3.2. In view of the small samples of these sub-groups the data should be interpreted with caution. However, such data might be of relevance in terms of the interpretation of the reading records (3.3.3.).

A comparison of the mean input time, summary time and summary length of the high, medium and low scorers in both experimental and control groups showed significant differences (AppendixB,3.3.2). Inspection of these results shows that:

in the first learning session of the experimental group,

- low scorers spent less time on their summaries and wrote shorter ones than the medium scorers.
- low scorers spent less time on their input and summaries and wrote shorter summaries than high scorers.
- medium scorers spent less on input times and wrote shorter summaries than high scorers.

In the second learning session of the experimental group,

- low scorers wrote shorter summaries than medium scorers.
- low scorers spent less on input times, and wrote shorter summaries than high scorers.

medium scorers spent less on summary times and wrote shorter summaries than high scorers.

in the third learning session of the experimental group,

low scorers spent less on input time, summary time and wrote a shorter summary than medium scorers.

low scorers spent less on input time, summary time and wrote a shorter summary than high scorers.

medium scorers spent less on input time, summary time and wrote a shorter summary than high scorers.

in the third learning session of the control group,

low scorers wrote a shorter summary than medium scorers.

low scorers spent less on summary times and wrote a shorter summary than the high scorers.

medium scorers spent less on summary time and wrote a shorter summary than high scorers.

Within the experimental and control groups the high (A), medium (B) and low (C) item scorers can be distinguished in terms of gross measures of input and output activities. However, the differences in theme score within one class of item score, particularly in the medium and low scores, may mean that these classes or sub-groups contain more than one type of reading strategy. This interpretation is supported by the high standard deviations shown within the sub-groups. In the absence of detailed reading records it was impossible to relate the changes in input and output activities with any changes in the reading protocols. However, gross data of the reading protocols indicate certain differences between the high (A), medium (B) and low (C) item scorers.

3.3.3. Analysis of Reading Records and Discussion

The reading records suffered from a major drawback in that about two-fifths of the recordings got no further than the 'sounds into S.E.T.A.R.' stage. Thus, out of 80 subjects ((3 + 20) + (1 + 20)) 45 were eventually plotted by an x,y plotter. However, from these partial results and observational records from each session in terms of number of reads, number of note sessions, number of 'thinking' sessions and duration of each read, some analysis was possible. Reading patterns could be grouped into:-

a) A straightforward "beginning to end" exploration of the text with very few hesitations. This pattern seemed to be associated with a general assessment of the text when practised as a first stage in a reader's protocol, or as a general review when practised as a last stage.

b) A slower "beginning to end" exploration of the text patterned throughout with hesitations. This pattern seemed to be associated with small unit learning or the acquisition of knowledge relating to 'specifics'.

c) A scanning backward and forward from one part of the text to another, either from sentences within a paragraph or from one paragraph to another accompanied or unaccompanied by note making sessions. The notes prepared in the type b read differed from those in the type c read, the former consisting of lists of "specific facts" and "terms" and the latter consisting of selected "translations" of groups of sentences or paragraphs.
In some protocols, type b read occurred twice or three times. often the notes made in subsequent type b reads approximated more closely to those made during the type c read.

d) Intermittant periods of "no reading" activity at the termination of a particular "beginning to end" read within the whole protocol, and/or at the end of the reading activity.

Discussion

From an analysis of the input and output activities, and an analysis of the reading protocols, a classification of the subjects into three groups was possible.

The High Item Scorers (A)

Those high scoring subjects who did not attempt to differentiate between any of the items of the text and whose summaries consisted of efforts at recalling most of the knowledge items regardless of their degree of relevance within a summary of the text. The reading protocols of this group which were available consisted of the b and d read patterns described, the type of activity in d being largely devoted to very lengthy 'memorising' sessions. These subjects were classified as Mass Producers.

The Medium Item Scorers (B)

Those medium scoring subjects who selected some knowledge items from the text according to their evaluation of these items in terms of a summary. Some medium scorers were more successful than others in that their selections of items related to the themes of the text. The reading protocols available for this group consisted of the a, b, c and d patterns described, the type of activity within d involving 'thinking' sessions, further note preparation sessions and note review sessions. These subjects were classified as Selectors and were further differentiated into those Selectors who reported themes adequately and those Selectors who were unable to report the themes adequately.

The Low Item Scorers (C)

Those low scoring subjects who selected few items from the text according to their evaluation in terms of a summary. Some low scorers were successful in that they attempted to formulate a very generalised version, relating to most of the themes of the text. Some abstractors were less successful in that their selections of items did not relate to all the themes of the text. Very few reading protocols were available for this group, but those that were consisted of a, b and d patterns described. These subjects were classified as Abstractors and were further differentiated into those Abstractors who reported themes in a highly generalised way and those Abstractors who failed to report themes adequately.

3.3.4 Further Analysis of Summaries

Introduction

The evaluation of summaries in terms of Total number of items and Total number of themes reported, appears inadequate, since the relation between the number of items and the number of themes reported is inconsistent. It is clear that Total item score alone is no adequate measure of summary performance. The results show that Mass Producers increase the number of items and themes with familiarity. The Selectors and Abstractors on the other hand represent mixed groups of high and low theme reporters, and while item score appears to remain unchanged, some selectors and abstractors increase the number of themes with familiarity.

In order to identify these Selectors and Abstractors more adequately a more refined technique of evaluation was introduced. Firstly, each item identified in the texts was allocated one of three categories of relevance in terms of the summary. Knowledge items were differentiated into very highly relevant (...), highly relevant (..) and least relevant (.), for the summary. The analysed texts are shown in Appendix A. On the basis of this analysis two methods of assessing the performance of subjects were introduced.

1. A Measure of Performance

This measure was assessed by evaluating the most highly relevant item score in the summary and expressing this as a <u>percentage of the total most highly relevant items identified in the original text.</u>

2. <u>A Measure of Selection</u>

   This measure was assessed by evaluating the most highly relevant item score in the summary and expressing this as a <u>percentage of the total items reported in the summary</u>.

One major theme (or Generalisation) from Text 1 (Generalisation 1) and from Text 3 (Generalisation 3) were analysed on this basis, and all summaries in the experimental and control groups were reassessed. This data is shown in Appendix B, 3.3.4. Since the number of the most highly relevant items in Generalisation 1 Text 1 and Generalisation 3 Text 3 were very small in relation to the total number of items (5/33 in Text 1, 8/44 in Text 3), it was decided to base the assessment on the combined most highly relevant (∴.) and highly relevant (∴) items.

<u>Results</u>

The three dimensions of categorisation of subjects according to: Total item score, Measure of Performance and Measure of Selection, resulted in a more detailed differentiation of the experimental population. This data is shown in Appendix B, 3.3.4. Tables 9 and 10 show the position of each subject in the experimental and control groups according to the distribution of Total item scores, Measure of Performance and Measure of Selection.

TABLE 9

KEY:

A = HIGH SCORERS
B = MEDIUM SCORERS
C = LOW SCORERS

	TEXT 1			TEXT 3		
SUBJECT	Total Item Score Percent	Measure of Performance	Measure of Selection	Measure of Performance	Measure of Selection	Total Item Score Percent
A 3	81	83	56	84	64	57
5	78	78	54	84	61	59
4	70	67	52	89	74	52
1	70	67	52	89	52	75
2	67	67	55	84	50	73
6	67	67	55	92	50	82
7	64	61	52	100	51	84
B 17	54	61	61	84	69	52
18	54	61	61	68	65	45
12	48	39	44	42	38	48
15	45	28	33	26	26	43
20	45	44	53	63	60	45
19	42	44	57	63	63	43
13	42	33	43	32	35	39
16	36	33	50	37	44	36
14	36	33	50	32	33	41
C 9	30	56	100	42	100	18
8	27	33	66	42	73	25
10	24	44	100	37	100	16
11	21	39	100	42	100	18

The distribution of the Total item score, Measure of Performance and Measure of Selection in the Experimental Group for Texts 1 and 3.

TABLE 10

KEY:
A = HIGH SCORERS
B = MEDIUM SCORERS
C = LOW SCORERS

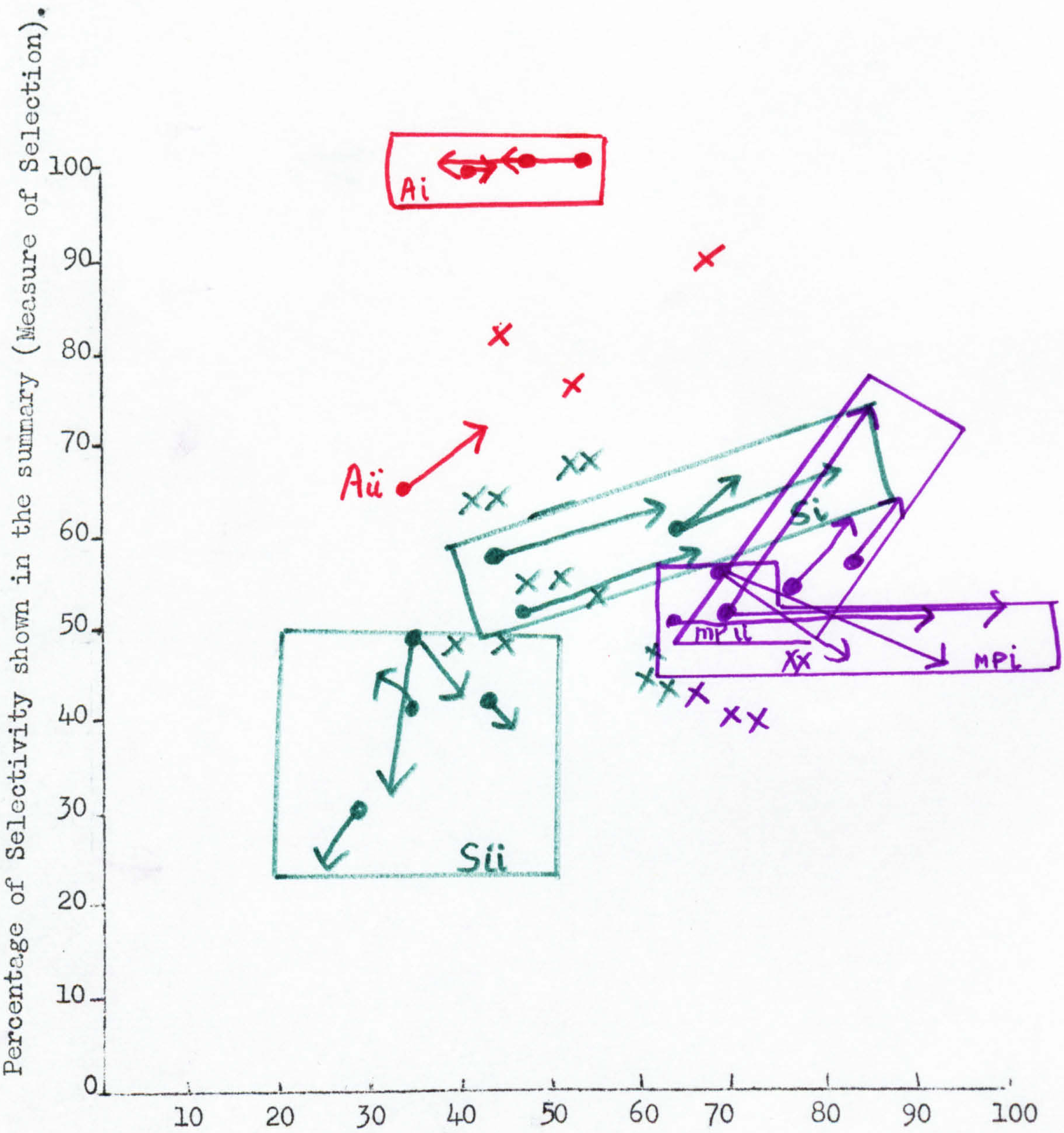
SUBJECT	TOTAL ITEM SCORE PERCENT	MEASURE OF PERFORMANCE	MEASURE OF SELECTION
24	73	79	47
22	73	68	41
25 A	70	79	48
23	68	68	43
21	64	63	43
39	59	63	44
40	59	63	46
38	57	63	48
37	54	42	50
31	41	53	55
29 B	36	47	56
33	36	42	56
34	32	47	64
36	32	47	64
30	31	37	50
35	29	42	62
33	29	42	62
28	27	58	90
26 C	27	47	75
27	23	42	80

The distribution of Total item score, Measure of Performance and Measure of Selection in the Control Group.

These tables show that the Measure of Performance and the Measure of Selection are better measures of subject performance than the Total item score. The high scorers (A) (or Mass Producers) could be distinguished by their high level of Total item score and mediocre selectivity. The medium scorers (B) (or Selectors) could be differentiated into those subjects whose performance in terms of the most relevant items (Measure of Performance) was fairly adequate, and those subjects whose performance in terms of the most relevant items(Measure of Performance) was inadequate. The low scorers (C) (or Abstractors) could be distinguished by their selection of most relevant items (Measure of Selection) into those whose level of selection was very high and those whose level of selection was not so high.

Plotting the Measure of Selection score against the Measure of Performance score in the experimental group for Text 1 and Text 3 shows changes in learning outcome behaviour. Table 11 shows this for the experimental group. The Measure of Selection score against the Measure of Performance score of the control group is also plotted in Table 11.

KEY
- Abstractors i, ii experimental (Text 1-3)
- Abstractors control
- Selectors i, ii experimental (Text 1-3)
- Selectors control
- Mass Producers experimental (Text 1-3)
- Mass Producers control.



Percentage high level items identified in the summary (Measure of Performance).

TABLE 11

Selection scores plotted against Performance scores in the Experimental Group for Text 1 and 3 and in the Control Group for Text 3.

Inspection of this graph and the data in Appendix B, 3.3.4., showing the difference in Total item score, Performance score and Selection score in the experimental group for Text 1 and Text 3 indicate that as a result of increased familiarity specific changes in learning outcomes took place. These can be summarised as follows:-

A. (i) The High Scorers or Mass Producers.

Those subjects (4) who maintained their definition of the task for Texts 1 and 3 and increased their Total item score and Performance score but their Selection score showed no change. These Mass Producers can be considered to have improved within their own definition but did not become more efficient summarisers.

A. (ii) Those subjects (3) who adjusted their task definition from Texts 1 to 3 and decreased their Total item score, increased their Performance score and Selection score. These Mass Producers who redefined their task as Medium scorers or Selectors, became more efficient summarisers.

B(i) The Medium Scorers or Selectors.

Those subjects (4) who were consistent in their task definition for Texts 1 and 3 and increased their Performance and Selection scores, while maintaining the same Total item scores. These Selectors became more efficient summarisers.

B(ii) Those subjects (5) who maintained their task definition from Text 1 to Text 3 and who showed no change in Total item score and Performance score but decreased their Selection score. These Selectors tended to become less efficient summarisers.

C(i) Those subjects (3) who were consistent in their task definition for Texts 1 and 3 but showed a tendency to decrease the Total item score and Performance score while maintaining their

Selection score. These Abstractors became more efficient within their definition.

C(ii) The subject (1) who maintained his task definition for Texts 1 and 3 and who showed little change in Total item score but tended to increase his Selection and Performance score. This Abstractor tended to become more efficient within his definition.

3.4. GENERAL CONCLUSION

1. The introduction of measures of higher order item selection, increased control of the assessment of summaries and resulted in a higher precision of learner classification, than that which was possible on an analysis based exclusively upon the criterion of Total item score.

2. It was apparent that the 40 subjects who participated did not assess the task of summarisation in the same way when given the same instructional directives and learning material. According to Total item score, Measures of Performance and Measures of Selection, it was possible to identify three classes of learners.

CLASS A (The Mass Producers or High Scorers).

The Mass producers who were consistent in their task definition and who reported a large number of items from each category of relevance and as a result, produced inadequate summaries. The Mass producers, who changed their definition and became Selectors and who as a result produced adequate summaries.

CLASS B (The Selectors or Medium Scorers).

The Selectors, some of whom could be further classified into those whose selection was more or less arbitrary in relation to the three categories of item relevance and as a result produced inadequate summaries, and those whose selections followed a distinct pattern relating to the higher order of relevant items and as a result produced adequate summaries.

<u>CLASS C</u> (The Abstractors or Low Scorers)

The Abstractors, who were more or less efficient in their selection of higher order items, and who as a result produced abstracts rather than summaries.

Individual variation within each class can be accounted for by errors in selection, and/or in the recall of items. Table 12 summarises this interpretation of learner task definition.

THE CLASSIFICATION OF LEARNERS

The Set Task or
Instructional Directives
(To compose a summary)

'Conditions' within the learner
determining an orientation to the
task in terms of the learning
material provided, and the in-
structional directives.

CLASS A	CLASS B	CLASS C
The Mass Producer. A long summary	The Selector. A medium length summary	The Abstractor. A short summary

Variation in performance within each class accounted for by:

← increasing chance of error in recall of items

→ increasing chance of error in selection of the most relevant items

Less Efficient	More Efficient	Less Efficient	More Efficient	Less Efficient	More Efficient
attempt at recall less adequate, random omission of items, subjects less well aligned within the task definition	attempt at re-call more adequate, subjects better aligned within the task defini-tion.	attempt at selection more arbitrary, subjects poorly aligned within task defini-tion.	Attempt at selection related to higher order items, subjects well aligned within task defini-tion.	Attempt at selection not so well re-lated to the higher order items.	Attempt at selec-tion highly sophisticated, subjects well aligned within their task defini-tion.

TABLE 12

The distribution of efficient and inefficient summarisers within the class of Selectors and Abstractors accounted for the large standard deviation within the population in relation to the mean item score, mean input time and summary time as well as mean summary length, noted in the earlier result section (3.3.2 and 3.3.3.).

Within a hierarchical classification, the Abstractor represents the most <u>evolved</u> class, in that abstraction demands the highest efforts at selection and extrapolation the Selector falls within a lower class, since the demands of selection and extrapolation i are less stringent and the Mass producer falls within the lowest class, since minimal selection and extra- extrapolation are demanded. Reference to The Taxonomy (Bloom 1956), Bruner's report on the Process of Education (1960) and Gagné's review of the Conditions of Learning (1965) validates this classification, since they conclude that the ability of recall of knowledge only is at a lower level of intellectual organisation than the ability of discrimination and comprehension. From the point of view of utility, the fairly substantive report. of the Selector, aligned to the higher order items of the text, is more informative to others, the brief report of the Abstractor, aligned exclusively to the highest order items of the text is essentially a form of self-reference, or for the specialist, while the long reports of the Mass producer covering most of the items is not only time consuming to read but more 'work" has to be done by the reader to evaluate the themes.

3. The diversification of task definition within the experimental population which resulted in three classes of definition, did not appear to show any relationship to educational achievement. The Graduate sample was fairly equally represented within the three classes, the Undergraduates and Advanced Level students tended to cluster within one class, the class of Selectors. In view of the fairly small population any evaluation concerning task definition and educational achievement should be interpreted with extreme care. However, it is concluded that the 'cognitive

state' of each participant appeared to influence an <u>individual interpretation</u> of the task (or instructional directives).

4. Improvement in efficiency as a result of increased familiarity with the knowledge area of the texts was not a universal phenomenon. It depended upon the task definition of the participant. Some Mass producers tended to improve within their own definition in that they remembered and reported more knowledge items. Other Mass producers redefined their task and became Selectors. Some Selectors improved within their definition in that they selected more of the higher order items. Other Selectors remained ineffective and tended to become worse selectors in terms of the higher order items. Few learners defined their task as Abstractors, those who did so tended to improve within their definition.

5. The reading records which were available indicated that Abstractors, Mass producers and Selectors were distinguishable.

<u>Mass Producers</u> were conspicuous by :-

(i) The absence of a <u>c</u> type search read.

(ii) The presence of the long <u>b</u> type data processing read.

(iii) The presence of the long <u>d</u> type 'non reading' activity which consisted of a massive memorising session from detailed notes.

<u>Selectors</u> were characterised by:-

(i) The <u>a</u> type brief exploratory read.

(ii) The long <u>b</u> type data processing read, or reads.

(iii) The <u>c</u> type search read, a scanning backwards and forwards between various sentences and paragraphs in the text.

(iv) The <u>d</u> type 'non-reading' activity, which consisted of further efforts at evaluating the 'main points' and of memorising related items.

<u>Abstractors</u> were characterised by:-

(i) The <u>a</u> type brief exploratory read.

(ii) The <u>b</u> type data processing read of longer or shorter duration.

(iii) The <u>d</u> type 'non-reading' activity which consisted of the memorising and drafting of 'main points.'

6. Any changes in input and output behaviour within each class, possibly as a result of increased familiarity with the learning material, could not be related to the reading records, because not all of these were available. It was, therefore, not possible to relate changes in task definition (Mass producers in Text 1 became Selectors in Text 3), to changes in reading tactics and strategy. Neither was it possible to relate changes in efficiency within the task definition (of Mass Producers, Selectors and Abstractors) to changes in tactics and strategy.

7. Finally, it was considered that, in order to identify more conspicuous changes in input and output activities it would have been necessary to extend the study to more learning sessions within the knowledge area of the expository material, and to run these sessions at closer intervals for each subject.

3.5. SUMMARY

The introduction of more than one criterion for the evaluation of the summaries (Total item score, Measure of Performance, Measure of Selection), was useful in differentiating the experimental population in terms of their learning outcomes. These three criteria combined provide an index of learner task definition. Advanced Level students, Undergraduates and Graduates interpret a particular learning task, such as, the preparation of a summary on a particular text, such as, the Darwinian texts on evolutionary theory, in one of three ways. Subjects were classified as Mass producers, Selectors and Abstractors. This diversification of task definition did not appear to relate in any specific way to the level of general education achievement. However, the internal 'conditions' or 'state' of each student led to an individual interpretation of the task. Most students remained within their original definition over the three chapters read, but tended to change their efficiency within that definition. A comparison of the learning outcome (the summary) with the reading protocols, showed that some distinction between the three classes of task definition could be made in terms of reading tactics. However, owing to the unavailability of all the reading records, it was not possible to relate changes in input (time) and output (summary time, length, score) activity to any changes in reading tactics and strategies.

UNIT 3 - An Empirical Study to clarify the 'Problem' and to test the Assumptions

Experiment 2

Further Explorations of the Instructional Directives, Learning Material, Task Definition, Reading Protocols and Learning Outcomes.

3.6. Introduction

The second experiment was designed to explore further the learner's definition of the learning task, and to assess how this was related to 'conditions' within the learner, to the type of written material and to the type of learning task set.

It was decided to construct a series of objective tests. It was important to recognise that this type of learning task differed considerably from that set in Experiment 1. Essay-type tests (such as summarisation) differ from objective tests in a number of ways (Ebel 1965, Gardner 1969). It was possible, therefore, to test whether differences in the type of test expected would influence the preparation subjects make for it. To date, there is very little evidence in the literature on this issue. Surveys of student opinion thirty years ago did suggest that students studied 'more thoroughly' in preparation for essay-type tests than objective tests (Meyer 1935), Terry 1933). More recently Torrance (1969), has shown some influence on a student's learning of the type of test administered.

3.7 Experimental Procedure

The experimental population, which consisted of thirty first-year Advanced Level students was divided into three groups.

GROUP 1. Ten subjects were given the general instruction, that the learning task consisted of recall and recognition responses to two separate objective test question papers A and B, with 16 questions in each.

GROUP 2. Ten subjects were pretested on Question paper A and were given the instruction that the learning task consisted of reanswering Question paper A and answering another Question paper B, which was of a similar type, with the same number of questions.

GROUP 3. Ten subjects were pretested on Question paper B and were given the instruction that the learning task consisted of reanswering Question paper B and answering another Question paper A, which was of a similar type with the same number of questions.

The value of the prelearning tests in Groups 2 and 3 was considered to be two-fold. Firstly, the pretest provided a measure of the 'knowledge state' of the learner in the cognitive domain to be read and, secondly, any influence of the pretest on subsequent learning activity could be evaluated. Reasons which governed the choice of the objective tests and the construction of the tests are discussed in Unit 2. The Question papers A and B are presented in Appendix A, 2.6.3.

The learning material.

The learning material used in this study was the 3,900 word passage on 'Hearing' from the McGraw Hill Encyclopaedia, the analysis of which is presented in Appendix A.2.6.1.

A comparison of the texts in Experiment 1 and 2 with reference to 'The Taxonomy' is represented in Table 12.

TABLE 12

Taxonomical Comparison of the Evolutionary Texts and the Hearing Text

Knowledge			TEXT Evolution	TEXT Hearing
1.10 Knowledge of Specifics	1.11 Knowledge of Terminology	1.11a To define technical terms by giving their attributes, properties or relations.	✓	✓
		1.11b Familiarity with a large number of words in their common range of meaning.	✓	✓
		1.11c Knowledge of the terms and concepts peculiar to work in science.	✓	✓
	1.12 Knowledge of Specific facts.	1.12a Knowledge of biological facts important to a systematic understanding of biological processes.	✓	✓
		1.12b Knowledge of physics and chemistry important to an understanding of biological processes.	-	✓
1.20 Knowledge of Ways & Means of dealing with Specifics.	1.21 Knowledge of Trends & Sequences.	1.21a To develop a basic knowledge of the evolutionary development of organisms.	✓	-
		1.21b To develop a knowledge of the several dimensions of response to sound stimuli.	-	✓
	1.23 Knowledge of Classification	1.23a Knowledge of classes, and divisions which are regarded as fundamental or useful in a scientific field.	✓	✓
	1.24 Knowledge of Criteria	1.24a Knowledge of criteria by which facts and concepts are tested or judged.	✓	✓

TABLE 12 cont'd.

Knowledge			TEXT Evolution	TEXT Hearing
1.30 Knowledge of Universals & Abstractions in a field.	1.31 Knowledge of Principles & Generalisations.	1.31a Knowledge of the major principles and generalisations involved in Darwin's evolutionary doctrine.	✓	–
		1.31b Knowledge of the major principles and generalisations involved in hearing.	–	✓
	1.32. Knowledge of Theories & Structure.	1.32a Knowledge of the complete formulation of the theory of evolution.	✓	–
		1.32b Knowledge of the interrelations and organisation of the range of specifics and generalisations involved in hearing.	–	✓

This taxonomical comparison of the texts indicated, that while differing in intellectual content, style and cultural importance, the intellectual organisation was similar.

The 'Hearing' passage was chosen on the basis of being unfamiliar at this level of detail, to the advanced level students. These students had not reached the stage, within their curriculum when this information was taught. However, to maximise ego involvement, students were informed that the learning material related to their advanced level course and that their individual scores and reading records would be shown to them.

The Reading Records.

The later version of the reading recorder was used in this experiment, so that earlier difficulties in the recording of the reading records were overcome. This technique yielded detailed records of the way in which each subject read the text.

The Task Evaluation

The two objective test Question papers A and B were scored by allocating one mark to each correctly answered question. The total marks per question paper was, therefore, 16. These marks were distributed as follows:-

Four marks were allocated to the Recall simple questions, four to the Recognition, or Multiple-Choice questions, and 8 marks to the Recall Complex questions.

3.8. Results and Discussion

3.8.1. A Comparison of Performance in Question papers A and B in the Control Group (Group 1).

Tables 13 and 14 show the distribution of individual differences in the Recall Simple and Recognition scores and in the Recall Complex score in Question paper A and B for Group 1.

TABLE 13. Individual differences in Recall Simple and Recognition scores for Group 1 (No Pretest).

Question paper A	Question paper B	Difference in Score
8	8	0
8	7	-1
7	7	0
7	7	0
7	8	+1
4	5	+1
3	4	+1
5	3	-2
6	5	-1
5	6	+1

TABLE 14. Individual differences in Recall Complex Score for Group 1. (No Pretest)

Question paper A	Question paper B	Difference in score
7	8	-1 +1
8	7	-1
8	7	-1
7	8	+1
6	6	0
2	3	+1
3	3	0
0	0	0
1	0	-1
1	0	-1

The score in questionpaper A and the score in question paper B, was fairly balanced and shows no significant difference.

3.8.2. A Comparison of the Effects of Two Instructional Directives

The score frequency distribution of Groups 1, 2 and 3, illustrated differences in the pre- and post-learning states of the subjects as well as pre-test influences on the learning activity. Histograms illustrating the distribution of Recall Simple and Recognition scores and Recall Complex scores for subjects in each group are presented in Tables 15-20 inclusive.

The Score Frequency Distribution of Recall Simple and Recognition Tests in Groups 1, 2 and 3.

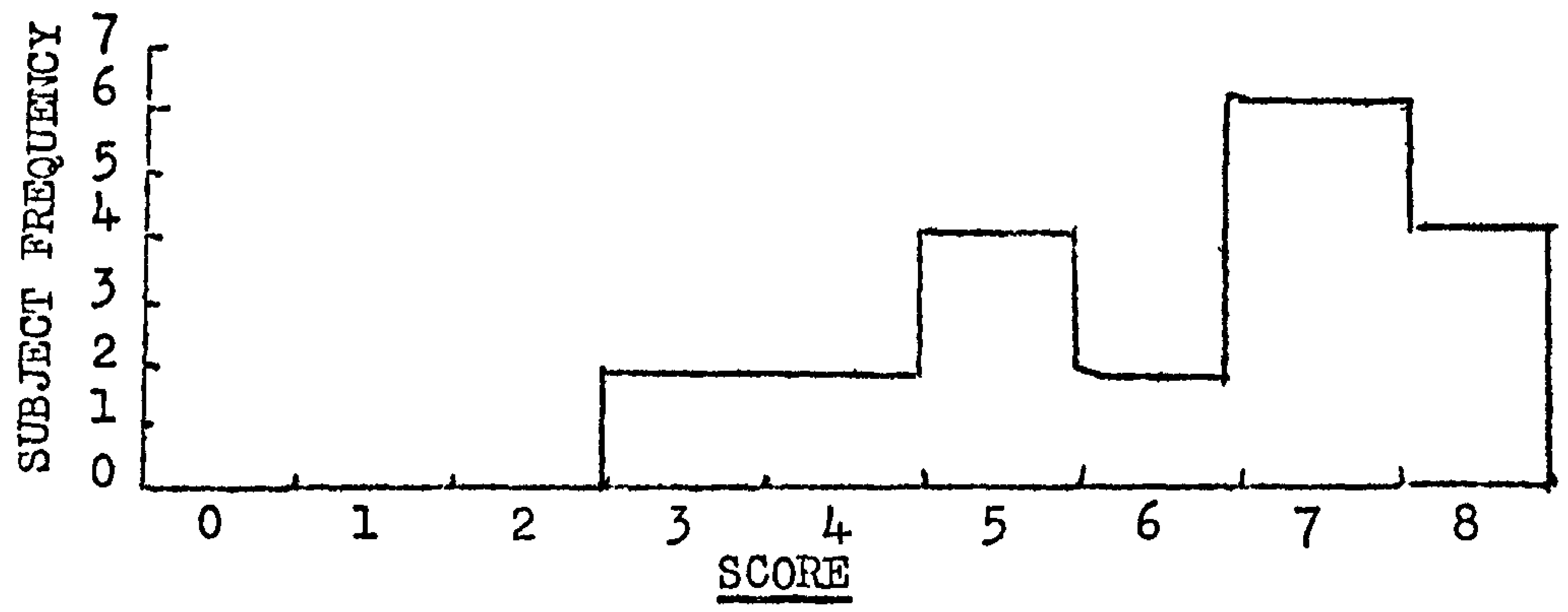


TABLE 15. Score Frequency Distribution of Recall Simple and Recognition Tests in Group 1. (No Pretest).

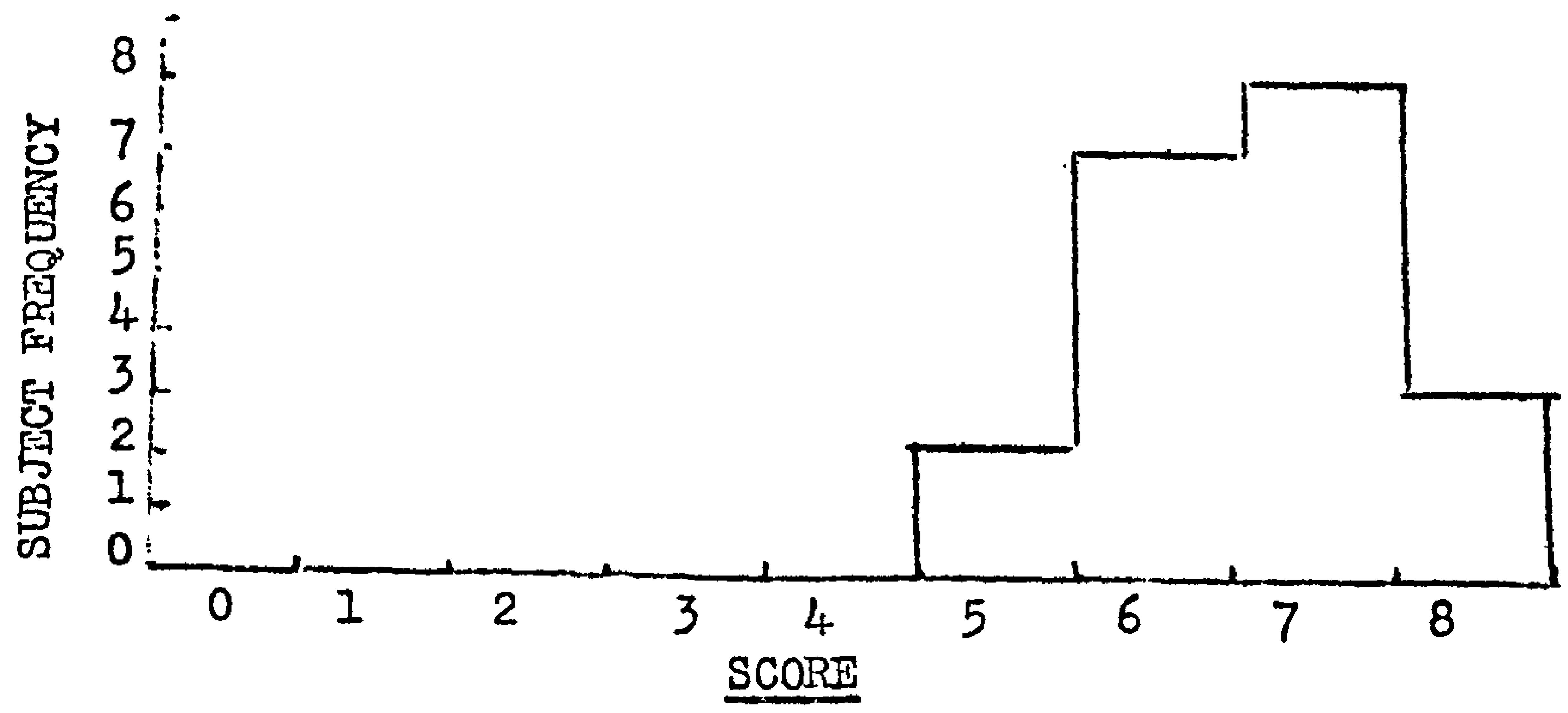


TABLE 16. Score Frequency Distribution of Recall Simple and Recognition Tests in Groups 2 and 3 in question paper not pretested.

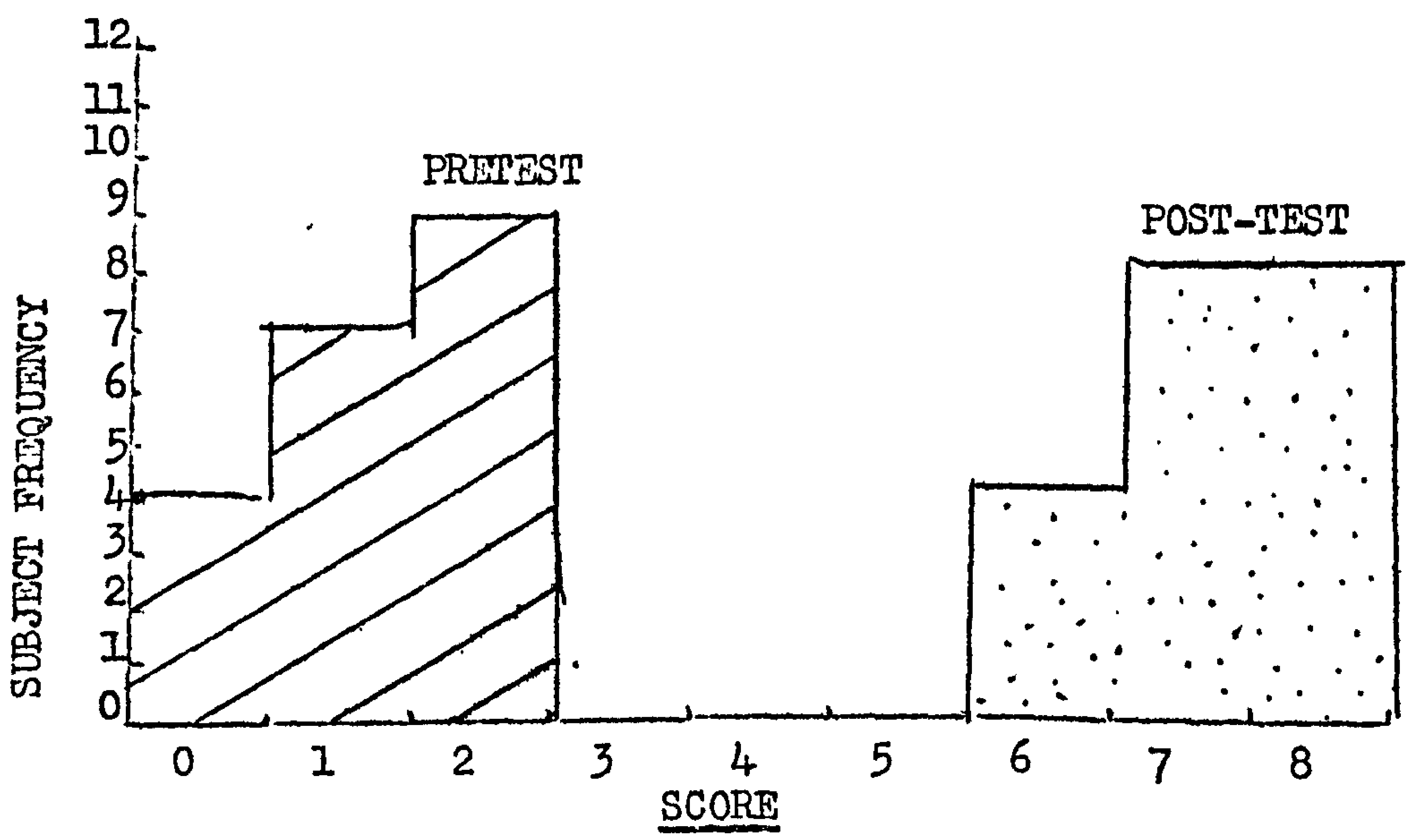


TABLE 17. Score Frequency Distribution of Recall Simple and Recognition Tests in Groups 2 and 3 in pretested question paper.

The Score Frequency Distribution of the Recall Conplex Test in Groups 1, 2 and 3.

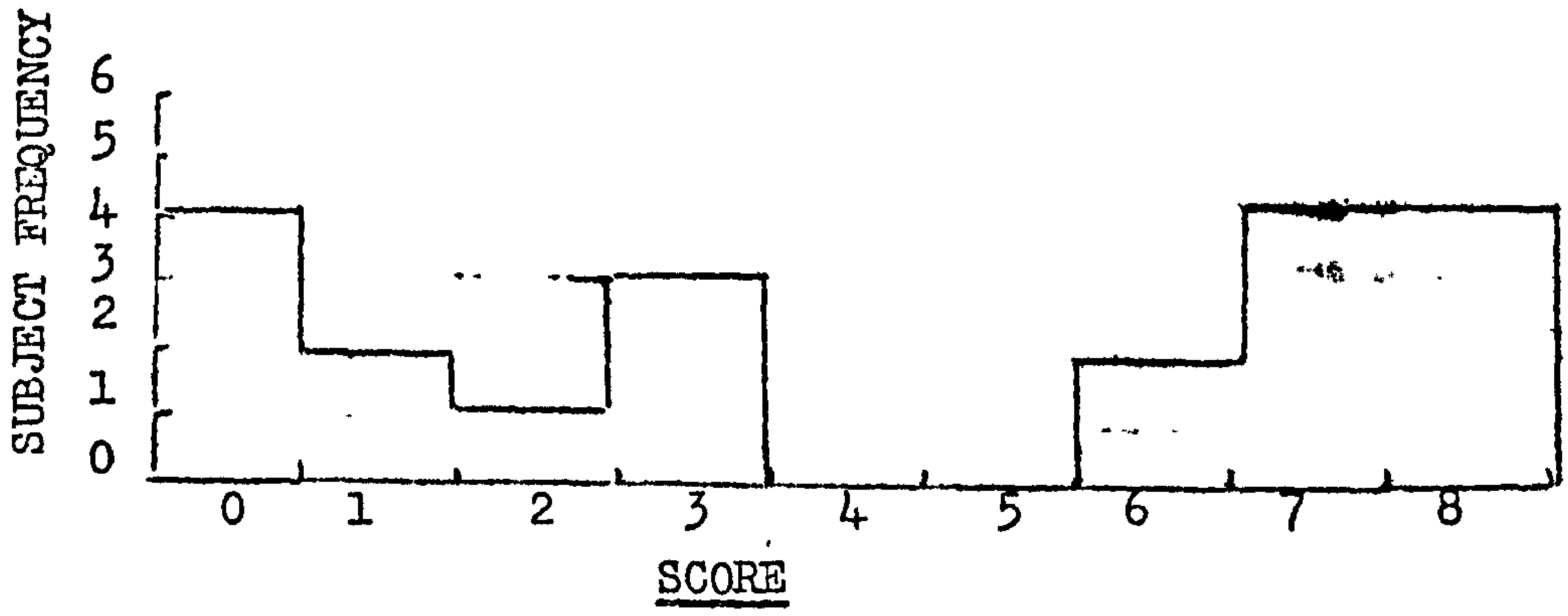


TABLE 18. Score Frequency Distribution of Recall Conplex Test in Groups 1 (No Pretest).

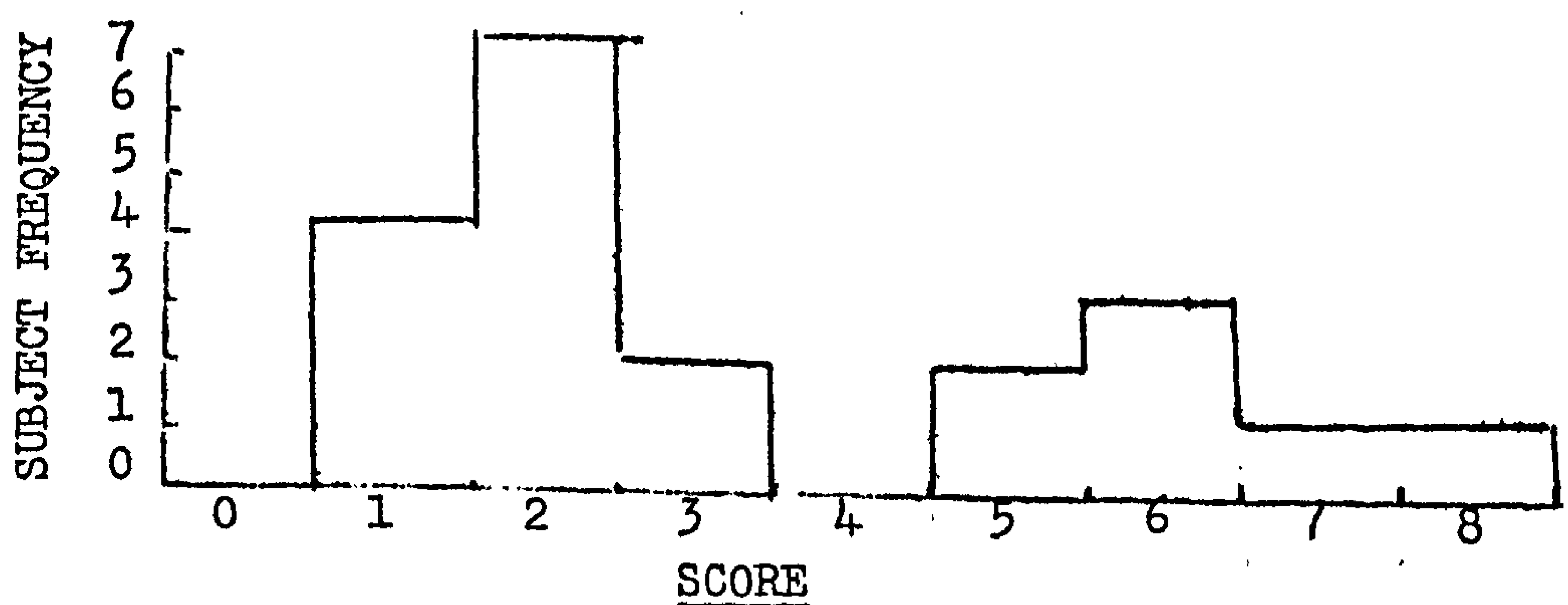


TABLE 19. Score Frequency Distribution of Recall Conplex Test in Groups 2 and 3 in question papers not pretested.

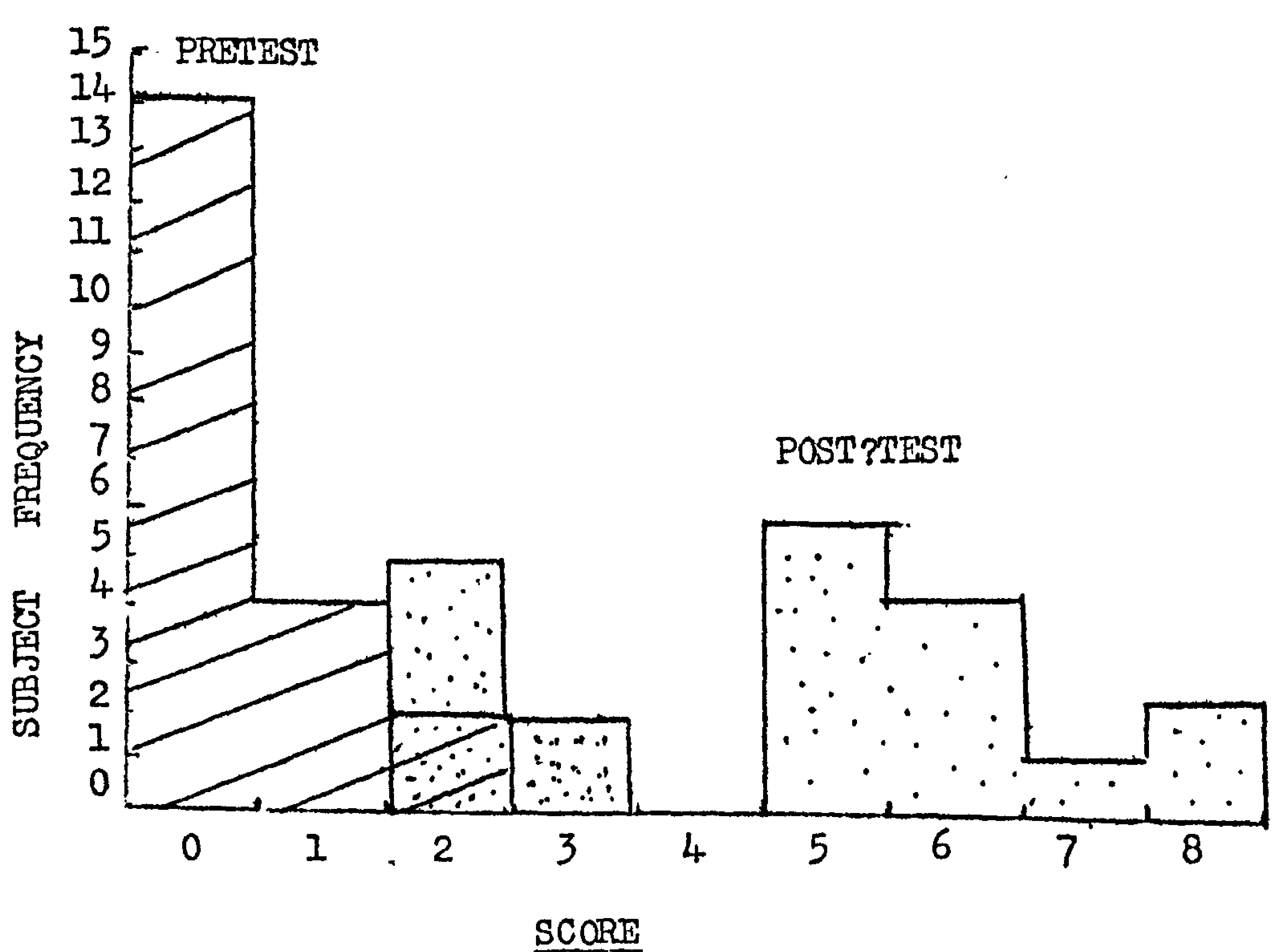


TABLE 20. Score Frequency Distribution of Recall Conplex Test in Groups 2 and 3 in Pretested question papers.

3.8.3. <u>The Classification of subjects on Performance</u>

<u>Recall Simple and Recognition.</u>

The distribution of subjects according to their scores in the recall simple and recognition tests did not provide a clear-cut basis for sub-division. The relatively high score indicated, that success did not depend upon the pursuit of a particular learning strategy. The Recall Simple and Recognition tests were not effective in discriminating between subjects.

<u>Recall Complex</u>

The distribution of subjects according to their Recall Complex scores identified effective and ineffective sub-divisions. Three levels of performance were distinguished (Appendix B, 3.8.2.).

SUB-DIVISION	Level of Performance	Group 1	Groups 2 and 3	
		(No pretest)	not pretested	pretested
A	Effective	5	7	13
B	Ineffective	2	9	7
C	Very Ineffective	3	4	-

Differences in the score frequency distribution in the pretested and unpretested question papers of Groups 2 and 3 in the Recall Simple and Recognition tests and in the Recall Complex tests pointed to a direct influence of the pretest on the experimental population. Differences in the score frequency distribution of Group 1 in the Recall Simple and Recognition tests and in the Recall Complex test and in the unpretested question papers of Groups 2 and 3 in the Recall Simple and Recognition tests and in the Recall Complex test pointed to some indirect influence of the pretest on the experimental population.

The distribution of individual scores in the Recall Simple and Recognition tests and in the Recall Complex test in Group 1 (Not pretested), and in Groups 2 and 3 in the pretested and unpretested question papers is given in Appendix B, 3.8.2. The mean score and standard deviation for all Groups in the post-test is shown in Table 21 .

TABLE 21. The mean score and standard deviation in the post-test for the experimental population.

GROUP	Recall Simple & Recognition		Recall Complex	
	Mean	S. Dev.	Mean	S. Dev.
GROUP 1 no pretest	6.05	1.60	4.25	3.06
GROUP 2 and 3 not pretested question paper	6.65	.933	3.40	2.28
GROUP 2 and 3 pretested question paper	7.2	.767	4.60	2.064

Recall Simple and Recognition

The mean score of Group 1 and Groups 2 and 3 in the pre-tested question paper showed some significant difference, (at the probability level of .02 in a two-tailed test), Some direct influence of the pre-test was apparent. The mean score of the pre-tested and unpre-tested question papers in Groups 2 and 3 tended to **differ** (at the probability level between .10 and .05). There was some difference in the influence of the pre-test on the post-test performance in the two question papers. Any indirect influence of the pre-test on the post-test performance of the Groups, which was apparent in the histograms of the score frequency distribution, could not be statistically verified, since the mean score of Group 1 and Groups 2 and 3 in the question paper not pre-tested were not significantly different (probability level of .10).

Recall Complex

The standard deviation in Group 1 (no pre-test), Groups 2 and 3 not pre-tested, and Groups 2 and 3 pre-tested, was very large, which suggested that the experimental population could be discriminated on the basis of their performance in the recall complex test. Any direct or indirect influences of the pre-test based on the performance of the whole Groups in the Recall Complex tests were not statistically apparent since differences between the mean scores were not significant.

3.8.4. A Comparison of Performance in the Pre-tested and not Pre-tested Question Papers in Groups 2 and 3

Table 22 shows the mean difference in score between the pre-tested and not pre-tested question papers in the Recall Simple and Recognition tests and in the Recall Complex test.

TABLE 22. The mean difference in score between the pretested and not pretested Question paper and the standard deviation, in the Recall Simple and Recognition tests (combined) and in the Recall Complex test.

Test	Mean difference	S. D.
Recall Simple and Recognition	.55	.59
Recall Complex	1.25	.371

There was no real difference in performance in the Recall Simple and Recognition tests but there was an indication of some difference in performance in the Recall Complex test (significant at a probability level, between .01 and .002).

Table 23. compres the performance level of Group 1 and Groups 2 and 3, in the Recall Complex test, which was not pretested.

TABLE 23. The distribution of subjects into Effective (A), Ineffective (B), and Very Ineffective (C) in the Recall Complex test (Not pretested).

	GROUP 1	GROUP 2 & 3
A	5	7
B	2	9
C	3	4

$CHI^2 = 1.99$, probability level between 0.50 and 0.30.
The performance of subjects in Groups 2 and 3 in the not pretested Recall Complex test was not significantly influenced by the pretest.

Table 24 compares the performance level of Groups 2 and 3 in the Recall Complex test which was not pretested and in the Recall Complex test which was pretested.

TABLE 24. The distribution of subjects into Effective (A) and Ineffective (B and C) in the pretested (PT) and not pretested (NPT) Recall Complex test.

	A P.T.	B & C P.T.
A N.P.T.	AA 7	0
B & C N.P.T.	BA & CA 6	BB & CB 7

$CHI^2 = 6.1$ probability $= .01$

Subjects in Groups 2 and 3 could be further sub-divided on the basis of their performance in the pretested and not pretested Recall Complex test into:

Sub-division AA - Effective in the pretested and not pretested Recall Complex tests.

Sub-division BA and CA - Effective in the pretested Recall Complex test, Ineffective in the not pretested Recall Complex test.

Sub-division BB and CB - Ineffective in the pretested and not pretested Recall Complex tests.

The pretest had a direct influence on the performance of subjectsin the BA and CA sub-division.

3.8.5. An analysis of Test Time.

Table 25 shows the mean output time and standard deviation in the Question papers A and B for Group 1, according to the level of performance.

Individual output times and t and p values are shown in Appendix B 3.8.5.

TABLE 25 . The mean output time and standard deviation in Group 1

GROUP 1	Mean time (in mins) on Question paper A	S.D.	Mean time (in mins) on Question paper B	S.D.
SUB-DIVISION A Effective	24	9.3	22	5.7
SUB-DIVISION B Ineffective	16.5	4.9	17.5	.7
SUB-DIVISION C Very Ineffective	5.67	1.15	7.67	2.08

There was no significant difference in the time spent on Question papers A and B in the Group.

Sub-division A tended to spend more time on Question paper A and B than sub-division B, (probability level .05).

Sub-division A spent longer on both Question papers A and B, than sub-division C (probability levels .01 and .002).

Sub-division B spent longer on both Question papers A and B than sub-division C (probability level .1 and .02).

TABLE 26. ; The pre-and post-test times and standard deviation for Groups 2 and 3. (Individual output times and t-and p values are shown in Appendix B 3.8.6.)

GROUPS 2 & 3	Mean time (mins) on pretested Question paper	S.D.	Mean time (mins) on pretest in the post test	S.D.	Mean time (mins) on not pretested Question paper	S.D.
SUB-DIVISION A.A. Effective in pretested and in not pretested Question paper	12.5	1.8	16.1	2.9	18.2	4.2
SUB-DIVISION BA & CA Effective in pretested Question paper only.	20.3	5.4	14.5	4.1	9.6	3.3
SUB-DIVISION BB & BC Ineffective in pretested and in not pretested Question paper.	5.7	1.1	13	2.3	12	3.7

Table 26 shows that the inspection of the subjects who were effective in the pretested question paper only (BA & CA) spent longer on the pretest than the subjects who were effective (AA) and ineffective (BB &BC) in both Question papers, (probability level .01 and .001). The time spent on the pretested question paper was longer than in the not pretested question paper (probability level .05).

The ineffective subjects (BB & BC) spent the least time on the pretest (probability level .001).

There was no significant difference in the time spent on the pretested and not pretested Question papers in the effective (AA) and ineffective (BB & BC) subjects.

3.8.6. An Analysis of Input Time.

An analysis of the input time in Group 1 and Groups 2 and 3, showed that the pretest influenced the learning behaviour of subjects.

Table 27 shows the frequency distribution of Input time in the experimental population.

TABLE 27. The Frequency Distribution of INPUT Times in the Experimental Population.

INPUT TIME (mins.)	GROUP 1	GROUPS 2 & 3
130 - 139	1	-
120 - 129	-	-
110 - 119	1	-
100 - 109	-	-
90 - 99	1	-
80 - 89	1	3
70 - 79	2	4
60 - 69	1	2
50 - 59	-	4
40 - 49	-	6
30 - 39	-	1
20 - 29	2	-
10 - 19	1	-

A comparison of test performance and input times in Group 1 and Groups 2 and 3 is shown in Tables 28 and 29 .

TABLE 28 . The mean input times and standard deviation (S.D.) in Group 1.

GROUP 1.	Mean INPUT Time (mins.)	S.D.	Mean INPUT Time (mins.)	S.D.
SUB-DIVISION A Effective A1	124	8.4	100	23.37
A2	84	9.8		
SUB-DIVISION B Ineffective	67.5	9.19	40.4	26.5
SUB-DIVISION C Very Ineffective	21.67	5.78		

TABLE 29. The Mean Input Times and standard deviation (S.D.) in Groups 2 and 3.

GROUPS 2 & 3	Mean INPUT Time (mins.)	S.D.
SUB-DIVISION A EFFECTIVE IN PRETESTED AND UNPRETESTED QUESTION.	79.4	7.67
SUB-DIVISION BA, CA, EFFECTIVE IN PRETESTED QUESTION ONLY.	52.8	8.4
SUB-DIVISION BB & BC INEFFECTIVE IN PRETESTED AND UNPRETESTED QUESTION.	47.7	10.76

The individual Input times, mean times and the t-and p values are shown in Appendix B.3.8.5.

GROUP 1.

The effective subjects (A) spent longer than the ineffective subjects (B) and (C) on learning, (probability level .01 and .002).

The ineffective subjects (B) spent longer than the very ineffective subjects (C) on learning (probability level .01).

The standard deviation in the effective sub-division (A) was large. Further sub-division of subjects according to their Input time distribution identified A1 and A2 sub-divisions. This result is evaluated further in the reading protocol analysis.

GROUPS 2 and 3.

The effective subjects (AA) spent longer than the effective in pretest only subjects (BA and CA) and the ineffective subjects (BC and BB), (probability level .001) on learning.

The effective in pretest only subjects (BA and CA) and the ineffective (BC and BB) subjects did not differ significantly in their learning time. Inspection of the reading protocols show that time is only one indicator of the learning characteristics. The reading records of subjects effective in the pretest (BA and CA) and ineffective in both tests (BC and BB) were different in kind.

3.8.7. Analysis of the Reading Records.

An analysis of the 30 reading records showed that there appeared to be three basic patterns of read. As in the records available in Experiment 1, these three read types consisted of:-

Type (a) A quick fairly even read through the text from beginning to end.

Type (b) A slow steady read through from beginning to end showing hesitations but with few regressions. An analysis of this read pattern using the vertical cursor scales of the Sengano analyser (Unit 2, 2.4.1.), showed that the distribution of hesitations was not always the same. Some Type (b) read patterns showed fairly even distribution of hesitation from beginning to end, (Type b_1). Other Type (b) read records showed a distribution of hesitations significantly weighted to 'items of knowledge' relating to the pretest, (Type b_2). Not all the items of knowledge relating to question paper A and B could be discriminated with high accuracy because of an overlap of the knowledge items within the 5 lines of the viewing window. However, sufficient number of 'items' could be distinguished to allow an assessment of the distribution of hesitations in relation to the pretest. This type (b) read appears to be associated with the identification and effective storing of 'specific' items of knowledge.

Type (c) A read that shows considerable forward and backward search through the text, from one paragraph to another and within paragraphs.

The 30 subjects combined these read types to produce strategies of reading.

3.8.8. A Comparison of Test Performance and Reading Records

A comparison of the reading records of subjects in the three groups, with the level of performance showed that there was a relationship between methods of reading (tactics) and the outcome of reading. The comparison was made as follows:

	GROUP 1	GROUPS 2 & 3
Effective in Recall Complex Tests	A	AA
Ineffective in Recall Complex Tests	B & C	BA, CA BB, CB

The Effective Subjects

GROUP 1

The effective subjects (sub-division A), produced reading protocols of two distinct types. This reflected the differences between sub-division A_1 and A_2.

$\underline{A_1}$ The longer input time protocols (2 subjects) were characterised by a similar strategy to that outlined in Experiment 1, for the successful summarisers (the selectors), consisting of an exploratory (Type a) read, a specific fact (Type b) read, and a search (Type c) read, as well as intermittent review periods (Type d activity).

$\underline{A_2}$ The shorter input time protocols (3 subjects) consisted of one or more long data collecting reads (Type b read). Specific fact notes were prepared by some subjects. There was no review period.

Examples of A_1 and A_2 protocols are shown on the next two pages.

3.9. General Conclusion

3.9.1. Classification of subjects

The identification of reading protocols and the assessment of the objective test performance in the three groups enabled a classification of subjects into one of three types of ~~reading~~-to-learn strategies.

<u>Group 1 (no pretest given)</u>

<u>STRATEGY TYPE 1 SUB-DIVISION A_1</u>

<u>The summary type</u> strategy (S.T.) (2 subjects)

The reading protocols of this division consisted of the (a), (b), (c) and (d) patterns outlined in 3.8.7.
Performance in objective tests was rated as efficient, but within this not significantly different from:

<u>STRATEGY TYPE 2 SUB-DIVISION A_2</u>

<u>The efficient objective test type</u> strategy (E.O.T.) (3 subjects)

The reading protocols of this division consisted of (a) and (b_1) type reads, that of type (b_1) varying from hesitations with detailed note sessions to hesitations with no note sessions. Patterns of read relating to (c) and (d) were conspicuously absent.

<u>STRATEGY TYPE 3 SUB-DIVISION B & C.</u>

<u>Inefficient objective test type</u> strategy (I.O.T.) (5 subjects)

The reading protocols of this division consisted of one or more smooth reads of the type (a) only, with minimal hesitations and note taking. Varying degrees of inefficiency were detected, based upon performance at the level of the Recall Complex tests. Differences in protocol were identified as differences in the rate of reading of the 'smooth' type (a) read.

GROUPS 2 and 3 (pretested with one of the two Question papers).

STRATEGY TYPE 2 SUB-DIVISION AA.

Efficient objective testtype strategy (E.O.T.) (7 subjects)

The reading protocols of the subjects in this division were similar to those of the subjects in division A_2 Group 1.

STRATEGY TYPE 3 SUB-DIVISION BA, CA, BB and CB.

Inefficient objective test type strategy (I.O.T.) (13 subjects)

This type of strategy could be sub-divided further into:-

SUB-DIVISION BA & CA, Partially Ineffective objective test type (6 subjects).

The reading protocols of this division consisted of a particular kind of type (b_2) read, in which the distribution of the hesitations related to the 'items of knowledge' in the pretest, almost exclusively.

SUB-DIVISION BB & CB. Ineffective objective test type (7 subjects).

The reading protocols of this division consisted of one or more smooth type (a) reads, with minimal hesitations and no note taking.

Reading protocols of the 'Summary Type' strategy (Strategy Type 1) were conspicuously absent in Groups 2 and 3.

3.9.2. Influence of the Pretest.

Comparisons of performance on the pre and post objective tests in Groups 2 and 3 indicated that in all cases 'learning' had taken place during reading. In the I.O.T. type, (Group 1 C, Groups 2 and 3 BB & CB) learning had taken place at the level of simple recall and recognition only. The simplest and shortest reading protocols resulted in some success at this level.

The effect of the pretest seemed to be two-fold:-

Direct effect. Some subjects (Sub-Division BA, CA) interpreted the pretest as a specific instructional directive and their self-definition of the task resulted in a learning tactic, which was planned to perform effectively in the pretested Question paper after learning.

Indirect effect. The distribution of effective and ineffective subjects in Group 1 and in Groups 2 and 3 in the not pretested Question paper, according to level of performance, was not significantly different. However, the absence in Groups 2 and 3 of the strategy Type 1 (E.S.T. sub-division A Group 1) and of the protocols of the type found in sub-division C Group 1, which were classified within the strategy type 3 (I.O.T.), indicated that the pretest could have influenced the task definition and learning tactics. All effective subjects in Groups 2 and 3 produced protocols of the strategy type 2 (E.O.T.). The clustering of input times in Groups 2 and 3 was related to the restriction of strategy types, although the analysis of the reading records has shown that time alone is an inadequate criterion for discriminating the learning activity.

3.9.3. A Comparison of Reading Protocols in Experiments 1 and 2.

With the exception of the 2 subjects, who produced efficient 'summary type' strategies, the reading protocols of subjects in Experiment 2 were very different from those of Experiment 1. Major differences in reading protocols in Experiment 2 consisted of the marked *absence* of:

the type (*a*) read as combinations with other read types in most protocols,

the type (*c*) search read and the

type (*d*) non-reading activities.

It was, therefore, concluded that different instructional directives such as learning for objective tests and learning for summarising, influenced 'conditions' within the learner, which resulted in a different type of self-definition of the task. This had repercussions on the learning activity and was reflected in the reading protocols and performance. Assuming this to be so, it can be said that objective tests geared to test the acquisition of knowledge in terms of recognition and recall demand a degree of 'small unit learning', while summarising activities involving comprehension and evaluation of data demand a degree of correlating and generalising activity or 'large unit learning', in order to be effective. The existence of 'summary type' and 'I.O.T.' types of strategies in Experiment 2 and 'mass' and 'abstractor' types of strategy in Experiment 1, emphasised that the learning activities of subjects were not the same in relation to the instructional directives. From the point of view of economy, the elaborate and long (efficient summary type' (E.S.T.) strategy in Experiment 2, could be regarded as an example of overlearning and the simple and short 'inefficient objective test type' strategy (I.O.T.) as an example of underlearning.

3.10 SUMMARY. As assessment of the Input and Output times, the reading protocols and the level of performance, resulted in a classification of the experimental population into distinct strategy types. This classification reflected differences in task definition within the pre-tested and un-pre-tested experimental groups. The hypothesis was made that the subjects' definition of the task depended upon a predisposition to learning, which was influenced by the instructional directives. The pattern of learning activity could be at least partially understood by assuming that the way in which the task had been defined set up a complex system of checking the ongoing activity of reading in relation to a self-defined outcome. It can be said that subjects learnt 'more thoroughly' for the summary than for the objective tests.

UNIT 3. - An Empirical Study, to clarify the "Problem" and to test the Assumptions.

Experiment Three

The influence of the type of test, on the 'reading to learn' process. A comparison of two learning tasks.

3.11. Introduction

The distinctive protocol differences noted in the experimental population of Experiments One and Two could be attributable to such experimental variables as the intellectual content or style of the learning materials used. It was, therefore, decided to incorporate the learning task set in Experiment One, the Summary, and the type of learning task set in Experiment Two, responses to Objective Tests, within the parameters of one experiment, using identical learning material. A more effective comparison of the two types of learning tasks was possible within this experimental design.

The experimental design also allowed for a further assessment of the interrelationship between task definition as representative of predispositions within the learner, the structure of the learning material, the reading protocols and the performance.

3.12. Experimental Method

The Subjects

The 60 volunteer subjects, who formed the experimental population consisted largely of Grammar and Public School and Technical College second year advanced level Biology students and a few post-graduates

All students had pursued a preliminary genetics course and were, therefore, conversant with genetic terminology, but none had previous familiarity with the Genetic Code Theory. None of the students had read the Genetic Code article, which represented the learning material of the experiment.

This information was obtained by discussion with the teachers and the students prior to the experiment. With the exception of the very small sample of post doctorate research workers, the experimental population was fairly uniformly matched in terms of knowledge structure. In terms of academic ability, (as assessed by teacher grades and examination grades) and educational background the population sample was mixed.

<u>The Learning Material</u>

The learning material used in this study was the 3,100 word abridged article on "The Genetic Code" from Scientific American, the analysis of which is presented in Appendix A. Selection of this learning material was governed by two factors, stemming from the two previous experiments. Firstly, the passage had to be of the same intellectual organization in terms of The Taxonomy and secondly, it had to be of sufficient general interest to initiate and maintain motivation. The explosion of molecular Biology in this century has meant that information on The Genetic Code is of paramount topical interest and the work is on par in scientific importance with the evolutionary postulates of Charles Darwin in the last century. The passage was, therefore, judged to meet the motivational requirements of the experiment, since the experimental population consisted of biologists. The article reviewed the development and decipherment of The Genetic Code and its intellectual diversity in ranging from, Specifics, Ways and Means of dealing with Specifics and Universals and Abstractions, was considered to meet the (knowledge) requirements of the experiment. The <u>clarity</u> of the article matched that of the Darwinian texts, while the <u>precision</u> and <u>literative style</u> matched that of the MacGrow Hill 'Hearing' text.

The Experimental Procedure

The subjects were divided at random into four groups:

GROUP A

15 subjects were asked to answer an Objective Test Question paper A before reading the passage and were informed that they would be tested after reading by means of two Objective Test Question papers of a similar type to Question paper A. After their learning activity, they were in fact asked to answer Question paper A again and another unknown Question paper B, and to produce a summary of the passage.

GROUP B

15 subjects were asked to answer an Objective Test Question paper B before reading the passage and were informed that they would be tested by means of two Objective Test Question papers of a similar type to Question paper B. After their learning activity, they were in fact asked to answer Question paper B again and another unknown Question paper A and to produce a summary of the passage.

GROUP C

15 subjects were told that they would be required to produce a summary. They were given the further instruction that this summary should consist of a fairly substantial report of the 'main points' of the passage. (C.F.Experiment One, no further instruction concerning the summary was given). After their learning activity, they not only had to produce a summary of the passage, but also to answer the two Question papers A and B.

GROUP D

15 subjects were given the same instructions as Group C and after their learning activity they had to perform the same tasks as Group C. Subjects in Group D were, however, offered guidance to improve their reading to learn performance as reported in Unit Two, General Experimental Method, The Training Technique.

The Learning Tasks and the Task Evaluation

The distribution of the items in Objective Test Question papers A and B is described in Unit Two, 2.6.3. . The original Question papers are included in Appendix A. The Tests were scored by allocating one mark to each correctly answered question. The total marks per question paper were, therefore, 22. These marks were distributed as follows: seven marks were allocated to the Recall Simple questions, eight to the Recognition or Multiple Choice questions and seven to the Recall Complex questions.

The summaries were analysed in terms of the number of knowledge items recorded, relating to the three categories of item classification described in Unit Two, The Task Evaluation Techniques, 2.6. The maximum number of items relating to the category of Universals and Abstractions, was 52. The total number of items was 90. The identification of the items recorded in the category of Universals and Abstractions produced a measure of the nature and amount of selections (or omissions).

All subjects were retested on Objective Test Question papers A and B one week after the original learning session. They were not retested on the summary.

3.13. Results and Discussion

3.13.1. An Analysis of the Score

The summary scores of the experimental population were distributed as shown in Table 30. The cut-off point between effective and ineffective scores were set at the trough between the two modes of the bimodally distributed population. This cut-off point was at 30.

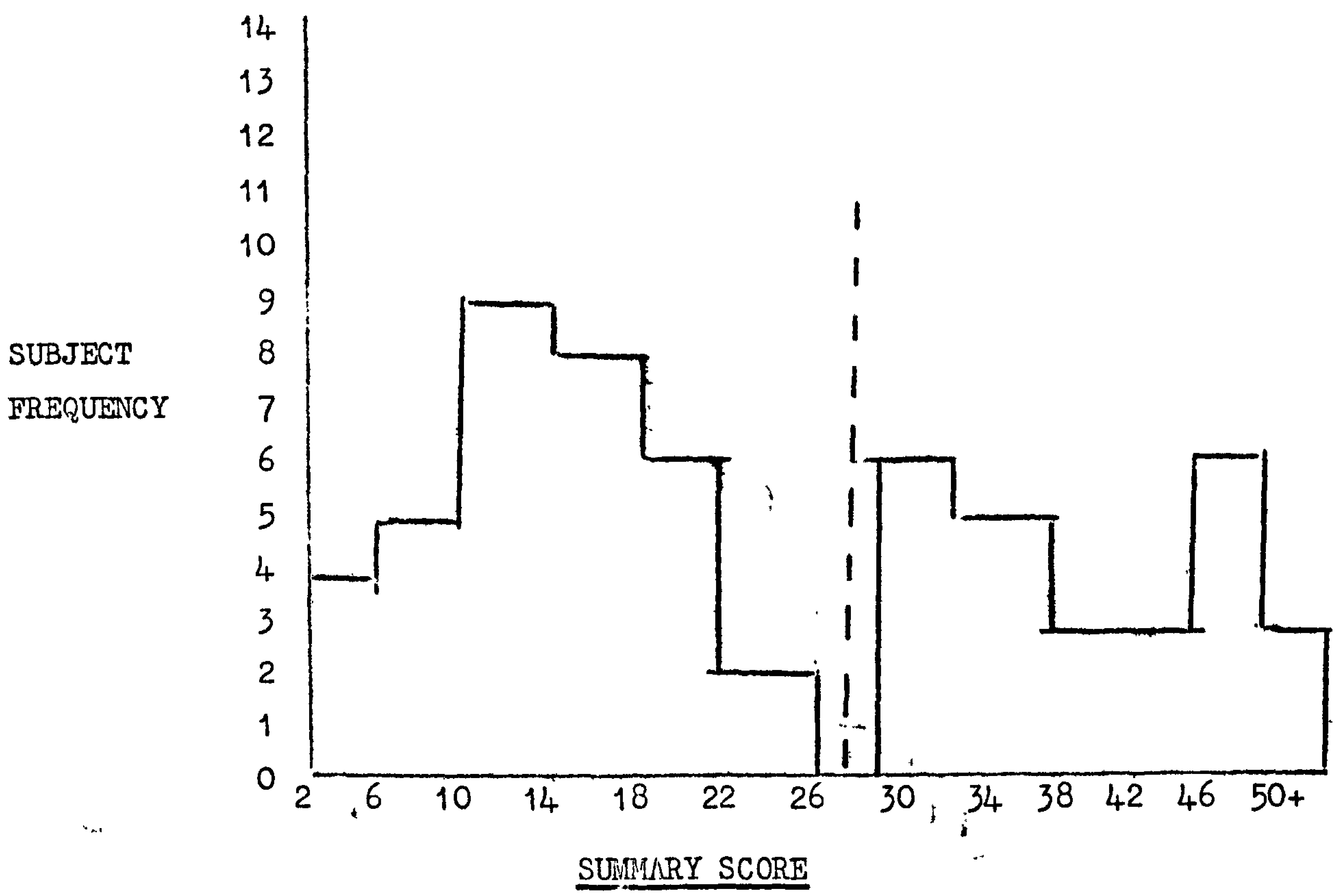


TABLE 30 The frequency distribution of scores in the summary in the experimental population.

The immediate post test and post 1 week objective test scores of the experimental population were distributed as shown in Appendix B, 3.13.1.

This distribution showed that the Recall Complex sections of the two Question papers A and B were the most discriminating. Table 31 shows the frequency distribution of scores in the Recall Complex sections of Question papers A and B for the experimental population. Cut-off points between effective and ineffective scores were set at the score of 4, as shown on the histogram.

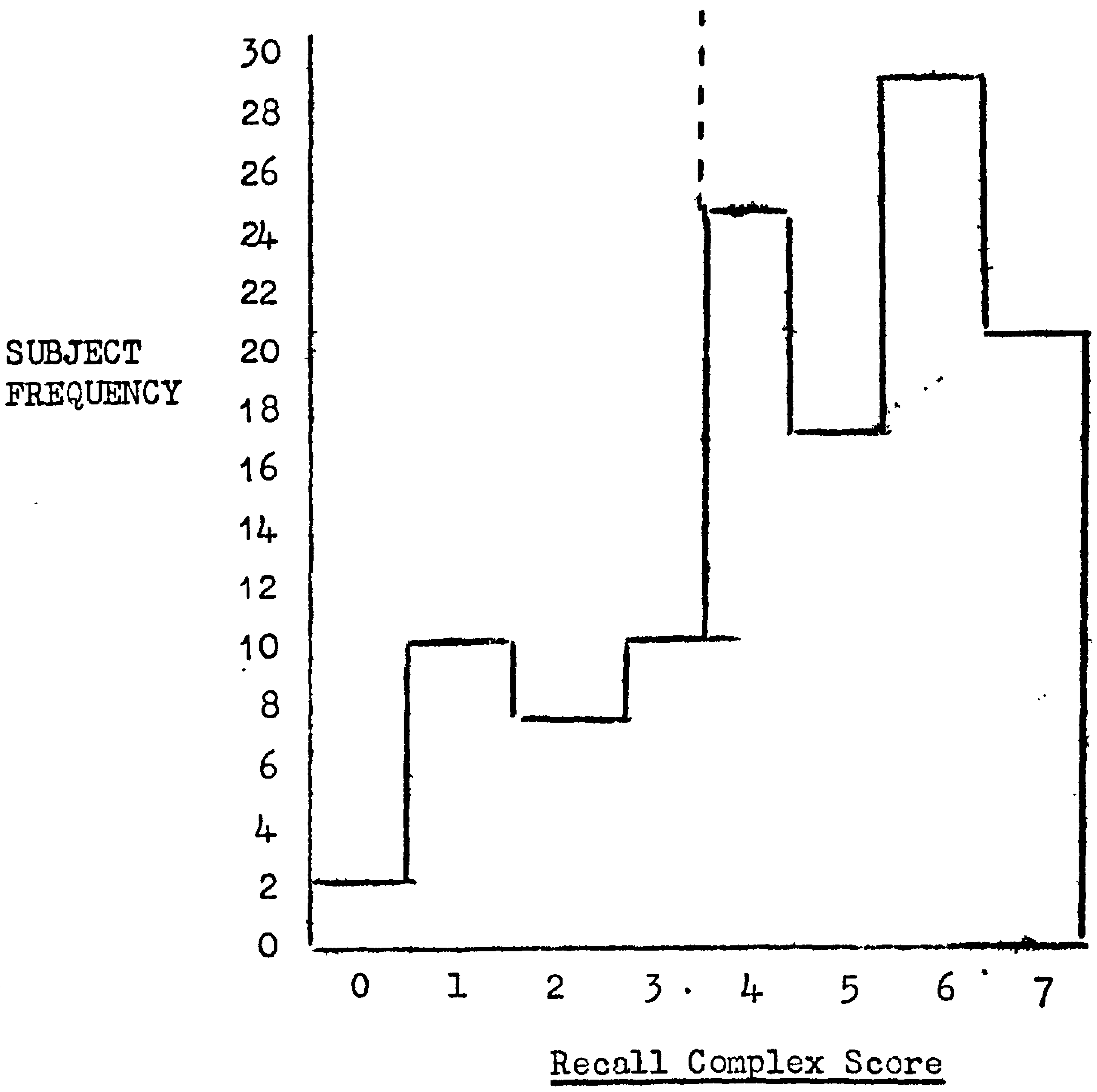
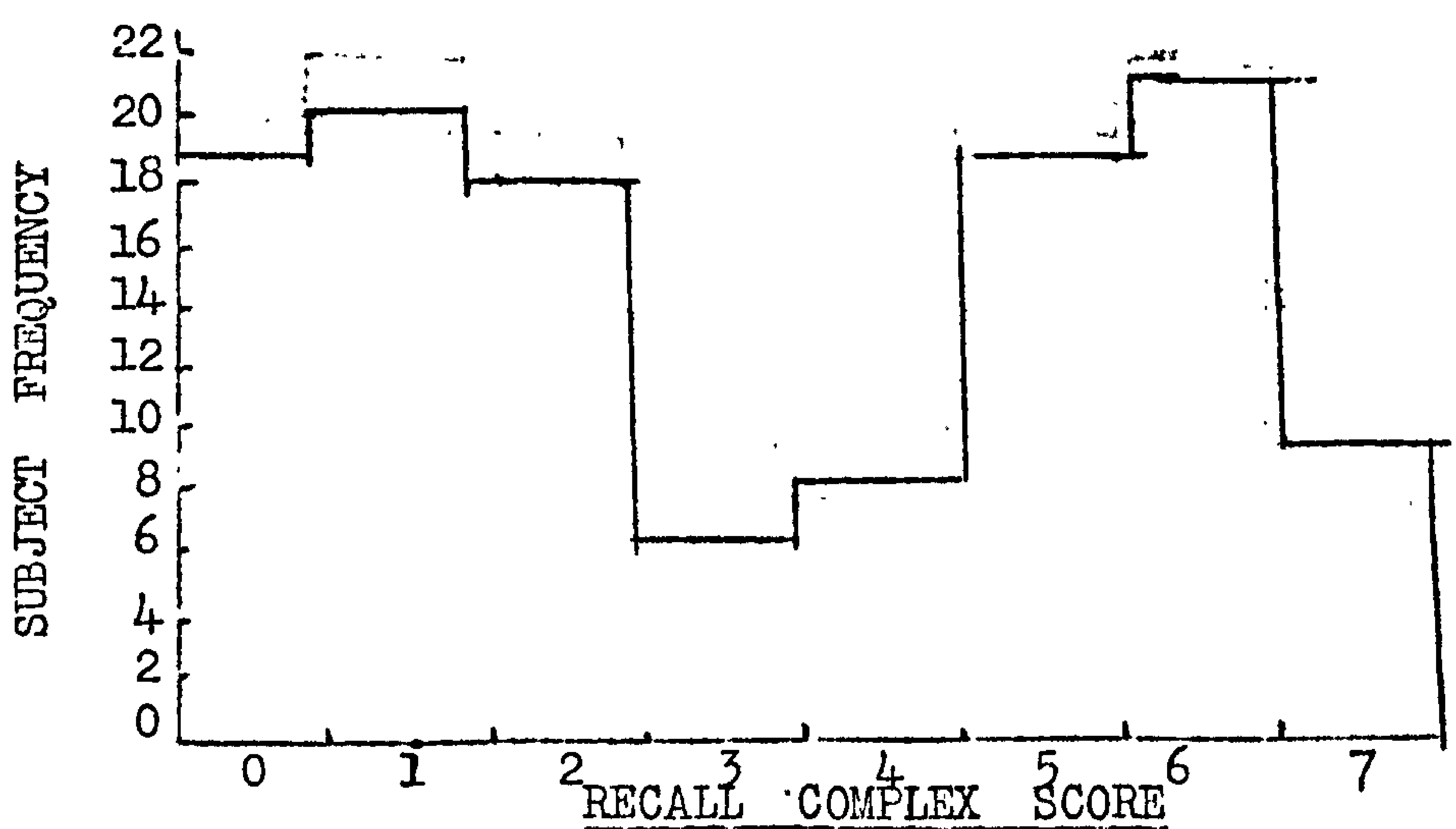


TABLE 31. The frequency distribution of scores in the Recall Complex sections of Question papers A and B for the experimental population.

Table 32 shows the frequency distribution of scores in the Recall Complex sections of question papers A and B post 1 week for the experimental population. The very marked binodal distribution of the Recall Complex Score after 1 week showed thatthe experimental population could be divided into those subjects who retained the information learnt and those subjects who had forgotten the information learnt. This result is discussed and evaluated later in this result section.



<u>TABLE 32</u>. The frequency distribution of scores in the Recall Complex sections of question papers A and B post 1 week, for the experimental population.

The pre-tested Objective Test scores of Groups A and B were distributed as shown in Appendix B, 3.13.1. A comparison of the frequency distribution of scores in the pre and post-tested objective test in Groups A and B, showed that learning had taken place.

Table 33 compares the performance of the two combined groups of 30 subjects each.

	Learning for	
	Objective Tests A & B	Summary C & D
Effective on Summary and Objective Tests	7	19
Effective on Summary only	0	0
Effective on Objective Tests only	14	6
Effective on neither	9	5
TOTAL	30	30

chi square = 11.42 probability = .01

TABLE 33. Everyone who produced an effective summary also scored effectively on the Objective Tests. But the reverse was not the case. Only seven of the subjects reading for an Objective Test were able to produce an effective summary.

3.13.2. An Analysis of Time in Relation to Performance

The Input and Output times (summary and objective tests) of the experimental population were analysed in terms of the grouping of the subjects into, effective on the summary and objective tests (E.E) effective in the objective tests and ineffective in the summary (E.I.) and ineffective in both tasks (I.I.) The mean time in minutes spent on the Input and Output phases and the standard deviation are shown in Appendix 3.13.2.

Tables showing the tests of significance of the Input and Output times between the experimental groups and between effective and ineffective divisions are also presented in Appendix B. 3.13.2 Inspection of the detailed Tables in the Appendix shows that significant differences in Input and Output times can be identified.

a) Group A and B (Instructional Directives, Objective tests)

There is a significant difference between input and output times of the E.E., E.I. and I.I. divisions within the groups.

b) Group C and D (Instructional Directives, summary)

There is a significant difference between input and output times of the E.E., E.I. and I.I. divisions within the groups.

c) E.E. Division (Efficient in both Objective tests and summary)

Subjects in Groups A/B spent significantly less on their input times ($p = .01$) and significantly more on their summary output times ($p = .01$) than subjects in Groups C/D. Subjects in Group D spent significantly more time on their Input activity ($p = .02$) and significantly less time on their summary Output activity ($p = .001$) than subjects in Group C. There was no significant difference in the time spent on the pretested and unpretested Question papers in Groups A, B, C and D.

d) The E.I. Division (Efficient in Objective tests, Inefficient in Summary)

There was no significant difference in the Input times and Output times between Groups A and B. There was some significant difference in Input and Output times between groups A/B and C/D ($p = .02$). There was no significant difference between Groups C and D in either Input or Output times.

e) The I.I. Division (Inefficient in Objective tests, Inefficient in Summary)

There was no significant difference in Groups A/B and C/D in Input time, but the groups tended to differ in Output times.

f) The Pretest (given to Groups A and B)

There was no significant difference in the pretest times between the E.E., E.I. and I.I. divisions.

The individual distribution of time on the pretest in the I.I. Division separated into long and short times on the Pretest (ABa, ABb). As a result of this, further sub-division input times and summary times showed no significant differences, but significant differences were apparent between ABa and ABb sub-divisions in the time spent on the pretested question paper after learning. There was no significant difference in the time spent on the unpretested question paper.

Table 34 shows average "reading and note-taking" times and average "summary writing" times in minutes for the two combined groups at different levels of performance.

	Learning for			
	Objective tests A & B		Summary C & D	
Effective on Summary and Objective Tests	108	78	156	45
Effective on Objective Test only	85	23	62	36
Effective on neither	44	20	50	32

Reading & note-taking time

Summary Writing Time

TABLE 34. On average the most effective learners took between 2 to 3 times as long to read the text as did the least effective. The distribution of individual scores is significantly weighted in the same direction.

Table 35 shows the distribution of subjects into short, medium and long "reading and note-taking" times for different levels of effectiveness.

	Learning time		
	Short up to 70 mins.	Medium 71-95 mins.	Long 96 mins. & over.
Effective on Summary and Objective Tests	3	1	22
Effective on Objective Tests only	10	7	3
Effective on neither	14	0	0

chi square = 42.0 probability = .001

TABLE 35.

These results indicate that the longer a subject spent reading, the more likely he was to be successful. However, inspection of the reading records show that time is simply an indicator of more important characteristics of the reading process.

Table 36 shows the distribution of subjects into short, medium and long summary times for different levels of effectiveness.

	Summary Time		
	Short up to 38 mins.	Medium 38-68 mins.	Long 68 mins. & over.
Effective on Summary & Objective Tests	5	16	6
Effective on Objective Tests only	17	3	0
Effective on neither	13	0	0

$chi^2 = 33.32$ probability = .001

TABLE 36. The distribution of subjects into short, medium and long summary times for different levels of effectiveness.

These results indicated that the less time a subject spent on the summary, the more likely he was to be unsuccessful. Most successful subjects spent an intermediate time on their summaries, and there were as many in the short category as in the long. This aspect is discussed further after a consideration of the protocols.

3.13.3. Analysis of The Reading Records.

Analysis of the reading records indicated that most subjects read the text more than once. Some read it 5 or 6 times, but as in previous experiments, readings differed in character. Four basic patters (or tactics) were again distinguished in the protocols.

Type (a) a rapid more or less even read through the text.

Type (b) a slow steady read through the text showing hesitations with or without note-taking.

Type (c) a read showing considerable scanning backwards and forwards through the text.

Type (d) periods of no reading associated with 'thinking sessions', note consultation sessions or note draft sessions.

Type (a) appeared in the reading patterns of effective and ineffective learners. The data from this experiment suggests that this type of read appeared to serve four functions. (C.f. Experiment One - 2 functions were assessed).

1) It can be the only type of record produced by a subject who is ineffective on both summary and Objective tests.

2) It can be the only type of record produced by a subject whose conceptual knowledge of the area read is well developed. (The 2 molecular biologists from Dr. F. Crick's team). One such subject did hesitate in some areas of the text because, as he reported, he had to pay attention to the differences between his current knowledge and some of the information in the article, which was out of date.

3) It can appear at the beginning of the reading protocol. As discussed in Experiments 1 and 2, at the beginning. this read performed on orienting and preparing function, as a result of which the subject adjusted his task definition and prepared his subsequent behaviour.

4) It can appear at the end of the protocol. Again, as in earlier experiments, this read seemed to perform a review function, the external information being checked against the subject's internal store. Sometimes hesitations and back-tracking demonstrate that the text had not been throughly mastered. This read is, to some extent, comparable to that of 2, in function.

Type (b) was associated with effective read patterns relating to Objective Tests and Summary. In the case of division E.I. (efficient in O.T. only), it was the only read of the protocol or was accompanied by a Type(a) read. In division E.E. (efficient in Objective Test and Summary), it was often accompanied by a Type(a) read and either by a Type(c) read or/and Type(d) activity. In all subjects this Type(b) read was associated with 'data processing' at the specific level. Detailed analysis of this read indicated that hesitations can be located ± 5 lines and that they were related to knowledge in the text. Notes, if made, were also related to small units of information in the text.

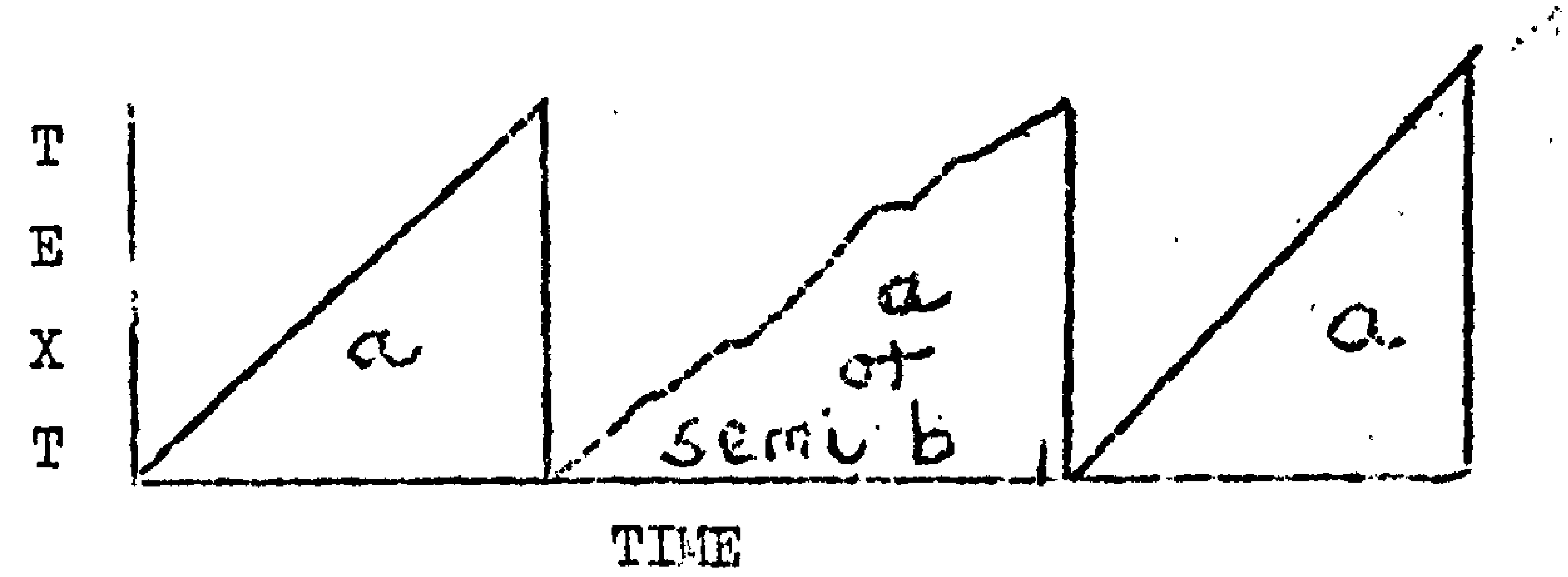
Type (c) was associated with effective read patterns in division E.E. (effective in Objective Tests and Summary). It was often accompanied by a Type(a) read and Type(d) activity, and always by a Type(b) read. This read was associated with a structuring of the text as a whole. Detailed analysis of protocols indicated that the scanning backwards and forwards through the text could be related to the flow diagram of the overall meaning structure of the text. Notes consisted of generalised statements relating to "Universals and Abstractions." The degree of efficiency of the summary seemed to depend upon the accuracy and extent of the correlation of generalisations in terms of the flow diagram.

Type(d) was a fairly long period spent not reading the text. This activity appeared to be associated with the subject thinking about what he had read or reading the notes prepared earlier in the reading. Sometimes additional notes were made. In many ways, this thinking period appeared to be an alternative to reading Type c. The subject would go over the major structure of the text as he conceived it, reorganizing his own ideas until he had produced an 'internal schema' which satisfied him.

In summary, a combination of these types of read patterns into a complete protocol (or strategy), typical of each of the three divisions, is illustrated as follows:-

DIVISION I.I. - Ineffective in Objective tests and Summary.

STRATEGY TYPE 1

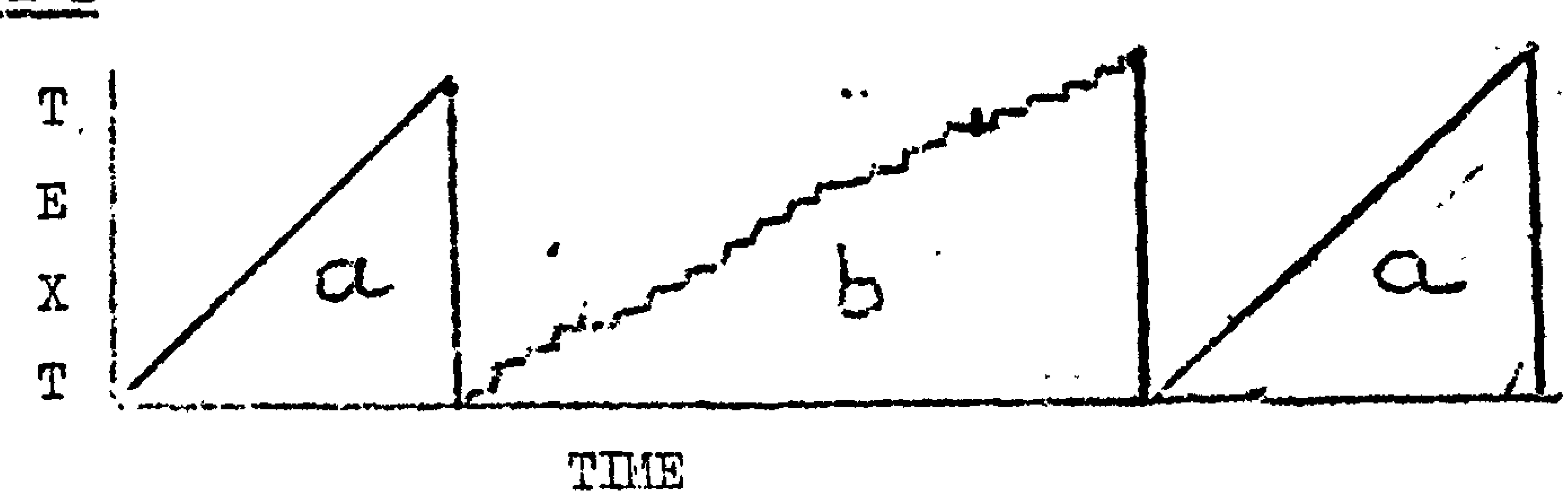


An example of a not effective in either Summary of Objective test strategy.

The poor performance on both Summary and Objective Test was associated with Type (a) readings and semi Type (b) readings. One, two or even three such rapid reads with few hesitations produced little significant learning.

DIVISION E.I. - Effective in Objective tests only.

STRATEGY TYPE 2



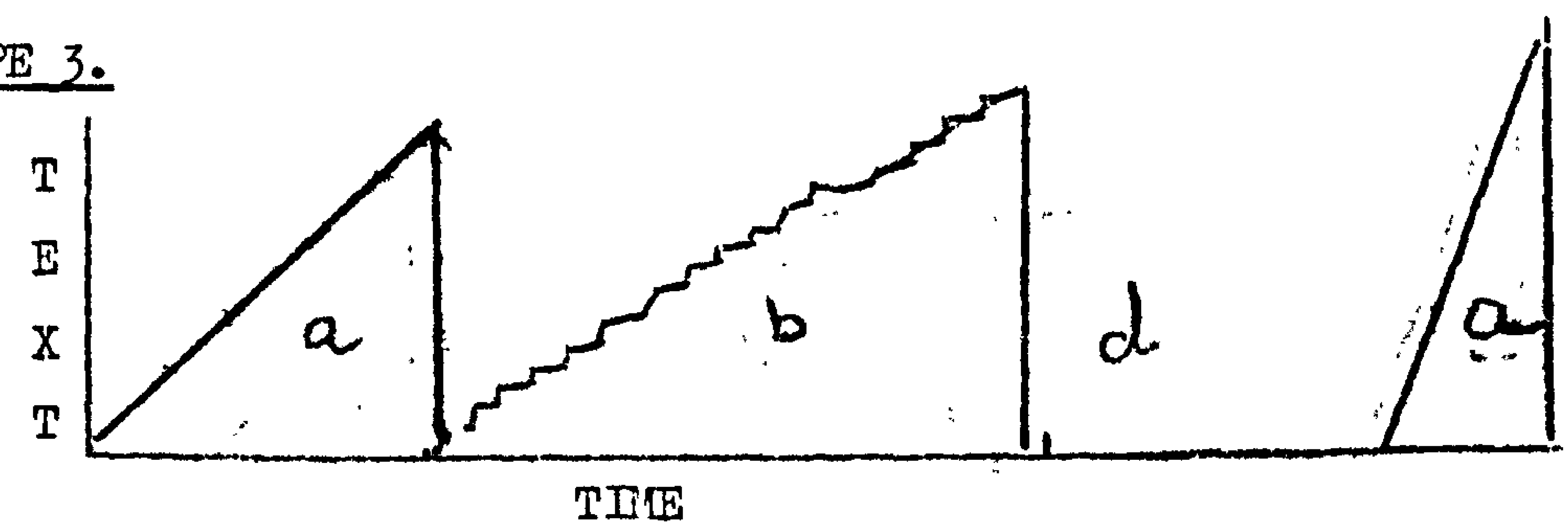
An example of an effective for the Objective tests only strategy.

The Type (b) read was often preceded and followed by Type (a) reads. Any combination of Type (a) and (b) without Type (c) or (d) was associated with an effective Objective test result, but an ineffective summary.

The note taking which often accompanied Type(b) read was almost always restricted to very short periods of time distributed regularly and frequently through the text. The notes made were related to small units of information in the text: in Bloom's terms, they were confined to the knowledge category.

DIVISION E.E. - Effective in Objective tests and Summary.

STRATEGY TYPE 3.

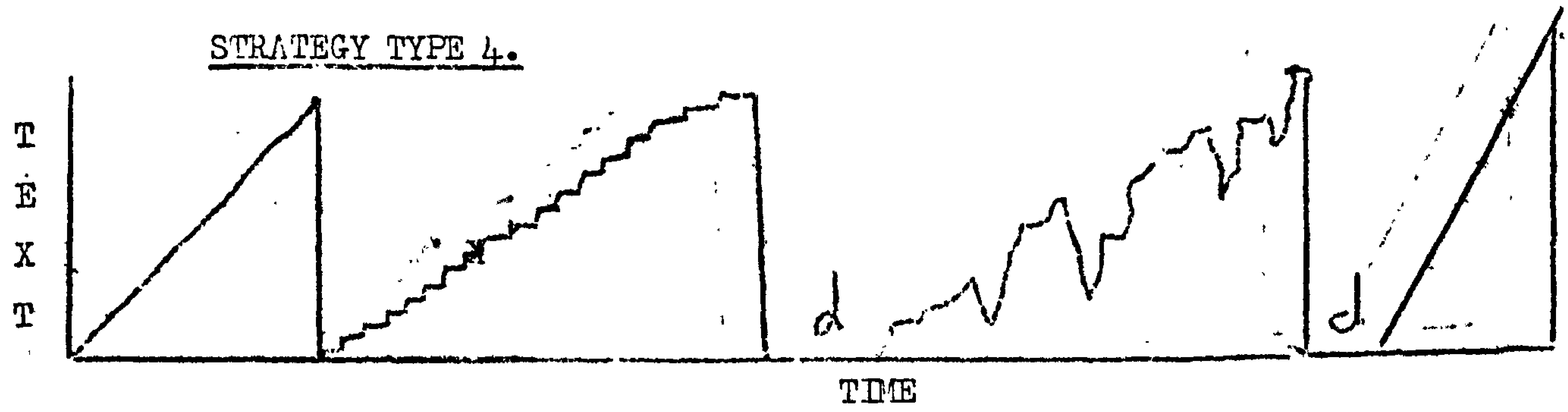


An example of an effective in both Summary and Objective Test strategy.

Effectiveness on both Summary and Objective test depended on either Type(c) reading or Type(d) activity or both. Subjects who pursued Type (a) (b) and (d) activities reported that during (d) they had been "sorting things out" or "thinking how to summarize it." Type(d) activity appeared to be equivalent to Type(c) read; either the notes were read in a Type(c) way or the details of the text were remembered and scanned in thought rather than on the reading recorder.

DIVISION E.E. Type 2.

STRATEGY TYPE 4.



An example of an effective on both Summary and Objective Test strategy.

When readings of Type(a)(b)(c)and(d)were associated in one strategy the subject scored efficiently on both Summary and Objective Tests. The note taking associated with Type(c)read usually occupied longer periods of time but these were at less frequent intervals than those notes made during Type(b)reading. These notes were selective and consisted of an assembly of the 'main points' (or Universals and Abstractions in terms of Bloom). They served to interrelate larger units of meaning within the text.

Photographs reduced to an appropriate scale, illustrating selected examples of the learning strategies in the experimental population are displayed in the following pages.

3.13.5. Influence of the Pretest.

Time. Table 37 shows the average times spent on the pretest in Groups A and B, and on the pretested and unpretested question paper in Groups A/B and C/D.

TIME

	Learning for				
	Objective tests A & B			Summary C & D	
	* Qu.<L.	* Qu.>L. Pr	* Qu.> L. UnP.	Qu.> L	Qu.>L
Effective summary and Objective tests	17	17	18	16	16
Effective Objective Tests only	15	18	19	15	16
Ineffective Objective Tests and summary	17	18	16	12	12
a	22	21	15	-	-
b	10	14	16	-	-

TABLE 37 . The average time spent on the pretest in GROUPS A/B and on the pretested and unpretested question papers in GROUPS A/B and C/D.

* Qu.<L = Pretest question paper before learning.

Pr* Qu.>L = Pretest question paper after learning.

UnP. * Qu.>L = Unpretested question paper after learning.

The distribution of individual times in the pretest in the I.I. Division separated into I.I.a (4) and I.I.b (5) respectively. The numbers were very small and, therefore, no valid conclusions could be made, but there was a difference between the time spent on the pretested question paper and unpretested question paper in the two sub-divisions I.I.a. and I.I.b. after learning.

I.I.b. spent longer on the pretested question paper than I.I.a. (Appendix 3.13.2.) The I.I.a. sub-division spent less time on the pretest than E.I. and E.E. and I.I.b. divisions.

Recall Complex Score.

Immediate

Table 38 shows the mean scores and standard deviation on the two post learning question papers, pretested and unpretested respectively. Tables showing tests of significance are presented in Appendix 3.13.5.

SCORE ON RECALL COMPLEX.

DIVISION		Qu. Pretested Qu. > L. Mean	Dev.	Qu. Unpretested Qu. > L. Mean	Dev.
E.E. A/B (7)	Immediate	6.5	.49	6.3	.69
	Post 1 week	6.1	.63	5.6	.5
C/D (19)	"	5.8	1.04	5.94	1.12
	"	5.7	1.03	5.58	1.03
E.I. A/B (14)	"	5.14	1.24	5.07	.96
	"	3.14	1.59	1.93	.94
C/D (6)	"	5.0	1.0	5.0	1.15
	"	1.83	0.68	1.66	0.74
I.I. A/B (9) A/B a) (4)	"	1.5	0.5	1.75	0.4
	"	0	0	0.5	0.35
A/B b) (5)	"	3	0.63	1.2	0.4
	"	1.8	0.4	0	0
C/D (5)	"	1.8	0.82	1.5	1.47
	"	0.25	.375	0.25	.375

TABLE 38. The mean scores and standard deviations in the pretested and unpretested Objective test question papers after learning.

There was no significant difference in the scores of all the subjects within the E.E., E.I., and I.I. Divisions.

There was a significant difference between the unpretested question paper and pretested question paper in the I.I.b. Division of Groups A/B (probability level .002). Subjects in this sub-division scored higher in the pretested question paper.

Post 1 week.

There was no significant difference in the scores of the subjects within the E.E. and I.I. Divisions.

There was, however, a significant difference between the unpretested and pretested question paper in the E.I. and I.I.b. Divisions of Groups A/B (probability level .02, .001). There was less loss in the pretested question paper than in the unpretested question paper.

Statistically, the samples were too small for any valid conclusions to be drawn from the data. However, the data provided a useful basis for an assessment of the influence of the pretest on the reading strategies.

The influence of the pretest on the reading strategies.

An analysis of the strategies of the I.I. Division indicated that the semi Type(b) read, practised by some subjects, was strongly biased to the pretested question paper. These were the five subjects who formed the I.I.b. sub-division of Groups A/B. Most of the hesitations that were made were related to the responses asked for in the pretest. (C.f. Experiment Two: the sub-division which scored higher in the pretested question paper in the post test).

An analysis of the strategies of the E.E. and E.I. Divisions of Groups A/B indicated that the subjects had not been as directly influenced by the pretest as some of the subjects in the I.I. Division. Within the two divisions (E.E. and E.I.) the E.E. Strategy 3 Type and the E.I. Strategy 2 Type were identified, respectively. The former, lacked the Type(b) read tactic, noted in the E.E. strategy 4 Type of Groups C and D.

The inference is tentatively drawn, that the influence of the pretest on Groups A and B could be direct or indirect. There was no apparent direct influence of the pretest on the subjects in the E.E. Division of Groups A and B. However, a general strategy adjustment may have been made. In other words, since none of the E.E. subjects in Groups A and B had pursued strategy 4 Type, it is suggested that the pretest had influenced the learners' task definition in such a way, that overlearning or the pursuance of an elaborate Strategy 4 Type did not take place. This inference is, to some extent, supported by the evidence and conclusions of Experiment Two. The pretested Groups 2 and 3 did not pursue the elaborate "summary type" Strategy 4, but two subjects in the unpretested Group 1 did pursue this elaborate type of strategy, although the subjects in this Group were told they should learn for an Objective test. There was no apparent direct influence of the pretest on the reading strategies of the subjects in the E.I. Division of Groups A/B, but when tested after one week there was less loss in Recall Complex score in the pretested question paper. Some of the subjects in the I.I. Division of Groups A/B pursued totally inefficient strategies and were not apparently influenced by the pretest. There was the possibility that these 4 subjects were negatively influenced and had underestimated the cognitive demands of the tests.

A direct influence of the pretest was apparent in the strategies of the remaining five subjects in the I.I. Division of Groups A/B. The semi Type b read was biased to the responses demanded by the pretest and these subjects scored higher in the pretested question paper, after learning.

3.13.6. Retention after one week.

Some interesting findings emerged from the retesting of the Objective Test Question papers after one week. If the subjects were divided into those who scored high on the summary and those who scored low on the summary the test retest differences vary considerably. This data is shown in Table 39.

Objective Test Score on Recall Complex Items.	Immediate		1 week later	
	High Score on summary	Low Score on summary	High Score on summary	Low Score on summary
14	3		1	
13	10		5	
12	8	1	7	
11	4	1	8	
10	2	2	3	
9	1	5	1	
8	1	5	2	
7	1	2	3	
6		2		1
5		2		2
4		4		6
3		3		5
2		2		4
1		1		7
0				5

TABLE 39 . The distribution of subjects of high and low summary score against the Objective Test score on the Recall Complex immediately and after 1 week.

Table 40 shows the correlation of the summary scores and the loss on the Objective Test scoresin the Recall Complex section after one week.

Summary Score	50	47	41	35	31	23	17	13	11	9	6
Loss on Objective Test.	1.8	2.6	3.4	4.0	3.6	7.6	9.5	9.0	10.0	8.2	8.4

Spearmans = 0.76 N = 60. probability .01

TABLE 40. The correlation of summary score and the loss of Objective Test score in the Recall Complex section after one week.

After a week the high summary scorers have significantly higher scores on Recall Complex section in the Tests than the low summary scorers. This factor accounted for the very marked bimodal distribution of scores in the recall complex section after one week (Appendix 3.13.) The E.I. division of the experimental population (inefficient in the Summary, efficient in the Objective Test), were inefficient in the Objective Test after one week.

This finding, coupled with the obvious differences in reading strategies between subjects scoring high on the summary and those scoring low, raises an important educational question which is discussed further in the General Conclusion of this experiment.

3.13.7. GROUP D. Result. (students guided to improve their strategies of Learning).

Of the 15 subjects in this group, only four chose not to use the guides, one of these produced an effective summary. All the subjects who used the guides produced effective summaries. This compares with the subjects in Group C, without the guides, half of whom produced effective summaries. Table 41 shows the distribution of subjects in Groups C and D in relation to effectiveness of performance.

	C	D	
		Used Guides	Not use Guides
Effective on Summary and Objective Test	7	11	1
Effective on Objective Test only.	4	0	2
Effective on neither	4	0	1

TABLE 41. The distribution of subjects in Groups C and D in relation to the effectiveness of performance.

There appeared to be some evidence that offering students an immediate, detailed record of how they are learning, linked with guides on how to interpret this record, allowed them to explore new strategies and establish more effective patterns of behaviour.

There were also spontaneous comments by teachers that some of the Group D subjects showed improvement in other areas of study.

The reading strategies of the efficient subjects in both groups were of a similar type (Type 4 strategy) although the total Input time of the groups was significantly different at the .02 level of significance. The subjects in Group D who used the guides were pursuing in 'slow motion' the same type of activities as the effective subjects in Group C.

3.14. General Conclusion

1) The relationship between reading strategies and the 'outcome' of reading. Learner task definition.

The experimental population was differentiated according to the effectiveness of the reading 'outcome' into three divisions;

E.E. Subjects efficient in Objective tests and Summary.

E.I. Subjects efficient in Objective Tests and inefficient in the Summary.

I.I. Subjects inefficient in Objective tests and Summary.

These differences in results, related to differences in reading strategies. A strategy which included a read, with hesitations and notes related to 'specifics' in the text, was effective in the Objective tests. A strategy which included a search read, with considerable scanning backwards and forwards in the text, or/and non reading sessions, consisting of note review, draft and 'thinking' sessions, revealed the development of an understanding of the larger structural properties of the text and was effective in summarization. It is inferred, that the record of the process of reading can be used to predict what type of learning has taken place.

Not all subjects in Groups A and B (told to prepare for Objective tests), were successful in the Objective tests. Some subjects were effective in the Objective tests only (E.I.), others were effective in both types of test (E.E.). Not all subjects in Groups C and D (told to compose a summary), were successful in the summary. Some were effective in the objective tests only (E.I.), others were effective in both types of test (E.E.). The pattern of reading, which an individual generated depended on his definition of the task, not only in general terms, but in terms of the operational plan (Miller, G.A., Pribram, K.L., & Galanter, E., 1960), which be brought to bear.

Instructional directives influenced this definition, but <u>did not totally determine it</u>. Some students were unable to translate the directives into an effective operational plan. Others persisted with their own operational plan in the expectation that, the result would at least partially meet with the expectations of the instructional directives. The plans of a 'beginner' and an 'expert' may bring about the same post learning result, but they will differ considerably. The 'expert' may have read the text through once, fairly smoothly, the beginner may have read the text five or six times, exploring the items of information and building this into meanings from which he can develop a structured understanding of the material. <u>The hypothesis is made, that task definition is a personally creative, operational plan which is derived from the stimulus situation, including both the instructional directives and the text, but is also largely influenced by the initial state or predisposition of the learner.</u> Frequently, there is a misalignment between the learner's plan and the instructional directives (externally set task) resulting in 'overlearning' or 'underlearning'. Some subjects in Groups A and B were effective in the Objective tests and Summary. Some subjects in all groups were ineffective in both tests. Clearly there is a need to develop training in reading to learn.

2) <u>The influence of the pretest on task definition in Groups A and B</u>

Objective tests given prior to learning, influenced the operational plan of subjects in Groups A and B, in one of two ways. Some ineffective subjects were influenced directly and specifically. Their task definition resulted in a strategy of reading which was effective on that particular pretest, but not on another test.

Subjects who were effective in both Summary and Objective test or effective in Objective test only were influenced in a less direct way, their task definition resulted in a strategy of reading which served to be equally effective in the pretested and unpretested Objective test, after learning. These subjects had conceptualized the nature of the test and were able to transfer this into a more generally effective plan.

The significantly higher drop in score in the unpretested Objective test after one week in the ineffective subjects (I.I.) and the subjects effective in the Objective tests only (E.I.), on the one hand, compared with no differences in score in both Objective tests in the subjects effective in both Summary and Objective tests (E.E.), on the other hand, has bearing on the conclusions of Ausubel (1960) on the role of advanced organizers. The pretest served to 'condition' the learner, by the advanced introduction of relevant organizers, which facilitated the retention of unfamiliar material. However, students interpret the 'advanced organizer' aspect of the pretest <u>differently</u>, and this is reflected in their operational plans or reading strategies, with the result that the influence of the organizer can be long term or short term. <u>The hypothesis is made, that the pedagogic value of a carefully prepared pretest, as an advanced organizer for effective operational plans in reading to learn could be of tremendous significance</u>. However, there is a danger that an over-intensive and undiscriminating use of pretests may lead the learner into too specific selectivity.

3) Learning and Testing.

The more skilled or competent the learner the more likely was he to translate effectively the instructional directives into a reading plan (or strategy), which was optimal for the test he expected to receive. Reading in an optimally effective way for an essay type answer produced learning, which enabled the reader to cope effectively, with Objective tests. The reverse was not the case. Students reading in an optimally effective way for Objective tests, did not cope effectively with the essay type question, which involved the development of structure, nor did they retain the information as effectively over long periods. The pedagogic value of Objective tests should be carefully reconsidered. Reading effectively for Objective tests only, in being reinforced, would be perpetuated. This can be likened to direct operant conditioning (Skinner 1957a). If reading effectively for essays is not similarily reinforced, the student's repertoire of strategies will be restricted and his learning capacity curtailed.

Objective tests foster a 'shallow' learning, since the very nature of the test provides information, which acts as a framework for the response; the organized schema is external to the learner. It is therefore not essential to take learning to the same end point as in preparing for a summary, in order to be effective.

The longer or shorter term retention effects of different types of reading-to-learn strategies, must be related to internal storage systems. Large scale organization of information, which involves concept and principle learning (Gagné - 1965) results in a more effective long term retrieval than learning specifics. The issue of whether long term storage (L.T.S.) and short term storage (S.T.S.) are different processes has been considered by Hebb (1949), Broadbent (1958), Melton (1963), Waugh and Norman (1965), Glanzer & Cunitz (1966) and Raymond (1969).

The data from this experiment is considered favourable to the two storage mechanism of memory hypothesized by these workers. Mandler (1969) has recently reported that the greater the number of categories in organized categorized word lists, the greater the number of words recalled in the long term. The findings of the experiment here reported support this study. Bruner (1960) has emphasized that the formulation by the learner of a structure or pattern, within subject matter is essential for learning progress. He points out, that grasping the structure permits items to be related more meaningfully and retrieved more effectively.

4) Guided Instruction Self-organized learning and feedback.

The effectiveness of all subjects in Group D, who used the visual guides, emphasized the importance of training. Feedback of information during learning was useful in increasing students' awareness of the process of reading to learn. Guidance appeared to influence the task definition, with the result that the operational plan was more optimally aligned to an effective performance.

As a result of differences in their initial state, the students' needs for training were not the same. It is considered essential, to develop an instructional procedure, within which each student can control his learning. Effective learning from written information depends upon organization and decision making, and the extent to which this is tutor or learner controlled, opens up a major educational issue. Too rigid external control, as in the case of some teaching situations and programmed texts, restricts individual freedom of operation and lowers motivation and intellectual potency (Bruner 1961). Such rigid external control of the learner can lead to conflict.

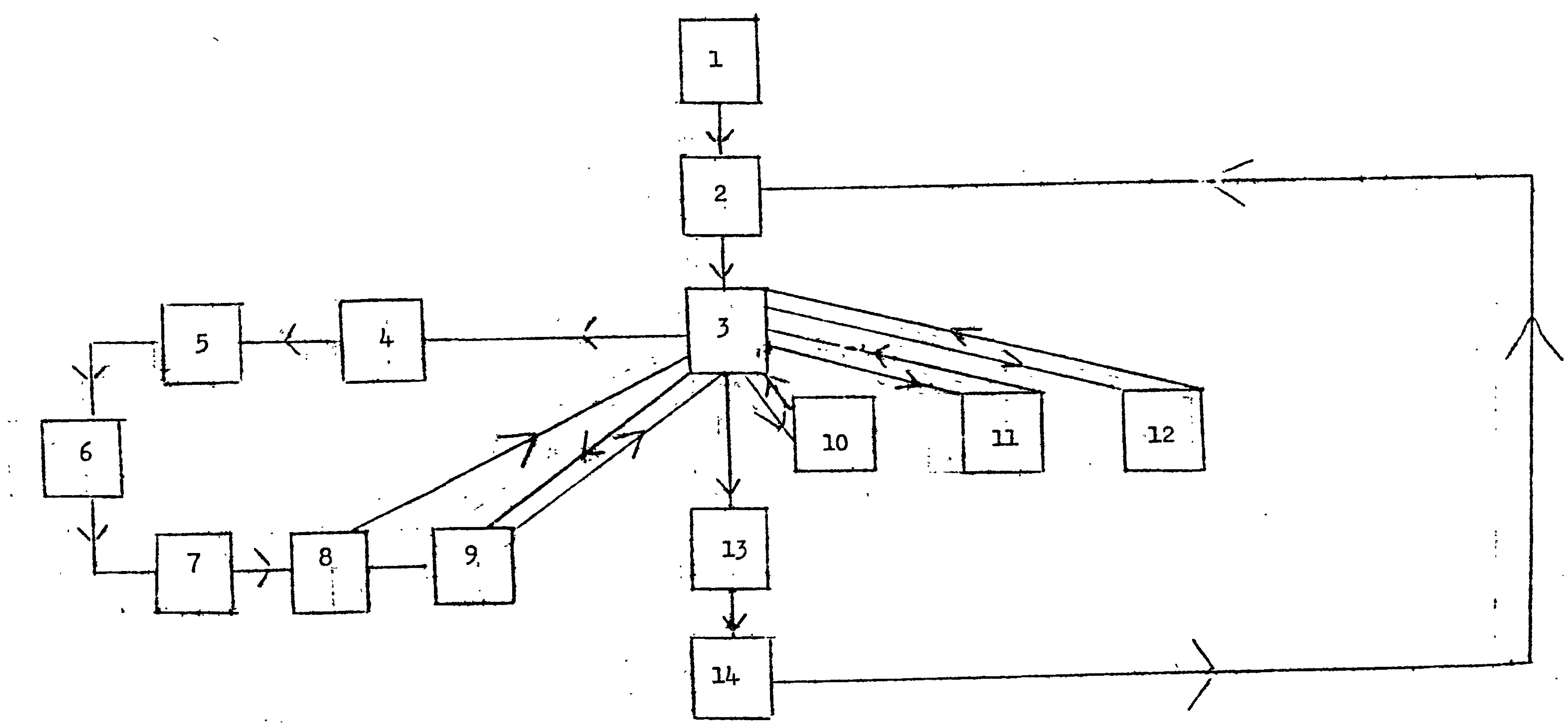
No external control can lead to ineffective standards, as this reported experiment has shown. Instruction should aim at a dynamic flexible relationship, between external and learner control of learning, to meet the individual needs. An instructional procedure, needs to be developed, which encourages self-organized learning. This issue is taken up in Unit 7.

3.15. Summary

A learning strategy which was aligned to good summary, and a learning strategy which was aligned to a good response only to Objective tests, were distinctly different. The former was associated with a longer Input time than the latter, but time was not the only criterion of differentiation. The reading strategy for good summarization was more complex, in that it was sub-divided into more phases of activity than the reading strategy, good only for Objective test responses. Within the experimental population task definition was not universally optimally aligned, to the externally set goal (instructional directive). Some subjects overlearnt for the Objective tests and others underlearnt for the Objective tests and Summary. It appeared that students defined learning tasks in idiosyncratic terms. It was suggested that the student has a predisposition to perceive the task in a particular way in relation to the stimulus, which consisted of the learning material and the externally set instructional directive, and this perceptual organization largely determined the task definition, and operational plan. The reading strategy or plan can, therefore, be understood as a complex operating system of checking, how the ongoing process of reading related to the self-defined goal. Pretesting appeared to have specific and general influences on task definition.

Guides to improve strategies of learning appeared to provide a referent framework, which led to successful task alignment, in terms of a summary. A learning strategy which was aligned to good summarisation resulted in a longer retention of knowledge than a learning strategy which was aligned to good Objective test responses only. These results are considered to be favourable to a two storage mechanism in memory.

A STRUCTURED GENERIC FLOW DIAGRAM OF UNIT FOUR

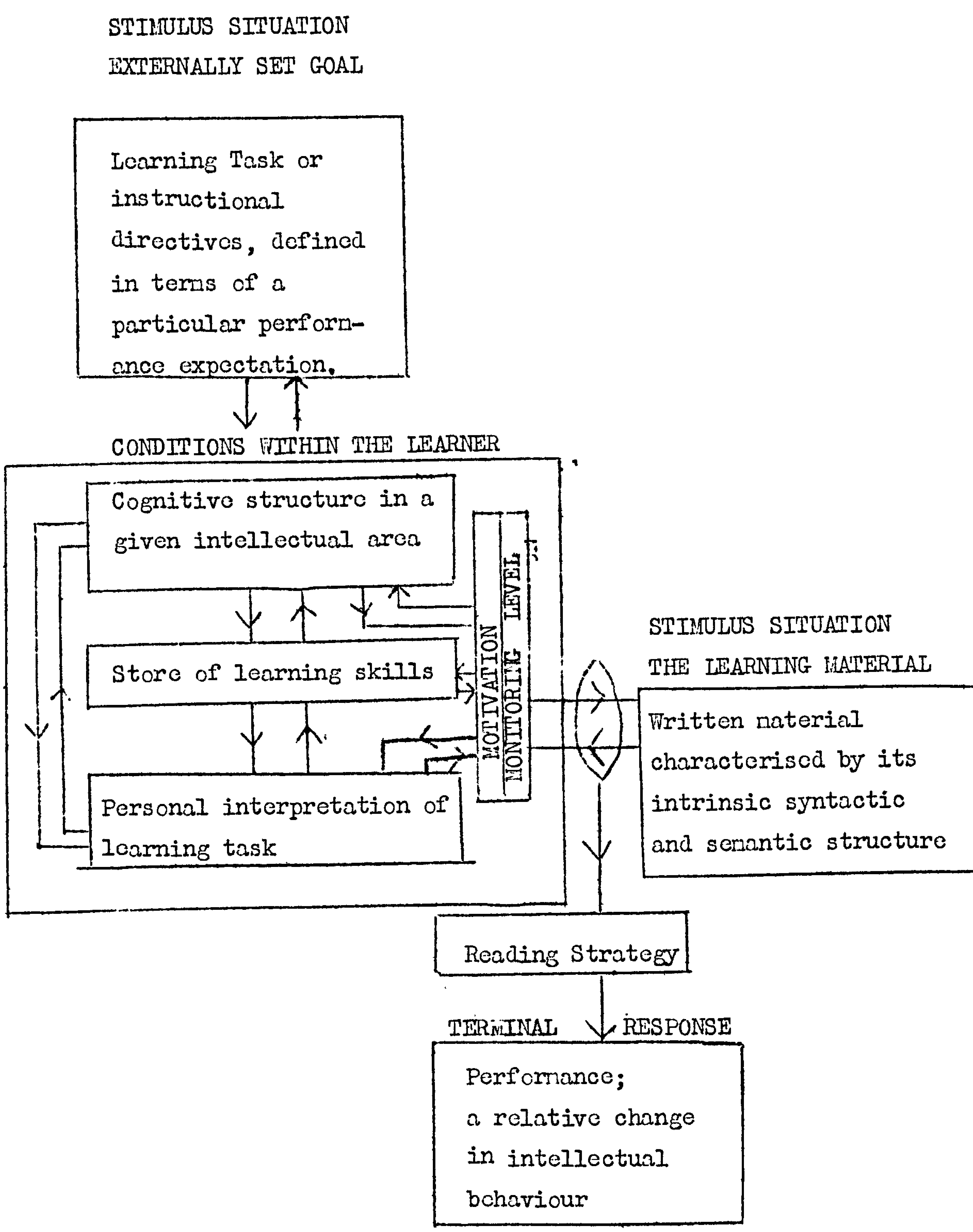


UNIT 4. Theoretical Discussion (1) A Preliminary Model of the Learner - Towards a Synthesis.

1. Learning is a generative process which involves an alignment between outside information and the internal model (Bruner 1964, Allport 1964, Broadbent 1958). In the case of learning by reading, the outside information is the written word which represents a symbol system, and the internal model is the cognitive schema which is related to this system (Piaget 1950). Any given intellectual area has its equivalent conceptual cognitive schema.

2. There may be a best method of reading for each individual, but this is conditional upon many operating factors, which form part of an ongoing process of receiving information and dealing with it. Reading-to-learn can be described as a cybernetic system and interference at any one level of feedback within the system can have repercussions at all levels. An attempt at making explicit some of these factors has been made in Unit 3. The hypothesis is made that if a learner is presented with an opportunity to be made aware of how and why he pursues a specific reading strategy, this can form a basis of a more precise assessment of the outcome of learning behaviour against self-defined learning purposes. In other words, providing the learner with an opportunity to evaluate his internal state or 'conditions within' in relation to the stimulus situation, can form a basis of a more precise assessment of the terminal performance against self-defined purposes. The combination of awareness of reading patterns in relation to internal 'conditions' and the stimulus situation could have repercussions on how an individual defines his learning purposes. This in turn prepares the foundation for a systematic improvement of task definition. This would be reflected in terms of an optimal match between the externally set task, the internal task definition, the learning strategy and terminal response. An ability

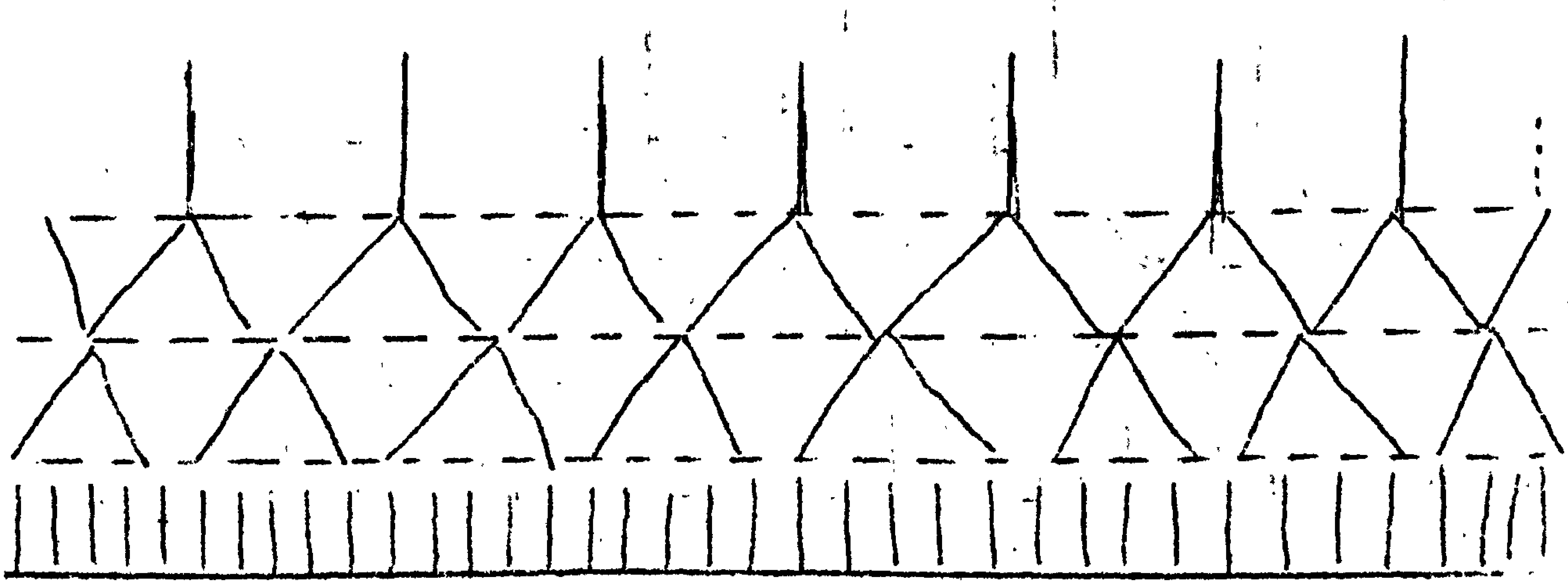
to self-organise learning behaviour efficiently could be nurtured. A cybernetic model of learning by reading, which forms the basis for these predictions is presented below:-



A CYBERNETIC MODEL OF LEARNING BY READING

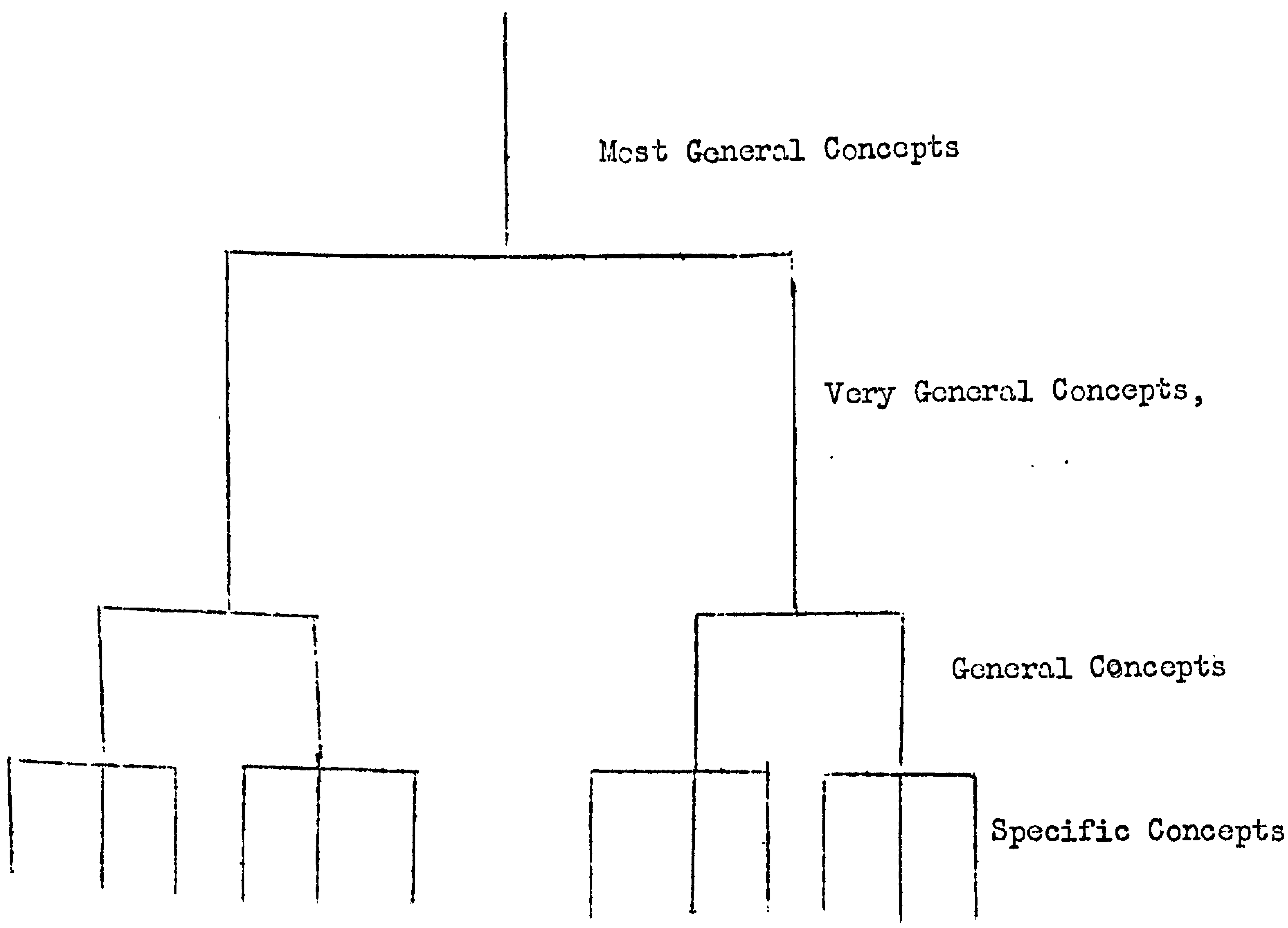
3. The hypothesis is made that the 'conditions within the learner' which determine the reading strategy incorporate several major factors, which are bound in a complex relationship. Some of these factors are considered briefly.

4. A 'Cognitive Structure'. This represents the total organisation of concepts, and it refers to the interrelationships of bodies of concepts. This Cognitive Structure is hierarchical. Piaget's Cognitive Schemas are integrated systems of concepts and, as such, are part of the total Cognitive Structure.
The public, agreed knowledge system about a given area is usually well defined and the relationships between the items of knowledge is logical. This does not mean that any one individual's Cognitive Structure equates to this. Many of us do not 'properly understand' the existing state of knowledge, and those who do often have idiosyncratic experiences which amplify and distort the common consensus. As one focuses on a specific task or knowledge area, it is often possible to analyse it in terms of a hierarchical organisation. The levels of organisation from specifics to abstractions and generalisations, which one individual has stored within a Cognitive Structure, can be represented ideally as follows:-



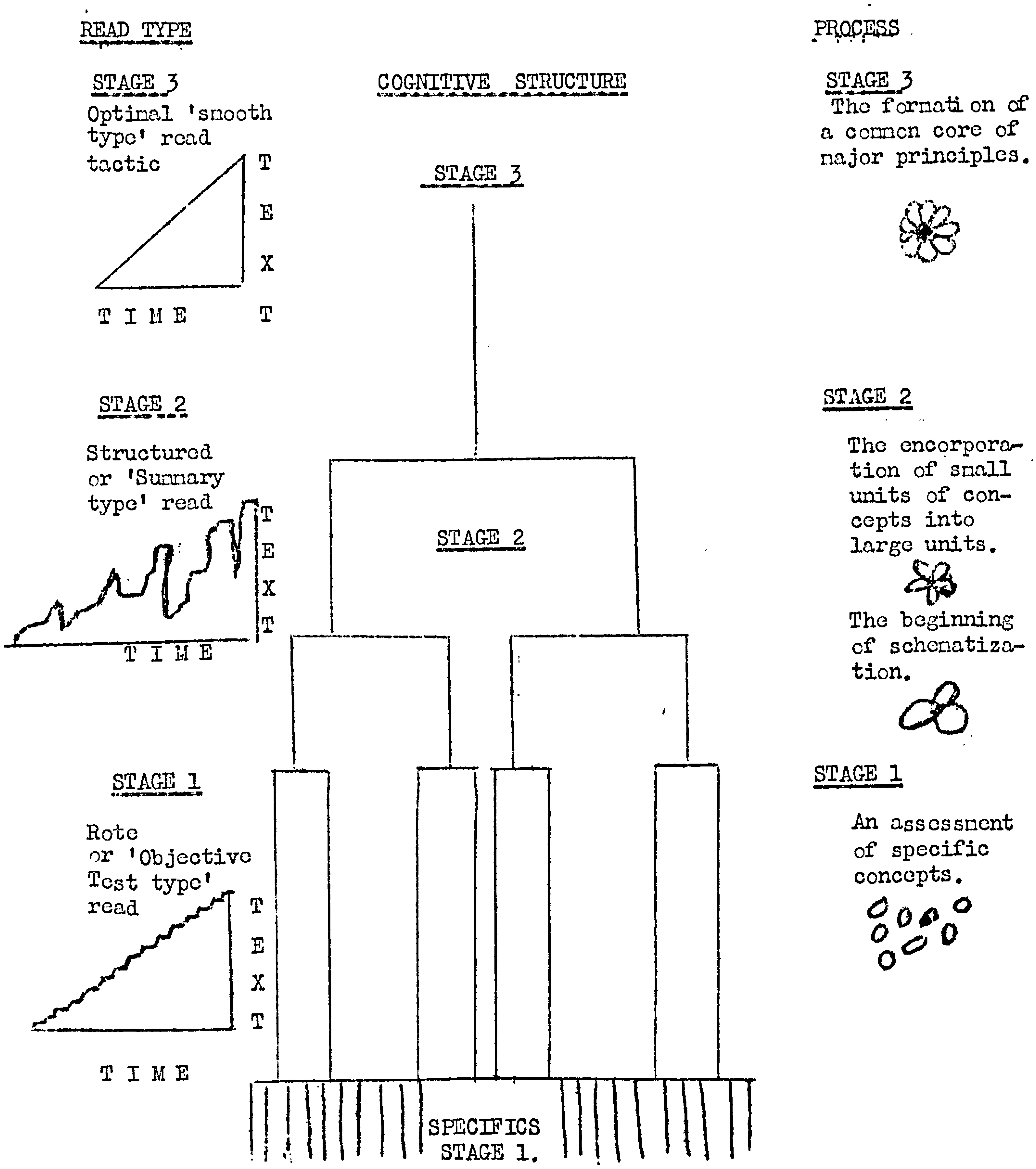
Levels of organisation in a hierarchy, from specifics to the most general concepts

The level of development of an individual's total Cognitive Structure is variable. From the neo-connectionist-cognitive point of view this Cognitive Structure represents an internalisation of an individual's experiences, which result from a dynamic interaction between the individual and his environment. An individual's Cognitive Structure increases in complexity with age and experience. Cognitive Structure in a given field can be represented in a simplified form as follows:-



5. A subject whose Cognitive Structure extends from specific concepts to the most "general concepts" pursues a pattern of input activity or plan (Miller 1960) differing in kind from that of a subject whose Cognitive Structure is at the level of "specific concepts."

A simplified hypothetical explanation of how efficient reading patterns relate to Cognitive Structure is shown below:-



STAGE 1

The acquisition of 'specifics' not correlated within a schema, can be related to a straight read with numerous hesitations. This type of read is associated with 'rote learning' and is the slowest of the three types of identified reads. In the absence of a structure, the storage of data is not organised. This type of input activity is related to potential efficiency in objective tests, designed to assess knowledge of specifics. If an individual's Cognitive Structure is dependent upon age and experience, it could be inferred that the reading habits of the infant school child may well be restricted to this type of read. The hypothesis is made that the reading habit of the older child, and some adults, may not have evolved beyond this stage. Training to read within the educational curriculum ends at the primary school. It is, therefore, considered that training to develop a store of qualitatively different reading tactics and strategies (reading skill) could have repercussions on cognitive growth.

STAGE 2

This relates to a structuring and restructuring of the specifics into small unit concepts, and of the latter into large unit concepts. Hesitations in the read signify a mismatch between the information read and the internal store. Regressions in the total read signify efforts at restructuring the Cognitive Structure. This type of input activity relates to a potential efficiency in generalising tests, such as the composition of a summary. Whether or not intellectual growth is associated with the acquisition of this type of read pattern is open to conjecture. Efforts at the correlation of the stages in cognitive development of children (as formulated by Piaget and Bruner) with the development of read patterns, could be rewarding. It could serve to further present knowledge on the development of man's ratiocinative capacity and to provide a technique for the systematic intervention of

Cognitive Growth in order to improve and accelerate it.

STAGE 3

This 'smooth type' read relates to an optimal input of information compatible with all levels of the Cognitive Structure. It is conjectural as to whether no acquisition of fresh concepts, associated with any of the three stages, is taking place, or whether the degree of prediction afforded within this highly organised Cognitive Structure incorporates an extremely fast implicit input activity, when additional concepts are being acquired. Accepting the former viewpoint, no learning of new concepts is taking place; accepting the latter, learning of the most sophisticated type is taking place.

6. A Cognitive Structure is restructured when new concepts are incorporated. The new concepts are probably fitted into an existing basic structure. This structure affects the basic structure . To the extent at which major restructuring of the Cognitive Structure has to take place during learning, as from one stage to another, behavioural changes must also be made. This would account for the structured read pattern described in Stage 2. The more elaborate the existing Cognitive Structure is in terms of its hierarchical organisation (as in Stage 3), the less restructuring has to take place during learning, and, therefore, the corresponding behaviour is not changed. This interpretation of behavioural activities during learning is related to the process of adaptation by accommodation and assimilation, (Piaget 1950). Learning by accommodation results in hesitations and regressions in reading. Learning by assimilation results in smooth 'optimal' reading. A cybernetic system in dynamic equilibrium is a useful model to understand the process of learning by reading. The restructuring of a Cognitive Structure can be considered as a different view of the same process. When a Cognitive Structure is restructured, the learner moves from one

level of equilibrium to a new higher level. When the equilibrium is disturbed, as when new concepts are encountered, it is restored when the new concepts have been incorporated into the existing structure.

7. The sophisticated optimal 'smooth'type read allows for proficiency in both the specific and generalisation tests. The pursuit of the 'smooth' type read exclusively, in the absence of a well developed Cognitive Structure, results in inefficiency in specific and generalisation tests.

8. The implication of this interpretation is, that in order to be able to summarise well, a learner with a minimal Cognitive Structure in that particular field, needs to pursue all the stages of input activity; the'rote' intake (Stage 1), the structured intake (Stage 2) and the final 'optimal' intake (Stage 3) are of equal relevance in the total pattern of the reading strategy. Knowledge of the three types of read is provided in the instructional procedure negotiated in Experiment 5, Unit 7, which represents a pilot study to encourage students to improve the range and effectiveness of their reading outcomes.

9. (ii) Cognitive Learning Skill.

This represents the total organisation of skills on which the process of reading-to-learn depend. The organisation of skills is hierarchical, but the nature of the hierarchy is not clear. From the neo-connectionist-cognitive point of view learning skills represent an internalisation of an individual's experiences which result from a dynamic interaction between the individual and his environment. Skills increase in complexity with age and experience. Learning skills in relation to reading are listed as follows:-

1) The skill of being able to read printed words.
2) The skill of being able to write printed words.
3) The skill of being able to recognise and manipulate the syntactic organisation of sentences.

4) The skill of being able to generate meaning from the syntactic and semantic organisation of sentences.

5) The skill of being able to store knowledge at the level of specific concepts.

6) The skill of being able to store knowledge at the level of more general concepts.

7) The skill of being able to store knowledge at the level of the most general concepts.

8) The skill of being able to retrieve knowledge when required from any level of the hierarchy.

9) The skill of being able to select and give priority to particular data at any level of the Cognitive Structure.

10) The skill of being able to translate in verbal terms the Cognitive Structure and hence to communicate to others.

10. (iii) Personal Interpretation of the task (Task Definition).

The personal interpretation of the task and the externally set task (or instructional directives) are not necessarily the same in terms of the learning outcome. An individual's interpretation of the task depends partly upon his existing knowledge, or Cognitive Structure, his cognitive learning skill and his motivation. It is also influenced, although largely unconsciously, by the cumulative impact of his whole learning history. The personal Task Definition determines the reading strategy, not only in general terms but also in terms of an operational plan, which the reader brings to bear on the printed material to be learnt. Task Definition is seen as a personally creative, operational plan, which is derived from the stimulus situation which includes the instructional directives and the text, but is also largely influenced by the interaction of internal factors which together determine the internal state of the learner.

11. (iv) Motivation.

Motivation is a factor which interacts with other factors within the learner to determine the reading strategy, While this aspect represents a study in its own right, as discussed in the literature review of the practical problem (Unit 1.2.3), it is an assumption of this research that learner participation is bound up with motivation. All subjects who participated in the empirical studies were volunteers.

12. (v) Monitoring Activity.

The system of monitoring the learning process is also bound cybernetically to the external and internal 'conditions' which relate to learning. It relates to the way in which the learning material is read in order to perform the task, and it is reflected in the type of reading strategy produced. A learner's monitoring level needs to be flexibly and systematically adjusted and controlled in order to meet the demands of the task and the requirements of the 'conditions' within the learner, in relation to the material to be learnt.

13. Instructional Procedures.

This model being developed is not only descriptive of the process of reading-to-learn, but also provides a psychological foundation for the construction of an instructional procedure to increase the range and effectiveness of the activity. This instructional procedure could operate in two main stages:-

STAGE 1

A learner is provided with a learning task, on a particular text. This makes up the stimulus situation. The learner operates the reading recorder and by means of the graphical record produced, is made aware of his reading activity. A tutor-controlled or self-controlled evaluation of the performance with reference to the task would diagnose the efficiency of the learning. The outcome of learning could be related to the reading strategy.

STAGE 2

An ineffective learner is given the opportunity by external supervision or by self-controlled instruction to examine his Cognitive Structure and Cognitive Learning Skill in relation to his reading strategy. He can then select, as a guide to learning, a reading strategy best suited to his predisposition, so that his personal interpretation of the task is better oriented to the requirements of the externally set goal.

14. A full evaluation of this instructional procedure depends upon a further elaboration of the relationship between reading strategies and the outcome of learning, and upon a more detailed analysis of the internal factors or 'conditions' within the learner which together determine the strategy of learning. This conclusion provided the impetus for the empirical studies reported in Units 5 and 7.

UNIT 5. An Empirical Study;- further testing and development of the Model.

Experiment Four

An exploration of Task definition, Reading protocols, and Learning outcomes at the Sentence level.

5.1. Introduction

A basic assumption in any investigation of the process of learning by reading is the interfunctional relationship between language and thought. A consideration of the meaning of meaning, presented in the literature survey, emphasizes the lack of understanding of this interrelationship of word and thought. Vygotsky (1962) has pointed out the danger of an analysis of a psychological problem, which involves breaking down wholes, into elements. He stresses the unitary nature of the process under study. The barrenness of phonetic studies in developmental psychology because the data contribute little to an understanding of linguistic development and remain essentially unrelated to the findings concerning the development of thinking, is an example of this erroneous mode of analysis. The type of analysis to follow is that into units. Unlike elements, the unit retains properties of the whole. Vygotsky defines a unit as that which cannot be further sub-divided, without loosing the properties of whole.

The unit of verbal thought, which fits this requirement is word meaning, - thought and speech unite in verbal thought. Clearly, the method to follow in an exploration of the nature of verbal thought is the semantic analysis of the structure and functioning of this unit - word meaning, which contains thought and speech interrelated.

A record of the learning activity of reading each word within the smallest syntactic unit, the sentence, in order to perform a specific task was considered to be crucial, to achieve a clearer understanding of the interfunctional relationship between thought and language at the molecular level.

The learning activities investigated in Unit 3 were operational at a molar level. This related to the learning material, which was considered in terms of its gross syntactical or surface structure as organized into words, phrases, clauses, sentences, paragraphs and chapter, and in terms of its semantic structure as organized into Specifics, Ways and Means of dealing with Specifics, Generalisations and the organising of Generalisations into a theoretical whole. It also related to the learning tasks. These consisted of responses to Objective tests relating to the text's semantic structure and an "essay type" summary requiring an assessment of the semantic structure in terms of the selection of the most relevant items and the recall of these items in translated form (in terms of the learner's verbal response), and their organization into a structured whole.

The learning behaviour identified in terms of reading strategies and performance in Unit 3 reflected the complexity of these interrelated factors. It was concluded in Unit 4 that the organization of skills, operating on a complex learning material, into short and longer-term learning systems (Objective test and Summary) related to a self-definition which determined the monitoring system of the learner. It was pointed out in Unit 3 that if the task definition and monitoring system were not aligned to the externally set task, the 'output or reading outcome' was ineffective. Identification of the relationships between the two was, therefore, crucial.

Observation and discussion with the less effective subjects in Unit 3 led to a differentiation of inadequacies in the use of reading as a learning skill at the chapter, paragraph and sentence level, as representative of size of meaning unit. Experiment 4 was an attempt at the sentence level to explore specific sub-skills in terms of reading strategies, and to identify the levels of monitoring relating to these skills in terms of the learner's task definition and of the structure of the written material.

Making explicit efficient reading protocols at this molecular level was considered to be of value in developing a programme of training to learn effectively. When a learner would be in difficulty as regards meaning generation in terms of his self-defined task at a particular molar level of monitoring, he needs to be able to control his activity and change from 'overdrive' into a lower 'gear' of monitoring. Awareness of the techniques involved in 'molecular monitoring' would aid this process.

It was considered that the molecular structure of reading, as practised at the sentence level, (in which the size of the meaning unit was small compared with the chapter level) on a particular learning task, might not reveal any specific protocol/performance relationship possibly owing to their implicit set-up (as a result of long established practise). Three measures were, therefore, introduced to test the adequacy of molecular reading skills. These were:

(1) The variety of learning abilities demanded by the learning tasks set.

(2) The distortion of the syntactic or semantic structure of the test sentence.

(3) The increasing complexity of the syntactic structure and semantic organisation of the test sentence.

Reference to Gagné (1965) and Bloom (1956) suggested that concepts of varying complexity become linked into a body of knowledge and that this store forms a basis for the practice of more complex learning skills. Gagné identifies 8 conditions of relevance to learning (1965). Cognitive skills must operate within the matrix provided by these conditions. In the Taxonomy, these skills are grouped into 6 categories (1956). The skills considered to be pertinent to Objective testing and summarization were selected for identification in Experiment 4.

In summary, these can be listed as follows:-

<u>Recall</u> and <u>Recognition</u> of

A. 1.00 <u>Knowledge</u> - those behaviours which emphasize remembering information in the form in which it was originally learnt.

1.10 Knowledge of specifics.

1.20 Knowledge of ways and means of dealing with specifics.

1.30 Knowledge of the universals and abstractions in a field.

B. 2.00 <u>Comprehension</u> - those objectives, behaviours, or responses which represent an understanding of the literal message contained in a communication.

2.10 <u>Translation</u> - competence in <u>translation</u> depends upon the possession of the requisite knowledge. It involves the giving of <u>meaning</u> to the communication and putting the communication in another language.

2.20 <u>Interpretation</u> - this requires a reordering of the communication into a new configuration in the mind of the individual. It includes thinking about the relative importance of the ideas and of their interrelationships.

2.30 Extrapolation - the making of predictions based on understanding of the trends in the communication.

C. 3.00 Application - To know an abstraction in the comprehension category well enough that it can be applied in a novel situation.

D. 4.00 Analysis - The breakdown of the material into its constituent parts and detection of the way the parts are organized.

5.2. Experimental Method

5.2.1. Design.

In a Latin square design 30 subjects (in 6 groups of 5) were asked to carry out 6 different learning tasks on 6 separate batches of eleven sentences, (66 sentences were read by each subject). The danger of serial effects producing a systematic bias in a given task mean was reduced by randomizing the order, subject only to the restrictions of a Latin square arrangement. In order to diagnose the strength or weakness of a particular batch of eleven sentences, each batch was tested on every task. To simplify the preparation and administration of the study, the batches of eleven sentences were always presented in the same order on the continuous stationary, i.e. neither the batch order nor the sentence order was randomized. However, since care had been taken to minimize any direct conceptual relationship between each batch of sentences, the danger of any serial effect of batch order or sentence order was considered to be minimal.

The experimental design is schematized below:-

GROUP	SUBJECTS	TASK ORDER per group of 11 sentences.						Sentences for all tasks.
1	5	4	1	3	2	5	6	6 x 11 (66)
2	5	3	2	4	1	6	5	6 x 11 (66)
3	5	6	4	5	3	2	1	6 x 11 (66)
4	5	2	6	1	5	4	3	6 x 11 (66)
5	5	5	3	2	6	1	4	6 x 11 (66)
6	5	1	5	6	4	3	2	6 x 11 (66)

Each sentence has been tested 30 times (5 x on each task) and the task order has changed 6 times. In the Latin square arrangement, it was possible to test for the differences among the means for tasks 1 - 6 inclusive, with the order effects balanced. Similarily, since each task and batch order involved all experimental conditions (the 6 tasks) it was possible to test for the task order and batch order effects with the experimental conditions balanced.

5.2.2. The Learning Material.

All sentences were selected from various articles in Scientific American, which dealt with the cognitive area of genetics. The selected sentences were thoroughly scrutinized in order to meet the following criteria:-

a) number of words

b) clausal complexity

c) intellectual complexity

d) independent semantic content

The sentences were grouped into three categories:-

1. Category A.

   10 word, 1 clause sentences whose knowledge content consisted of specific facts,

2. Category B.

   20 word, 2 clause sentences whose knowledge content consisted of specific facts and ways and means of dealing with them,

3. Category C.

   50 word, 4 or 5 clause sentences whose knowledge contant consisted of Universals and Abstractions.

Within each category, the syntactic and semantic content of each sentence was varied as follows:-

a/b) normal syntactic and semantic English sentence.

c) syntactic distortion, - the English worded sentence was given a Germanic syntactic structure.

d) semantic distortion - the English worded syntactically normal sentence was given a lower order of meaningfulness.

These sentences were not prepared by the technique developed by Miller (1950) and Shannon (1951) of statistical approximations to English. This was because all orders of approximation distort the syntactic as well as semantic organization of the sentence. The technique developed was to select a normal English sentence and to replace nouns, verbs, adverbs or adjectives with other words of equivalent class, but different meaning. The replacement classes of words were drawn at random from prepared lists taken from a dictionary. In ten word sentences three to four classes of words were replaced. In twenty word sentences 6 to 7 classes of words were replaced and in fifty word sentences 15 to 16 classes of words were replaced.

The experimental design called for 66 sentences, 24 Category A, 24 Category B and 18 Category C sentences. Within Categories A and B, 12 sentences were normal, 6 were syntactically and 6 were semantically distorted. These 66 sentences are reproduced in full in Appendix A. Each sentence was pretested on a control group of 6 students, on all 6 tasks, so that its discrimination in the test could be assessed. If a sentence proved to be particularly easy or difficult for the majority of the group, it was rejected.

Each sentence was presented, word by word in a diagonal row on the continuous stationery (which followed the natural eye movements in reading), so that only one word was visible at a given time on the viewer of the recorder. This provided a record of how the sentence was read.

5.2.3. The Tasks

Six learning tasks were selected. These were distributed within the range of intellectual skills as follows:-

KNOWLEDGE

1) Learning the original sentence for recall of any missing key word(s) in the test (rote).

2) Learning the original sentence for the recognition of missing key word(s) in the test (rote) (multiple choice).

COMPREHENSION

3) Learning the original sentence in order to recall a translation of missing key word(s) in the test with a word(s) of equivalent meaning.

4) Learning the original sentence in order to recognise a translation of the missing key word(s) in the test (multiple choice).

5) Learning the original sentence in order to generalise the sentence (extrapolation).

APPLICATION AND ANALYSIS

6) Learning the original sentence in order to analyse the grammatical structure of the sentence.

Instructions for each task were given in a test booklet, together with the accompanying batches of test sentences. In tasks 1 - 4 inclusive, the missing key unit of the test sentence varied in size according to the category of sentence. In Categories A and B, two key units were omitted in the test, each consisting of one or two word phrases (excluding propositions). In Category C, three key units were omitted from the test, each consisting of 4 or 5 word phrases. The gaps in the test sentences, which represented the missing units were denoted by a standardized 4 cm. line, in all cases. This line, therefore, gave no indication of the size of the missing unit. The task design thus incorporated three control variables, which can be enumerated as follows:-

1) an increase in sentence complexity in terms of syntax and intellectual organization,

2) a change in the syntactic and semantic values of the sentence,

3) an increase in the size of unit omitted from the test sentence in tasks 1 - 4 inclusive.

In the recognition tests of Tasks 2 and 4, two alternatives to the correct response were presented. Two factors governed the choice of these alternatives. One alternative should be phonetically similar to the original unit (Task 1) or to an equivalent translation of the unit (Task 4). The other alternative should be equivalent in meaning to the original unit (Task 1) or should fit reasonably into the context of the sentence, although the given meaning of the sentence would then be changed (Task 4).

5.2.4. The TASK Evaluation

The marks for each task were distributed according to the following scheme:-

Category of Sentence	Type of Sentence	TASKS 1	2	3	4	5	6
A	normal (a	1+1	1+1	1+1	1+1	2	2
	(b	1+1	1+1	1+1	1+1	2	2
	syntactically distorted(c	1+1	1+1	1+1	1+1	2	2
	semantically distorted(d	1+1	1+1	1+1	1+1	-	2
B	normal (a	1+1	1+1	1+1	1+1	2	2
	(b	1+1	1+1	1+1	1+1	2	2
	syntactically distorted(c	1+1	1+1	1+1	1+1	2	2
	semantically distorted(d	1+1	1+1	1+1	1+1	-	2
C	normal (a	2+2+2	2+2+2	2+2+2	2+2+2	4	4
	syntactically distorted(c	2+2+2	2+2+2	2+2+2	2+2+2	4	4
	semantically distorted(d	2+2+2	2+2+2	2+2+2	2+2+2	-	4
TOTAL	11	34	34	34	34	20	28

5.2.5. The Learning Programme

Task 6 demanded a basic knowledge of the techniques of (parsing sentence analysis), in terms of its syntax. While it was accepted that sixth-form students and post-graduates would be familiar with the parsing of sentences, it was considered necessary to eliminate the uncontrolled variables of differences in analysis skill and a learning programme on sentence analysis was prepared.

This was intended as a refresher course, but was so constructed that any subject entirely unfamiliar with the parsing of English grammar would be able to abstract the relevant concepts in order to apply this knowledge to sentence analysis. The studies of R. Gagné and L. Brown (1961) on how problem solving performance can throw light on the effectiveness of the learning of the concepts employed, stressed the importance of the development of an effective programme. These workers suggested that a guided discovery (G.D.) programme led to a superior performance in an application test, because the concepts used in the application test were systematically practised in the G.D. programme. The G.D. programme developed made explicit the syntactical structure of simple one clause sentences and of complex four or five clause sentences. The method of presentation of sentence analysis was also displayed.

5.2.6. PROCEDURE

Subjects. The experimental population consisted of Advanced Level students from a Public School, Grammar School and Technical College, as well as a few post-graduate research workers and lecturers, in the biological sciences. One of the post-graduate volunteers was German born and educated, one of the students was German born and one other student was Asiatic.

At the beginning of the experiment, each subject was provided with a practical pretest, to make sure that he (or she) had understood the nature of each task and had become familiar with the experimental procedure. This pretest, which was presented on the reading recorder consisted of three normal sentences of 30 words, structured into two or three clauses, for each task. The instruction for the task was presented and the Input and Output activity for each sentence was recorded in turn.

Before pretesting on Task 6 (sentence analysis), the subject was asked to go through the learning programme. Each subject was told to select the order of the 6 tasks and the experimenter made sure that this task order was not the order in which that subject performed the tasks in the experiment. The sentences used in the pretest had no conceptual relation to the sentences in the experiment. The size of the sentence unit was different to that of the sentences in the experiment. This pretest was designed to encourage the establishment of a 'learning set' for each task, but not for the other independent variables of the experiment, namely task order, sentence meaning, length, complexity and distortions. No time limit was set on this practice session and when the subject was ready he (or she) proceeded on to the experiment proper.

The experiment proceeded as follows:-

1) The instruction for the task, which was provided on one page of the test booklet was read.
2) One of the eleven sentences was read on the recorder in order to learn it. When this Input activity was completed, the equivalent test sentence, which was provided on one page of the test booklet was read.
3) Responses were recorded on the same page of the test booklet and the Output time was recorded by placing the booklet on the notepad, which was connected to an event pen holder of the recorder.
4) The next sentence was read on the recorder in order to learn it, and the cycle continued once more.

5) When the Input/Output activities of all eleven sentences was completed, the subject rested for 5 minutes before proceeding to the next task and the next batch of eleven sentences. During this rest period the subject was encouraged to discuss any problems which might have arisen with the experimenter. Any difficulties with learning tactics were not, however, commented upon by the experimenter, although they were noted. The purpose of this rest period was to reduce any 'carry over' effect of the learning tactic used in each task.

When the six tasks had been completed by each subject, a record was available of the Input/Output activity on 66 sentences. A detailed analysis of this record was made in terms of the following responses:-

a) The Score per sentence per task
b) The time (as recorded on the graphical record of the plotter of the reading recorder) of the Input/Output activity per sentence per task
c) The graphical record of the reading protocol per sentence per task was recorded on the plotter of the reading recorder. Each reading protocol was compared with a control record, which had been scaled in the perspex ruler of a graph analyser (Unit 2). This control record marked the distribution of the phrases, clauses and verb placements within the sentence.

In terms of the experimental design, the independent variables constituting the experimental conditions were task order and batch (of sentences) order. The independent variables constituting the trials were task type and learning material type (sentence size, complexity and structure). The dependent variables were the response measures of score, combined input/output time and reading protocols.

5.3. Results and Discussion

5.3.1. The Latin Square

The mean score and combined input/output time response ratings, demonstrated no significant effect of task order (Appendix C, Charts 5.3.1., t tests; Friedman 2 way analysis of variance by ranks; analysis of variance - F tests). However, mean score and input/output time response ratings separately differentiated the tasks and tasks 1 - 5 inclusive completely correlate.

() = Rank

	TYPE OF TASK				
	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5
Mean Score %	~~66.5~~ 64.7 (2)	87.6 (1)	~~55.4~~ 53.7 (4)	64.4 (3)	35.0 (5)
Mean time in minutes	84.8 (4)	75.8 (5)	114.5 (2)	91.2 (3)	128.6 (1)

TABLE 1. The mean score %, and the mean time percent for the experimental population in Tasks 1 - 5 inclusive.

TASK	SCORE RANK	TIME RANK
2	1	5
1	2	4
4	3	3
3	4	2
5	5	1

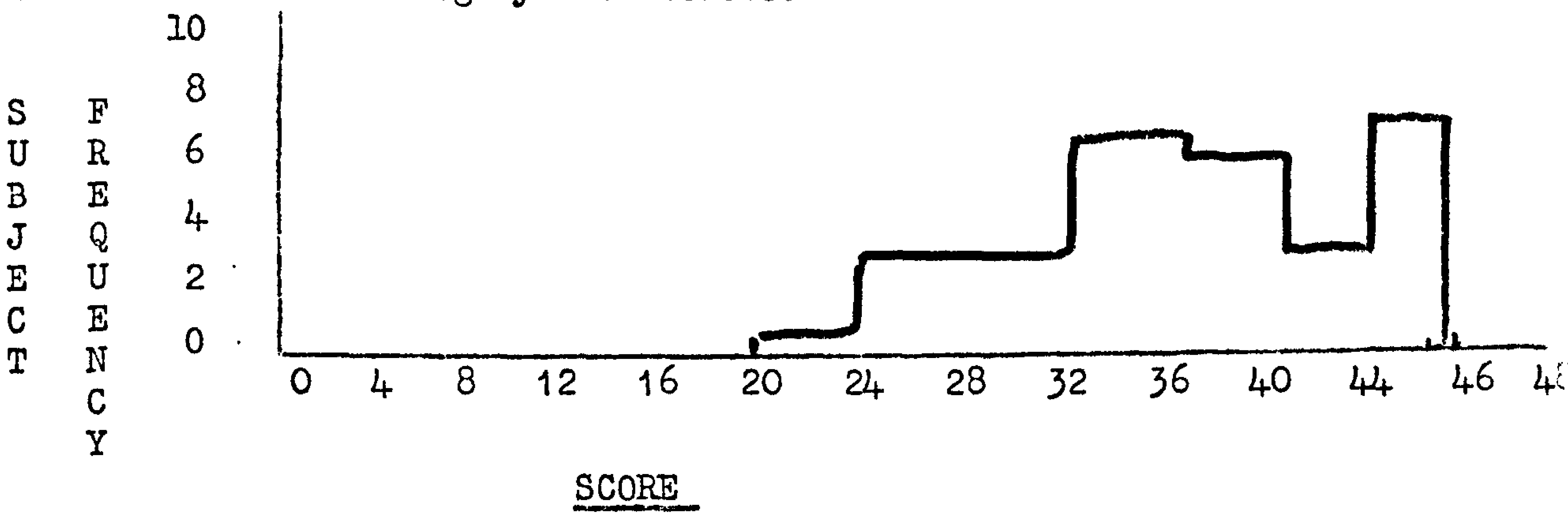
TABLE 2 . The rank number for score and time in the 5 Tasks.

Ranking time against score on the first five tasks indicated that the harder the task, the longer it took to perform it.

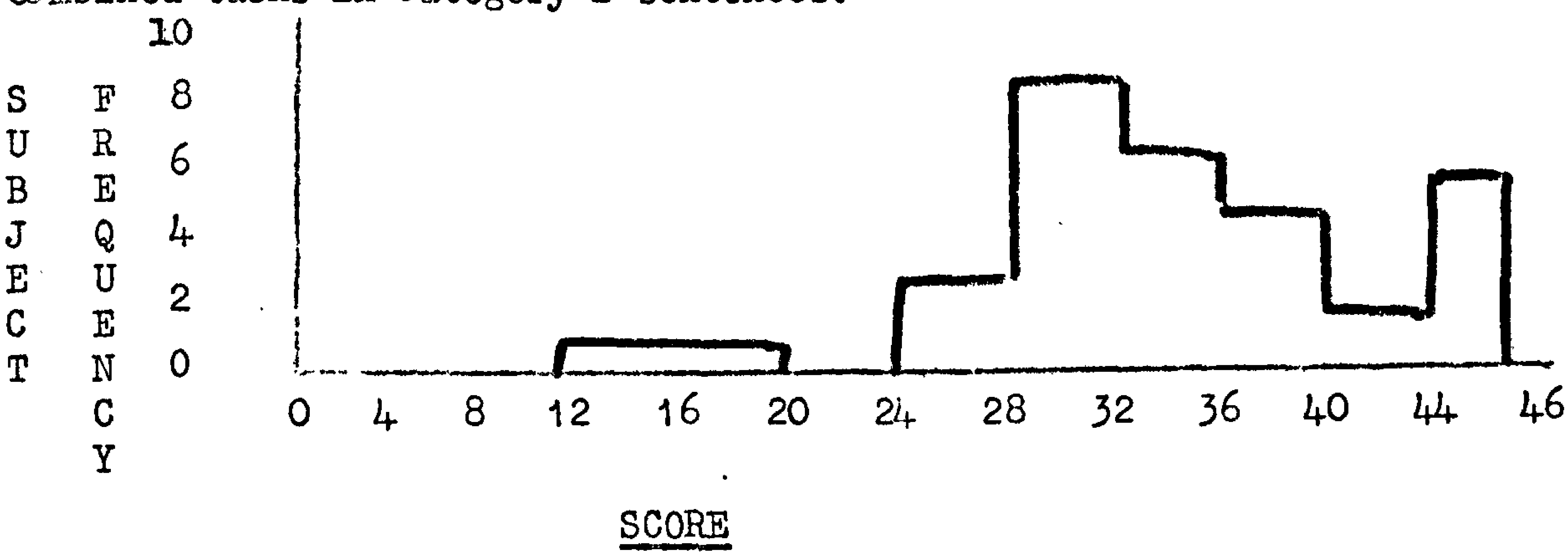
5.3.2. <u>An Analysis of the score in A, B and C Categories of sentences.</u>

The score frequency distribution of the experimental population in Category A, B and C sentences for the combined tasks indicated that sentences of increasing complexity were increasingly difficult to perform (Appendix 5.3.2.) Tables 3,4 and 5, show the score frequency for Category A, B and C sentences respectively.

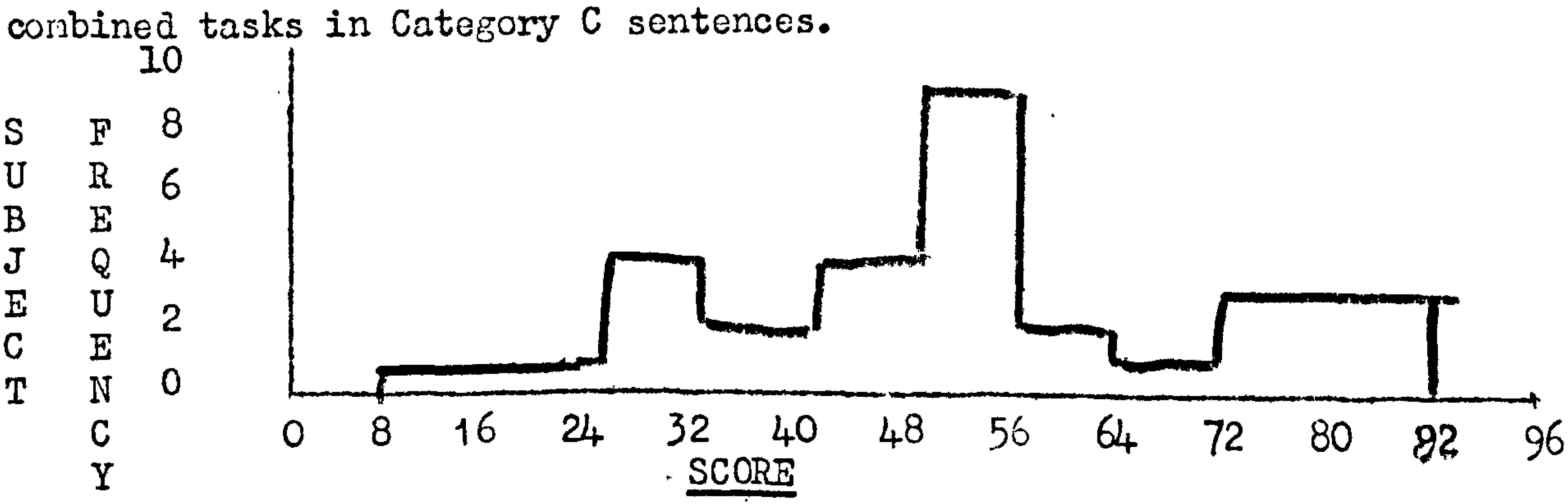
<u>Table 3 .</u> Histogram showing the score frequency distribution for the combined tasks in Category A sentences.



<u>TABLE 4 .</u> Histogram showing the score frequency distribution for the combined tasks in Category B sentences.



<u>TABLE 5 .</u> Histogram showing the score frequency distribution for the combined tasks in Category C sentences.



Category C is more discriminating, since it differentiates the population over a wider range of performance. These results indicated that, in order to perform adequately at the more complex level of sentence organization, some change in monitoring activity was necessary in order to accommodate the increase in complexity. An analysis of the reading protocols provided more evidence to support this inference.

The rank correlation of individual scores in Category B and C (Spearmans .786 significant beyond .001) showed an individual trend of very significant increasing difficulty in performance. A and B scores plotted against C scores showed that Category C sentences were more discriminating.

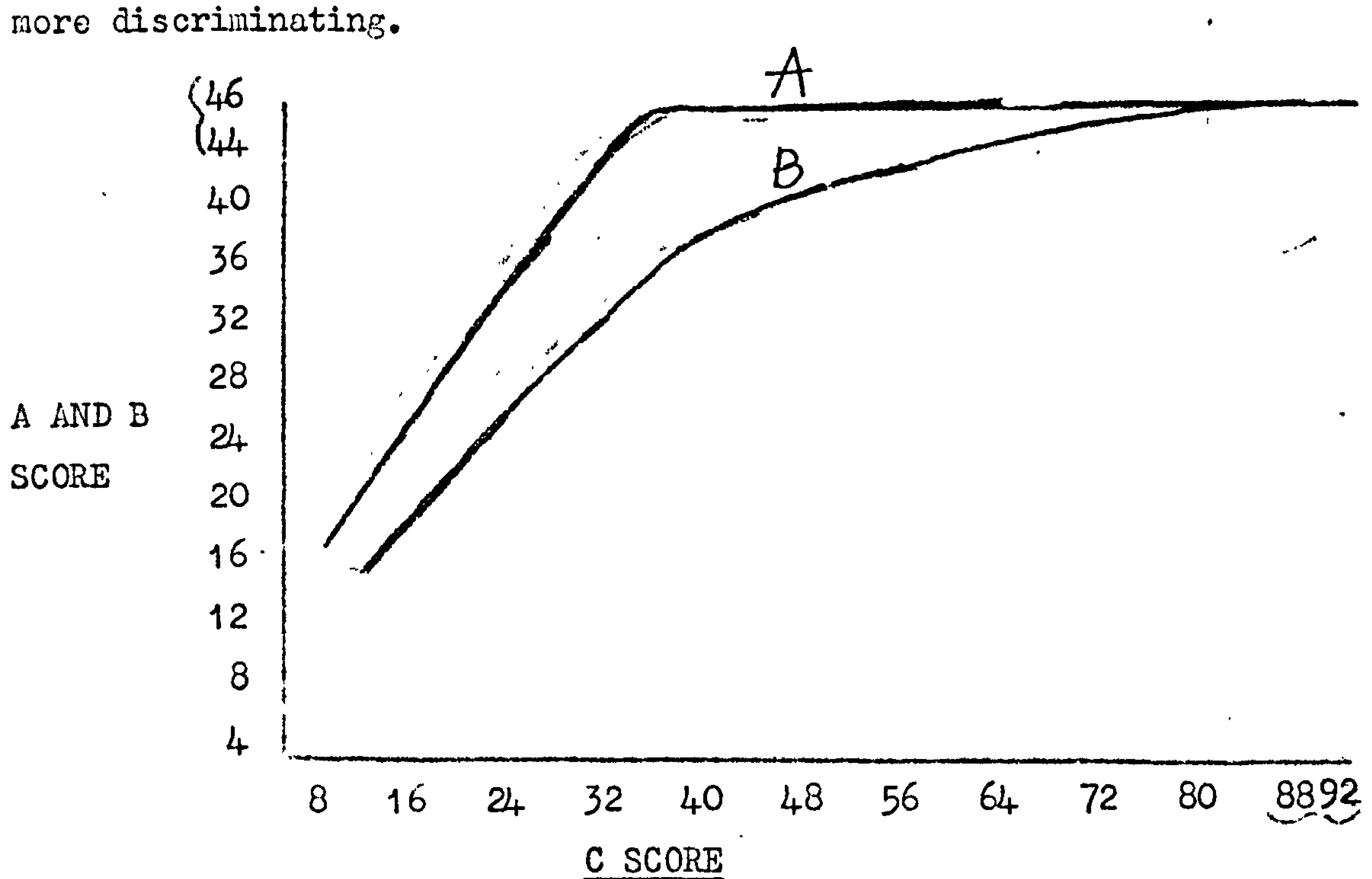


TABLE 6 . The C scores plotted as a function of the A and B scores respectively.

5.3.3. An Analysis of the score in normal, syntactically and semantically distorted sentences.

An evaluation of the normal (a/b), syntactically distorted (c) and semantically distorted (d) sentences for the combined A, B and C sentence categories, for all tasks showed no differentiation of performance.

When A, B and C categories of sentences are combined, the differentiation of performance does not follow the same pattern for each of the six tasks. In Task 3, semantic distortion of sentences, lowered the performance (p .001). In Task 4 semantic and syntactic distortion of sentences, lowered the performance (p .02 and .002). Tasks 1, 2, 5 and 6 showed no differentiation of performance (Appendix C, 5.3.3.). It appeared, therefore, that learning for knowledge only (Tasks 1 and 2) was not markedly affected by distorting the syntax and semantics of sentences, while learning for comprehension in terms of translation of the original knowledge was to some extent affected. Learning for generalisation (Task 5) was equally difficult to perform on normal and distorted sentences. Sentence analysis (Task 6) was not affected by semantic nor syntactic distortion. These results indicated that, according to the task type, some changes in monitoring activity was necessary in order to accommodate syntactic and semantic distortion of sentences.

This behaviour, which was analysed in terms of the total score of the combined A, B and C category of sentences, for each task, did not follow the same pattern when each category was considered separately. (Appendix C, 5.3.3.). In Category A, semantic distortion lowered the performance in Task 3 (p .01), and semantic and syntactic distortion tended to lower the performance in Task 4. In Category B, semantic and syntactic distortion lowered the performance (p .02, .001) in Task 3, and syntactic distortion lowered the performance (p .001) in Task 4. In category A and B syntactic distortion lowered the performance in Task 6 (p .05, .01 ,respectively). In Category C, no clear differentiation of performance was detected. At this level of sentence complexity, learning to perform most tasks (with the exception of Tasks 2 and 6) was difficult.

It was considered, that a higher level of discrimination would have been detected, within sentences of intermediate size and complexity to that of Category B and C, (possibly 30 - 40 words, 2 - 3 clauses).

It was concluded that, in 10 word 1 clause sentences, most tasks could either be accommodated by the same tactic for normal as well as syntactically and semantically distorted sentences, or that tactic adjustments were effectively made.

In 20 word 2 clause sentences, Tasks 3, 4 and 6 called for changes in tactics, when the syntax and/or meaningfulness of the sentence was disrupted.

In 10 and 20 word sentences, Task 5 called for changes in tactic, in the normal and syntactically distorted sentences.

In 50 word 4 - 5 clause sentences, all tasks, with the exception of the recognition of original data, called for changes in tactic in the normal as well as the syntactically and semantically distorted sentences.

On tabulating the C scores according to the individual distribution of the normal (a/b), syntactically (c) and semantically disrupted sentences, several interesting features emerged.

a) The distinctive separation of the three groups according to scores.

b) The scoring in d (semantic distortion) was lower than in a/b (normal) and c (syntactic distortion), particularly in the top group.

(c)The partial effectiveness of a/b, c and d sentences in the middle group.

(d)The total ineffectiveness of a/b, c and d sentences in the lower group.

These findings were used in the systematic analysis of the reading protocols.

Table 7 shows the individual score distribution of the normal (a/b), and syntactic (c) and semantic (d) distorted sentences in Category C.

CATEGORY C SENTENCES

SUBJECTS	Total combined score %	a/b score %	c score %	d score %
28		100	100	82
9		94	91	89
20	> 79%	91	91	82
1		81	88	79
26		81	91	75
24		88	72	79
23		63	91	82
3		72	63	57
21		66	78	50
8		63	59	61
11		53	59	61
5		50	59	64
10	> 50%	53	50	71
19		59	59	50
16		56	59	50
12		53	50	71
6		53	59	61
18		50	56	57
7		47	47	61
13		50	44	61
22		47	47	61
15		38	44	54
2		38	41	36
27		38	28	50
17	< 50%	34	34	32
30		34	31	29
14		31	34	29
25		38	28	25
4		16	22	18
29		19	13	18

TABLE . The individual score distribution of normal (a/b) syntactically (c) & semantically (d) distorted sentences in Category C, in the experimental population.

5.3.4. <u>An Analysis of the score in relation to the six tasks.</u>

The score analysis for each task for the combined A, B and C Categories of sentences indicated that it was possible to identify the tasks in terms of the efficiency of performance.

The individual score record for each sentence on each task is reproduced in Appendix 5.3. The Summary of the analysis of variance - F-tests is reproduced in Appendix 5.3.4. The Friedman two-way analysis of variance by ranks is reproduced in Appendix 5.3.1.

Table 8 shows the total mean score percent, standard deviation percent, t-and probability values per task for the combined six groups for each batch of eleven sentences. Categories A and B sentences did not discriminate all tasks effectively. All tasks were discriminated in Category C. Table 9, shows the mean score percent, standard deviation percent, t-and p-values per task for Category C sentences only.

Category A, B and C	TASK					
Sentences	1	2	3	4	5	6
Total Mean Score %	64.7	87.6	53.7	64.4	35.0	84.4
Standard deviation %	4.87	4.30	4.62	6.89	15.85	11.15

t 7.280
p .001

t 2.701
p .02

t 5.528
p .001

t 3.372
p .01

t 5.849
p .001

t 3.002
p .01

t 4.257, p .002

t 0.900
p > .25

t 7.178, p .001

t 2.769, p .02

t 5.089
p .001

t 4.072
p .002

t 2.804
p .02

TABLE 8. The total mean score percent, standard deviation percent, t-and p-values per task for the combined six groups.

TASK						
Category C Sentences	1	2	3	4	5	6
Total Mean Score %	50	79.7	42	51.2	23.0	79.4
Standard deviation %	8.24	7.43	6.18	8.99	13.47	11.78

t 6.00 p .001 t 1.68 p .10 t 7.056 p .001

t 1.305, p .25

t 5.284, p .001

t 3.797, p .002 t 4.614, p .001

t 8.225, p .001 t 0.16, p>.25

t 3.138 p .01 t 5.996, p .001

t 4.00 p .002 t 4.14 p .002

TABLE 9. The total mean score percent, standard deviation, t-and p-values per task for the combined six groups in Category C sentences.

Comparison of Tasks 1 and 2 indicated that it tended to be easier to recognise than recall knowledge.

Comparison of Tasks 3 and 4 indicated that it was easier to recognise than recall translation.

Comparison of Tasks 1 and 3 indicated that it tended to be more difficult to translate than recall original knowledge.

Comparison of Tasks 2 and 4 indicated that it was more difficult to recognise a translation than to recognise original knowledge.

Comparison of Tasks 1, 2, 3 and 4 with 5 indicated that it was most difficult to generalise.

Comparison of Tasks 1, 2, 3 and 4 with 6 indicated that Task 6 was as easy to perform as Task 2.

Comparison of Tasks 5 and 6 indicated that the application of sentence analysis was easier to perform than a generalisation of the sentence.

Summary of Score data.

Score differences according to the category of sentences (A,B,C), the structure of sentences (normal, syntactic distortion, semantic distortion) and the six task types show that :

i) the C category discriminates the experimental population;

ii) structural differences are emphasized in Tasks 3 and 4, particularly in the B category;

iii) all task types differentiate, particularly in the C category;

iv) high and medium scoring subjects in the C category show structural differences between the normal and syntactic distortion on the one hand, and semantic distortion on the other.

These results were used as criteria for the analysis of protocols.

5.3.5. An Analysis of the combined input/output time per task.

A comparison of the six tasks indicated that recognition at the translation level of comprehension tended to take less time than recall at the translation level of comprehension. Translation recall of the original data tended to take longer than recall of the original data. The time taken for the analysis of the syntax was significantly the longest. Generalisation took significantly longer than recall and recognition of the original data and the recognition of a translation of the original data. Tables 10 and 11 show this for the combined A, B and C categories of sentences. In order to compare Task 5 with each of the other tasks, it was necessary to eliminate the time taken on the semantically distorted sentences from each of these tasks. This was because these sentences were not tested in Task 5 since it is not possible to generalise meaningless sentences. Similar results for Category A, B and C sentences separately are shown in Appendix 5.3.5.

The Friedman analysis of variance by ranks is reproduced in Appendix 5.3.1. The summary of the analysis of variance -F- tests is reproduced in Appendix 5.3.5. These tests indicate significant differences at the 1% level between the tasks.

Category A, B & C sentences.	TYPE OF TASK					
	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5 *no (d)	TASK 6
Mean Time	138.4	119.1	176.1	137.9	128.6	214.8
Standard deviation	34.98	18.69	39.11	26.69	16.489	39.47

t 1.018 p .25

t 2.826 p .02

t 1.908 p .10

t 1.810, p .10

t 1.385, p .25

t 3.246, p .01

t 4.732, p .001

t 1.660, p .25-.10

t 3.616, p .01

TABLE 10. The mean time (in minutes), standard deviation, t- and p- values for the six groups according to the type of task, for the combined A, B and C sentence categories.

Category A, B & C sentences	TYPE OF TASK					
	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5	TASK 6
Mean time (-d)	84.8	75.8	114.5	91.2	128.6	145.7
Standard deviation (-d)	26.23	13.98	28.44	16.35	16.489	22.64

t 3.168
p .01

t 5.494
p .001

t 0.961
p >.25

t 3.610
p .01

t 1.368
p .10

TABLE 11. The mean time (in minutes), standard deviation, t- and p-values for the six groups according to the type of task with d (semantic distortion) sentences excluded, for the combined A, B and C sentence categories.

Summary of Score and Time data.

Data concerning the dependent variables of score and combined input/output time have been evaluated in relation to the independent variables of task type, task order, category of sentence (A, B, C) and structure of sentence, (normal, syntactic and semantic distortion.

i) It was shown that there was no task order effect.

ii) For the combined A, B and C categories of sentence it was shown that the harder the task (from Task 1 - 5) the longer it took to perform it.

iii) Only Task 5 differentiated within the A and B categories of sentences in terms of score and time.

iv) Syntactic and semantic distortion differentiated from normal sentences in Tasks 3 and 4 within the A and B categories.

v) Within the C category of sentence, all tasks were differentiated in terms of score and Tasks 3, 5 and 6, in terms of time.

vi) Syntactic and semantic distortion were not clearly differentiated in C, but high and medium scorers tended to be less effective in the semantically distorted sentences rather than the syntactically distorted sentences.

vii) High scorers in C category were more effective in normal, syntactic and semantic sentences than the medium scorers. Medium scorers were more effective in normal, syntactic and semantic sentences than the low scorers. These results were used as criteria for the analysis of the reading records (protocols).

5.3.6. An Analysis of the reading protocols.

The protocols were inspected according to the following criteria:-

CRITERIA

1	2	3	4	5	6
Category of Sentence.	Structure of Sentence	Task Type	Task Order	Individual distribution of scores	Combined input/ output time in Tasks1-6
A 10 word	a/b normal syntax & semantic	1 2 3	1st 2nd 3rd	at the A category	at the A category
B 20 word	c syntax distortion	4 5	4th 5th	at the B category	at the B category
C 50 word	d semantic distortion	6	6th	at the C category	at the C category

CATEGORY A PROTOCOLS (10 word sentences)

1. The majority of the protocols were of the smooth type (álfa) in all tasks,(i.e. an even read from beginning to end). No specific reading protocol type was identified for any one of the six tasks.

2. One type of reading protocol which was distinguished in the experimental population, was a 'verb reposition' read (thélta). This was noted in the reading records of some of the medium and high scorers within the syntactically distorted sentences.

3. Another type of reading protocol was distinguished in the experimental population. This was noted in some of the medium and high scorers, within the semantically distorted sentences. There were three variants, word by word (vita), phrase by phrase (ghána) or several repeated smooth reads (álfa). These variants were considered to be less elaborate forms of the rote read type (oméghа), which was distinguished in the semantically distorted sentences of the C category.

4. The medium scorers showed difficulty in translating and generalising from original data and lost most marks in Tasks 3 and 5. The longer combined input/output time which discriminated the population in Tasks 3 and 5, could have been due to a combination of factors. Differences in reading rate (input), terminal response rate (output) and the protocol adjustments described in sub-headings 2 and 3.

5. The reading protocols of the low scorers showed a similarity of pattern on all tasks and all sentence structures. Two types of read pattern were evident; either all sentences in all tasks were read in a word by word (vita) manner, or phrase by phrase (ghána), or all sentences in all tasks were read in a smooth manner (álfa).

CATEGORY B PROTOCOLS (2o word sentences)

1. As in the A category of protocols, the majority of the protocols were of the smooth type (álfa) in all tasks (i.e. an even read from beginning to end). However, a specific type of protocol was identified in Tasks 5 and 6.

2. As in the A category of protocols, one type of reading protocol was distinguished in the experimental population. This was the verb reposition read (thélta) which was noted in the reading records of some of the medium and top scorers, within the syntactically distorted sentences.

3. Again, as in the A category, variants of the rote read type (oméghа) were noted in the reading records of some of the medium and top scorers, within the semantically distorted sentences. These variants were word by word (vita), phrase by phrase (gháma) or several repeated smooth reads (álfa).

4. Another type of reading protocol with pronounced hesitations at the end of phrases or clauses was distinguished in the experimental population in Tasks 5 and 6. This protocol was of two kinds:

i) In Task 5, hesitations were associated with 'think' sessions and this type of record (épsilon) was noted in some of the medium and high scoring subjects.

ii) In Task 6, the hesitations were associated with written sessions, which represented the output (terminal response) activity of the task (syntax analysis). This type of read record (zita) was distributed amongst the whole experimental population.

5. The medium scorers showed difficulty in translating and generalising from original data and lost marks in Tasks 3, 4 and 5. The longer combined input/output time which discriminated the population in these tasks could have been the result of a combination of factors. Differences in reading rate (input), terminal response rate (output) and the protocol adjustments described in sub-headings 2, 3 and 4.

6. The reading protocols of the low scorers showed a similarity in pattern in all tasks and all sentence structures. As in the A category, two types of read pattern were evident: either all sentences in all tasks were read in a word by word (vita), or phrase by phrase (ghāma) manner, or all sentences in all tasks were read in a smooth manner (ālfa). In the case of the latter, the protocols could not be distinguished from some of the protocols of the medium and high scorers.

Table 13 shows in diagramatic form the type of protocols which were representative of each of the six tasks within the B category and within the normal, syntactically and semantically distorted sentences.

CATEGORY C PROTOCOLS (50 word sentences)

Inspection of these protocols showed that the overall drop in performance within this category was attributable to three factors:

1) Inability to adjust to the increasing complexity of sentences,

A	$\longrightarrow$	B	$\longrightarrow$	C
10 word, 1 clause		20 word, 2 clauses		50 word, 4-5 clauses

2) Inability to adjust to the distortion of syntax or semantics,

a/b $\longrightarrow$ c a/b normal $\longrightarrow$ c syntactic distortion

$\longrightarrow$ d $\longrightarrow$ d semantic distortion.

3) Inability to adjust to the increasing difficulty of the Tasks 2, 1, 4, 3, 5.

According to the individual score distribution, three groups were divided as follows:

1. OVER 70 MARKS (The high scorers)

7 subjects

Protocols exhibited adjustments in monitoring according to the three factors enumerated above.

2. OVER 46 MARKS (The medium scorers)

14 subjects

Protocols exhibited a partial adjustment in monitoring according to the three factors enumerated above.

3. LESS 30 MARKS (The low scorers)

9 subjects

Protocols exhibited very little or no adjustment in monitoring.

Specific, effective reading protocol types were identified in:

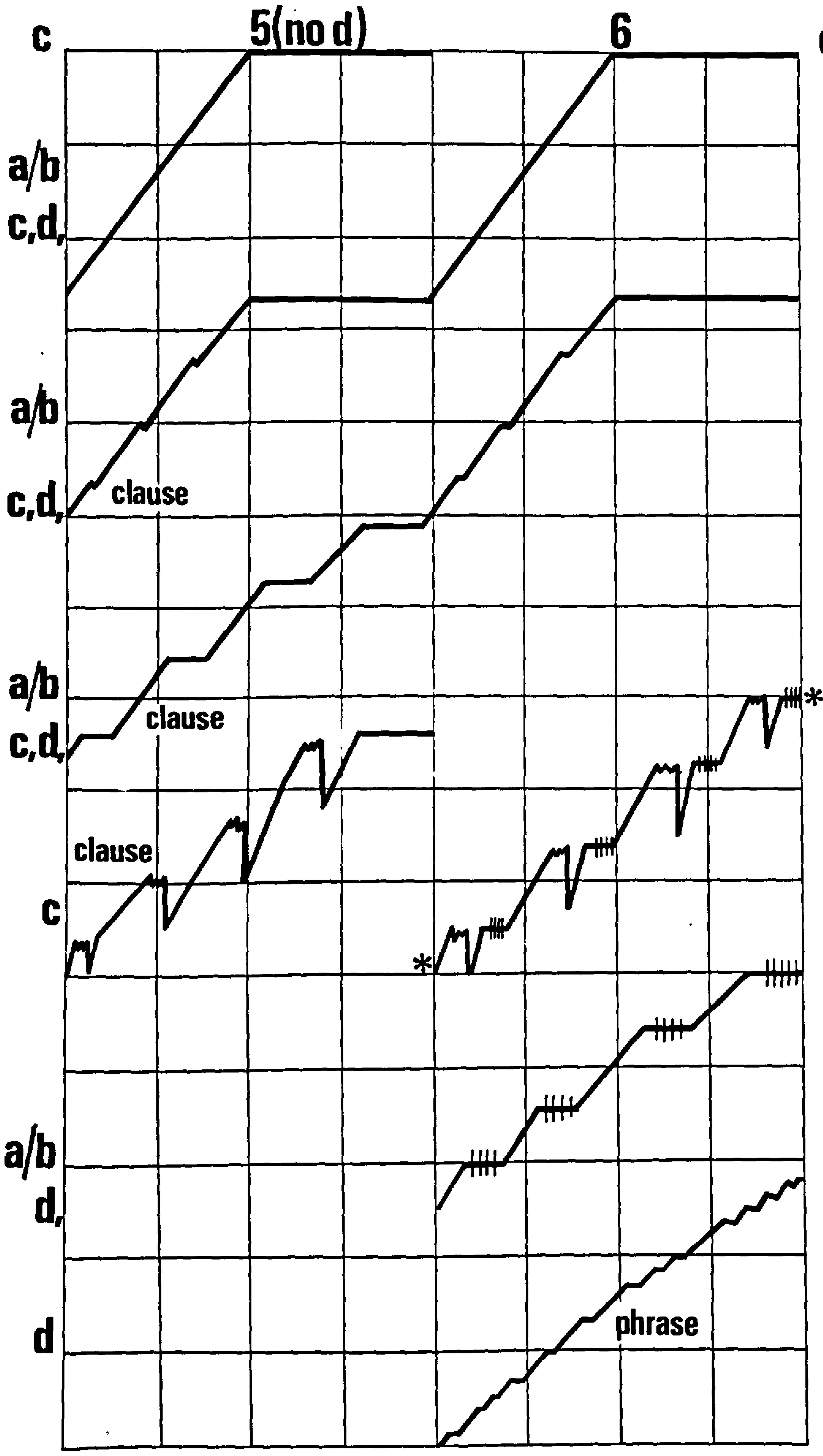
i) Task 2 (álfa), Task 5 (épsilon) and Task 6 (zita), in the high and medium scorers,

ii) normally structured sentences in all tasks (gháma),

iii) syntactically distorted sentences (thélta) and semantically distorted sentences (omégha).

MIDDLE THIRD OF EXPERIMENTAL POPULATION

TOP THIRD OF EXPERIMENTAL POPULATION
TASKS



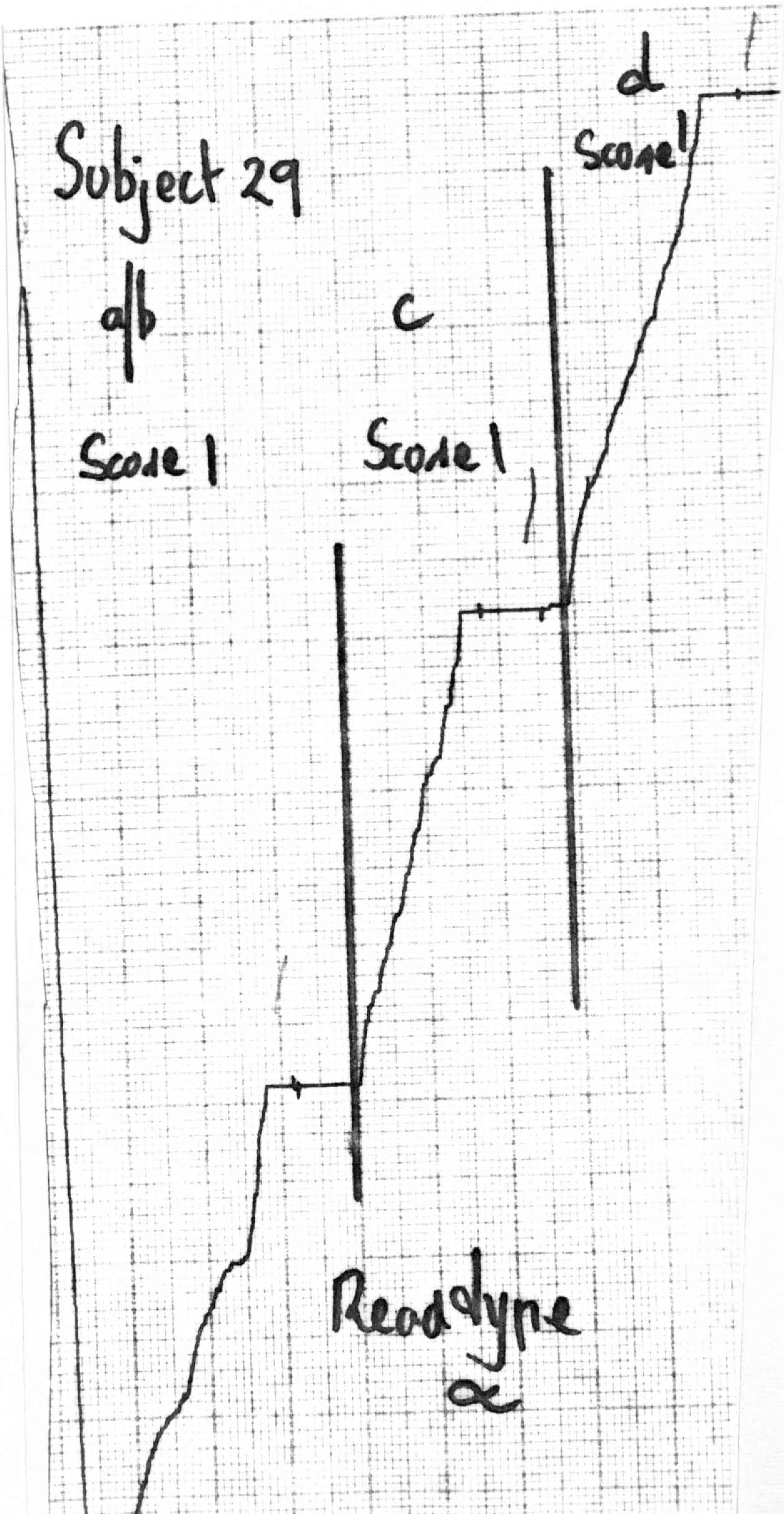
Classification of Read		Description of Read
α	alfa	smooth (sentence monitoring)
γ	ghāma	clause by clause (small unit monitoring)
ε	epsilom	clause by clause with distinct think sessions (small unit monitoring)
δ	thélta	verb reposition (Syntax monitoring)
*combination of δ and ʒ		
ʒ	zita	clause by clause with distinct written output sessions (Syntax monitoring)
γ	ghāma	phrase by phrase (small unit monitoring)

SCALE
20 WORDS ½ inch

Table[redacted] The diagramatic representation of read patterns in TASKS 5 and 6 at the C level of sentence complexity of the experimental population
14b

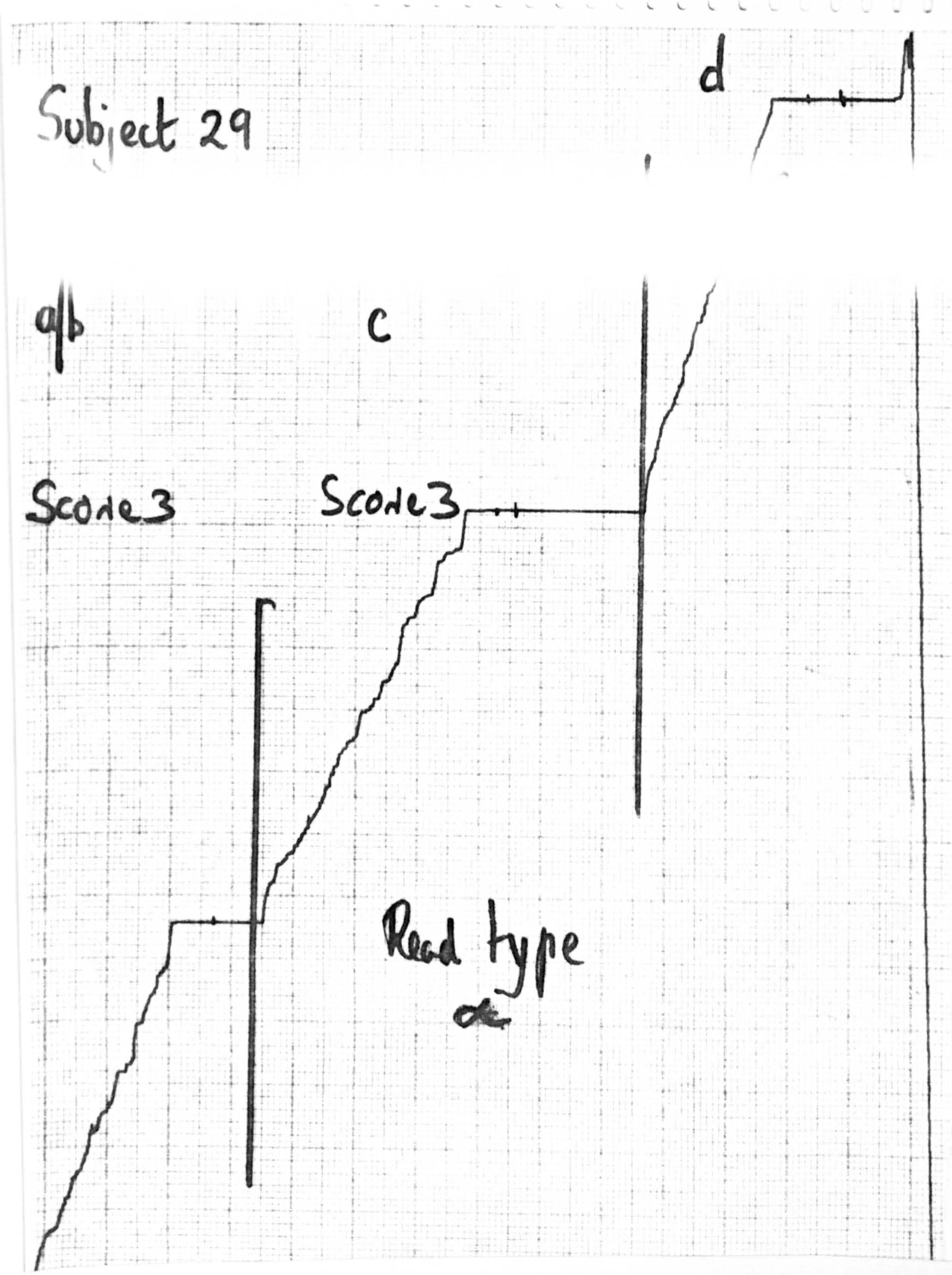
TASK 1. (Recall of Original Data

Subject	
1	High scorer
3	Medium scorers
7	
14	Low scorers.
29	


Subject 29
a/b
Score 1
c
Score 1
d
Score 1
Readyne
α

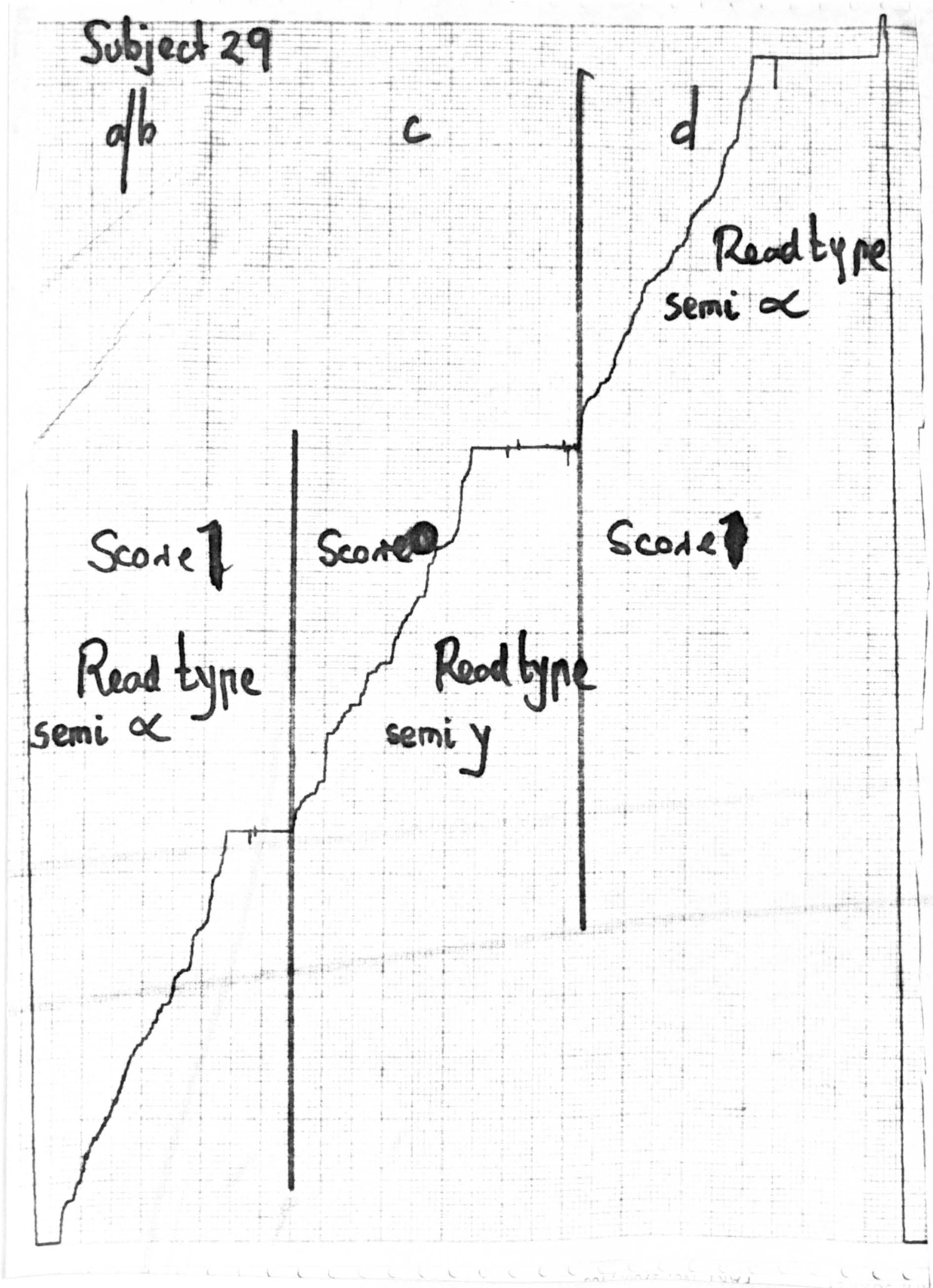
TASK 2. (Recognition of Original Data)

Subject	
1	High scorer
3	Medium scorers
7	
14	Low scorers
29	


Subject 29
d
a/b
c
Score 3
Score 3
Read type

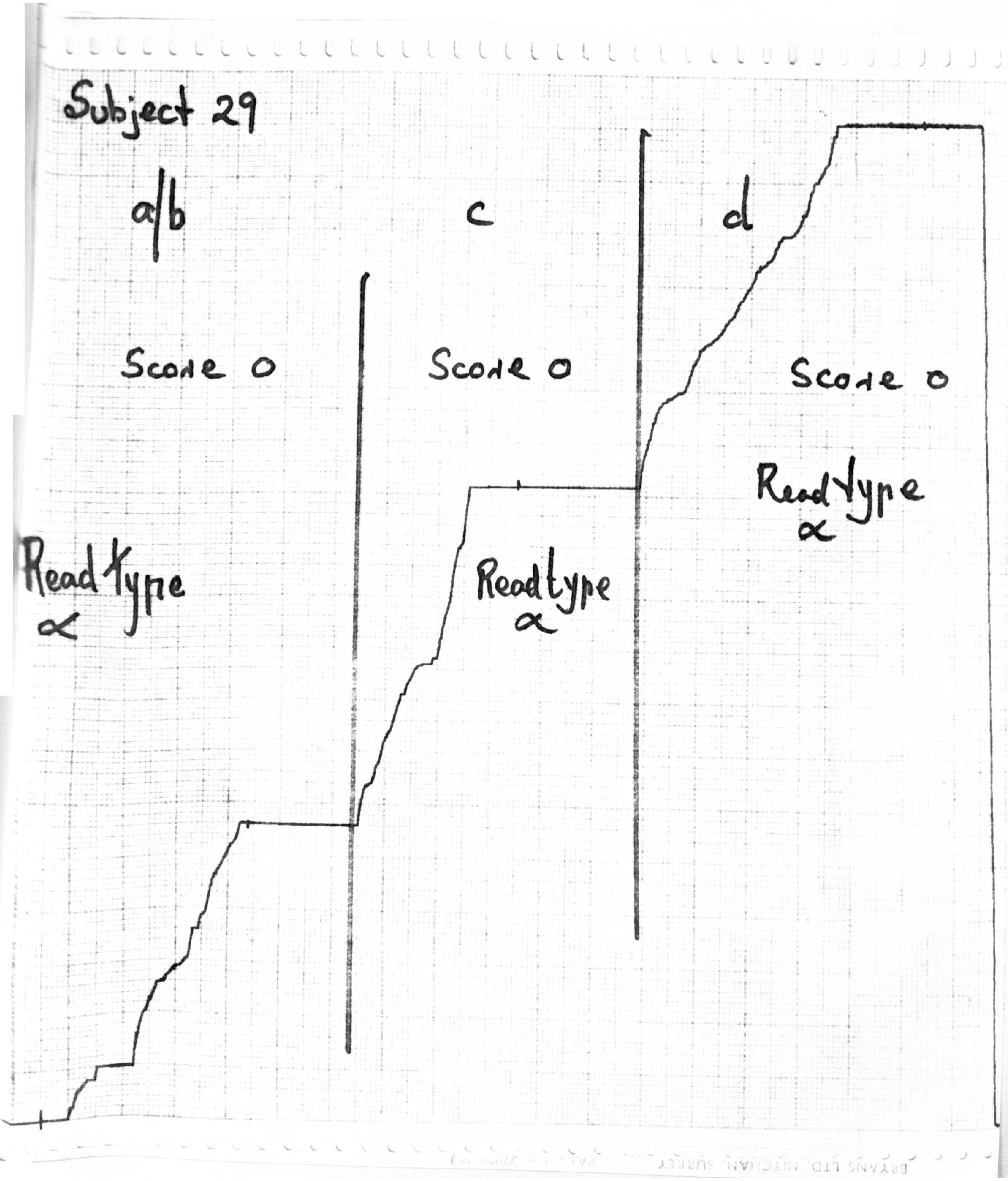
TASK 3. (Translation of original data).

Subject	
26	High scorer
3	Medium scorer
29	Low scorers
14	


Subject 29
a/b
c
d
Readtype
semi α
Score 1
Score
Score 1
Read type
semi α
Readtype
semi y

TASK 4. (Recognition of Translation of original data).

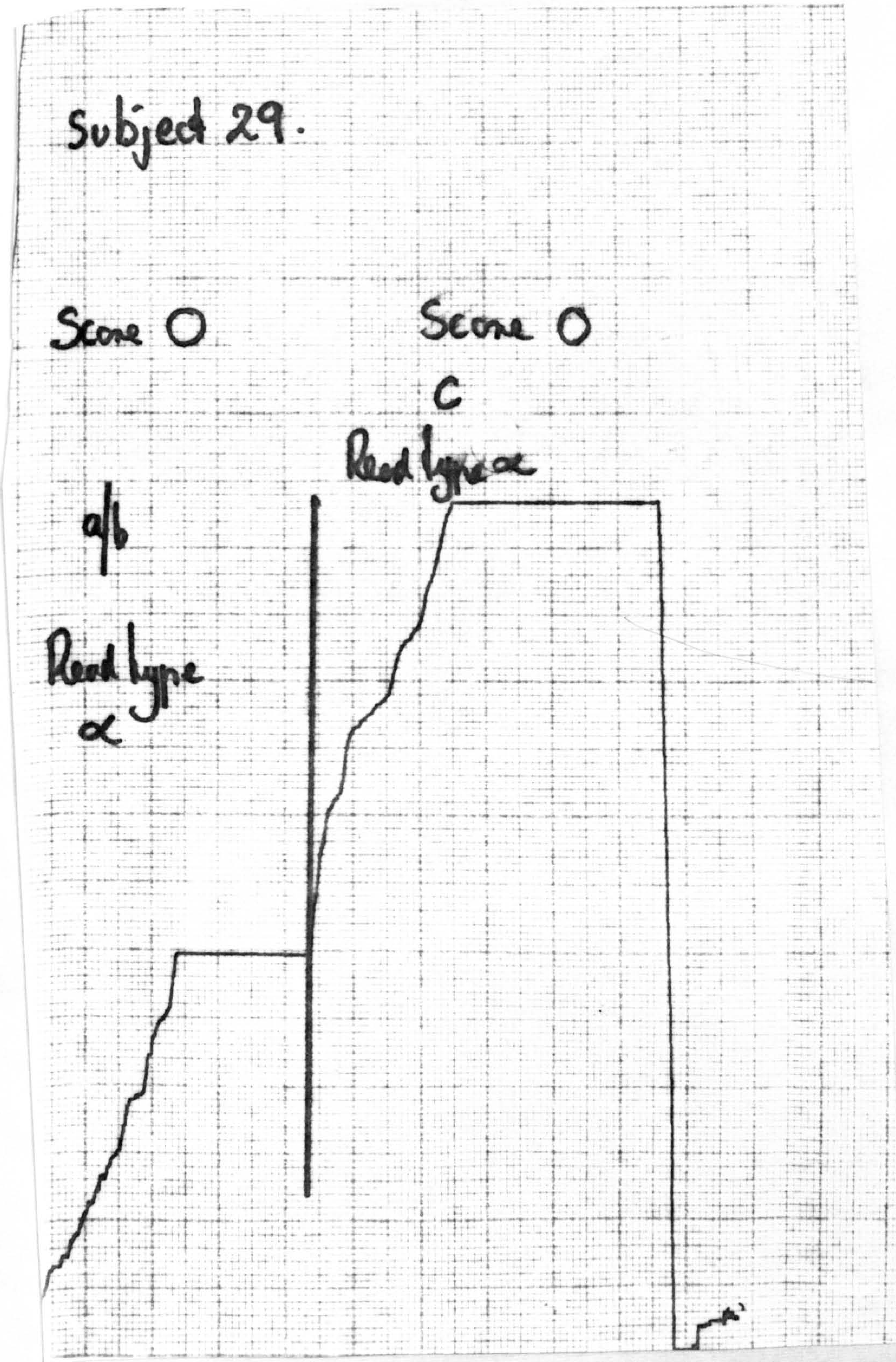
Subject	
1	High scorer
3	Medium scorer
14	Low scorers
29	



Subject 29
a/b
c
d
Score 0
Score 0
Score 0
Read type α
Readtype α
Read type α

TASK 5 (Generalisation)

Subject	
1	High scorers
26	
3	Medium scorers
16	
14	Low scorers
29	


Subject 29.
Score 0
Score 0
c
Read type α
a/b
Read type α

TASK 6. (Analysis of Grammatical Structures)

Subject	
1	High scorer
6	Medium scorers
13	
29	Low scorers
30	

Summary of Protocol, Score, and Time data.

Data concerning the dependent variables of score, combined input/output time and reading protocols have been evaluated in relation to the independent variables of task type, task order, category of sentence (A,B,C) and structure of sentence (normal, syntactic and semantic distortion).

There was a complicated relationship between score, input/output time and reading protocols on the one hand, and between these dependent variables and task type, category of sentence and structure of sentence on the other hand. The data of this experiment can be interpreted within the parameter of a broader interpretation, which takes shape from hypothetical states, which represent extremes of interaction between the dependent and independent variables, within the experimental population. These extreme states of interaction are enumerated as follows:-

1. Hypothetical state

High scores in all tasks, categories of sentence and structure of sentence, with no differentiation of the population in terms of input/output time and protocols.

Inference

All tasks were equally easy to perform and no specific cognitive skills were involved. The data in Category A approximated to this ideal state.

2. Hypothetical state

Low scores in all tasks, categories of sentence and structure of sentence, with no differentiation of the population in terms of input/output time and protocols.

Inference

All tasks were equally difficult to perform. The experimental population had not accommodated in terms of cognitive skills, to the specific demands of the tasks. The data in Category C showed some tendency to approximate to this state.

3. Hypothetical state.

High scores in all tasks, categories of sentence and structure of sentence, with a differentiation of the experimental population in input/output time and protocols.

Inference.

All tasks were equally easy to perform and specific, cognitive skills were involved. The experimental population had accommodated in terms of cognitive skills to the specific demands of the task.

The data in categories B and C can be interpreted as a complex interaction between the extreme states of 2 and 3.

A further inference is tentatively drawn, namely that in a category of sentence intermediate in size and complexity to B and C categories, the experimental data would have approximated to the hypothetical state of 3.

The evaluation of the experimental data is enumerated below:-

i) Grouping the reading records according to task order, did not show any specific relationship between the protocol patterns and task order, within the A, B and C categories of sentences.

ii) Specific, effective protocol patterns were differentiated in Tasks 5 and 6, particularly in the C category. The lower score and longer input/output time which differentiated Task 5, indicated that this task was the most difficult to perform. Tasks 5 and 6 were differentiated in performance, but not in input/output time. However, effective protocols in Task 5 (epsilon) and Task 6 (zita) were differentiated in kind. Time alone was, therefore, not an effective criterion for task identification.

iii) Specific effective protocol patterns were differentiated in sentence structure, particularly in the C category. Although the performance in syntactically and semantically distorted sentences was not differentiated from normal sentences in the C category; (C. F. in the A and B category, Tasks 3 and 4), specific effective protocol patterns could be distinguished in some of the medium and high scorers. Time and score differences were obscured, as a result of the wider range of performance within the experimental population in the C category.

iv) The high scorers in the C category showed accommodation to syntactic and semantic distortion of sentences. However, the score in semantically distorted sentences was lower. This indicated that even when accommodation was made, when the semantic value of a large syntactically complex sentence was reduced, the performance of a cognitive task became more difficult.

v) The high scorers in the C category showed more elaborate and better adjusted protocols in Task 5 (épsilon) and Task 6 (zita) and to sentence structure, (normal (ghána), syntactic distortion (thélta) and semantic distortion (omégha), than the medium scorers.

vi) Significantly higher scores in Task 2 (recognition of original data) than in Task 1 (recall of original data) with no real differences in input/output time in the C category suggested that recognition was an easier cognitive task than recall. An analysis of the protocols showed, that there were more effective smooth (álfa) type protocols in Task 2 than in Task 1. The more elaborate phrase by phrase (ghána) type protocol, which was used by many of the medium and high scorers in Task 2 could be considered as examples of 'overlearning'. A parallel can be drawn between this example of 'overlearning' and that example of 'overlearning' which was inferred in the elaborate summary type protocols for objective tests, in Unit 3.

vii) Significantly higher scores in Task 4 (recognition of a translation of original data) than in Task 3 (recall of a translation of original data), with no real difference in input/output time nor in protocols suggestedthat recognition of a translation was an easier cognitive task than recall of a translation.

5.3.7. Protocol Conclusion

1. Protocol - Task Relationship

Learning ten and twenty word sentences of one and two clauses respectively in order to perform different tasks, resulted in differences in effectiveness of performance and combined input/output times, in some tasks. However, a variety of reading protocols were associated with effective performance in each task, which meant that no specific protocol/task relationship could be identified. Adjustment to syntactic and semantic distortion was made by some of the most effective subjects, but in general, effective performances did not depend on this. It appeared that 10 and 20 word sentences could be read in the same way for all tasks. Time differences between some of the tasks could be accounted for by differences in reading rate (input) or response rate (output). However, since no detailed analysis was made of the separate input and output phases for each sentence, no further conclusions could be made. At the 50 word, 4/5 clause level of complexity, particular protocols could be specifically related to certain tasks, as well as to the structure of the sentence. It appeared, therefore, that the larger and more complex the meaning unit, the more elaborate the processing required and the more necessary it was to read the sentences in different ways for different tasks.

2. Syntax Accommodation

a) In Tasks 1-4 inclusive, the recognition of the syntax of the normal sentence was related to effectiveness of performance, particularly in 50 word sentences. This was crucial for all tasks in 50 word sentences with the possible exception of Task 4.

b) When the meaningfulness of a 50 word sentence was disrupted, the syntactical structure of the sentence was used as a framework for learning activity, by the effective subject. The elaborate oméga read pattern indicated that phrase or clause units of the sentence were monitored separately and these were checked and rechecked because the clause units could not be related to the meaning pattern for the sentence as a whole. To be successful meaning had to be assigned to each separate unit and recalled separately during the output. Less effective oméga reads consisted of inadequate checking or failure to detect all clause units.

c) When the syntax of the sentence was disrupted, a reorganization of the syntax was associated with effectiveness of performance, particularly at the 50 word level, in all tasks. The elaborate théta read pattern, indicated that efforts were made to relocate the verbs within an accepted norm for the English language. Less effective théta reads consisted of failure to relocate all the verbs in the sentence. It was of interest to note that the effective protocols of a German born subject on syntactically distorted sentences, lacked a thelta read pattern. This can be accounted for by supposing that the syntactic 'internal store' of this subject was adequate to meet the abnormal syntax. Adaptation was thus made implicitly and was, therefore, not reflected in the strategies.

d) Use of the syntactic structure was apparent at the 20 and 50 word level of sentence complexity in Task 5. The elaborate epsilon read pattern indicated that phrase or clause units of the sentence were monitored separately, before they were assimilated into the generalisation, which represented the output. Evidence from discussion suggested that these units were being checked against an internal store and reverbalized in the subjects' own words. Finally, prior to the output, each unit was united into a whole meaning structure, which was again related to an internal store, so that the meaning unit could be generalised.

e) Recognition of the syntactic structure was essential at all levels of sentence complexity in Task 6. The elaborate zita read indicated clause monitoring in effective subjects. In less effective subjects the zita read was less adequate in that not all clauses were identified correctly. It was of considerable interest to note that when the operational definition of the task demanded syntax recognition, a high proportion of the subjects were successful, yet the same subjects failed to use this technique in order to be effective in other tasks at the 50 word level of sentence complexity. Training to recall, translate and generalise original data would seem to require the explicit awareness of syntax monitoring.

3. <u>The Behaviour of the Individual.</u>

Subjects could be grouped into one of three categories of behaviour:

a) <u>Inflexibility</u>

The inflexibile readers could be distinguished at the 10, 20 and 50 word level of sentence complexity, and represented the subjects with lowest scores in A, B and C categories. This inflexibility resulted in degrees of ineffectiveness in Tasks 3 (Translation) and 5 (Generalisation) at the 10, 20 word level, and in all tasks at the 50 word level.

This inflexibility was of two types: word by word monitoring, or whole sentence monitoring. It is suggested that the former may be representative of immature read habits conditioned in childhood and the latter may be representative of a minimal meaning generation, which might result from inadequate task definition, as a result of an inadequate cognitive store. Staff assessment records for these subjects testified their low grading in most subjects, although this was not always the case for the physical sciences and mathematics. The Asiatic student fell into this category of behaviour, his reading protocols in all tasks was of the smooth, sentence monitoring type.

b) Partial Flexibility

The medium scorers exhibited varying degrees of flexibility correlated with partial effectiveness at the 50 word level. Three types of inadequacy characterised the group:

i) The protocol was not adjusted adequately to the large size of the meaning unit. Ghámma read patterns lacked hesitations at all phrases or clauses.

ii) The protocol was not adjusted adequately to the syntactic or semantic distortion. In some, épsilon or onégha read patterns were not at all pursued, in others, these read patterns lacked the reorganization of all verbs or recognition of all phrases and clauses respectively.

iii) The protocols were not adjusted adequately to each task. In some, the épsilon read pattern characteristic of Task 5, was absent, in others this read pattern lacked the recognition of all clauses in the sentence. The zita read pattern was characteristic of all subjects in the group, but in some cases not all the clauses were correctly recognized.

It appeared, that the ability to adjust to sentence complexity, syntactic or semantic distortion, and different learning tasks, was only partially developed in these subjects. It is suggested that learning skills, such as syntax recognition, knowledge recall, translation and generalisation, were only partially developed. This could be accounted for by the inadequate nature of the cognitive store. This is a contributory factor which must be taken into account in training to read effectively.

c) Effective Flexibility.

The high scorers exhibited flexibility to the task, sentence category and sentence structure. Within this group, two subjects showed adjustment patterns to the type of task and to the sentence distortion only. The effective ghámma read, distinguished by the syntactic recognition of phrases specific to normal sentence was not practised, at the 10, 20 or 50 word level of sentence complexity. The normal a/b 50 word sentence was read smoothly (alfa protocol), and effectively. These subjects were biology post-graduates and it is suggested that task effectiveness, as a result of practise of the álfa read only, was indicative of a 'high level' of monitoring, made possible as a result of an elaborate 'built in' cognitive structure or 'internal store', against which quick and effective 'matching' could be made. This behaviour was similar to one of the biology post-graduate researchers quoted in Unit 3, Experiment 3, who summarized the whole chapter effectively, after one smooth alfa type of read only. Other subjects showed effective adjustment to the sentence complexity by practising effective thélta and omégha patterns and to the type of task by practising an effective épsilon read pattern for generalisation and an effective zita read pattern for sentence analysis. Score differences between syntactic and semantic distortion amongst these subjects could be accounted for by failure to adapt to the syntax of the sentence.

5.4. GENERAL CONCLUSION

As indicated in the introduction, the purpose of this study was to explore at the sentence level, specific sub-skills and to idenfify these in terms of the learner's task definition and the structure of the written material. The results of this preliminary exploration did permit some generalisations to be drawn. However, before proceeding to a discussion of the conclusions, the more obvious limitations of the study must be presented.

First, the presentation of the material in a word by word sequence was artificial compared with the normal presentation in a book; the distortion of the material was also artificial and not directly comparable with the real situation, in a reading environment.

Second, bearing in mind the number of independent and dependent variables investigated, the experimental population was relatively small.

Third, the control of serial effects in the Latin square by randomization does not eliminate the possibility that some serial effects could operate systematically. It may be noted that Tasks 3/2 occur four times and certain other pairs of tasks twice.

Fourth, the combined record of input/output activity in terms of time and protocols, obscured any further evaluation of the identity of tasks in each of these activities, separtely.

Fifth, the experimental procedure did not allow for controlling the previous knowledge of the subjects in relation to the learning materials, other than by general discussion with them and their teachers.

Sixth, the gap between the B and C categories of sentences (20 word 2 clause, 50 word 4-5 clause) was probably too large to differentiate the population in an optimally effective way, in terms of scores, input/output times, and protocols, in the 6 task types.

With these limitations in mind, several tentative conclusions can be drawn from the results of the investigation.

1. The performance, input/output time and protocol identification of the 6 learning tasks in the experimental population supported the generally accepted view, that at the molecular level the process of learning depends upon the operation of specific sub-skills. A hierarchical order of tasks is suggested in accordance with the sub-skills, which were operational for each task.

Category of Behaviour	TASK	Type of Task
Comprehension extrapolation	TASK 5	Generalisation
Comprehension interpretation	TASK 3	Recall of translation of original data.
	TASK 4	Recognition of translation of original data.
Knowledge	TASK 1	Recall of original data.
	TASK 2	Recognition of original data.

This hierarchical scheme can be accounted for as follows:-

TASK 1.

the recall of original data depended upon an immediate memory store and the rote recall of knowledge only,

TASK 2.

the recognition of original data took less time to recall from the memory store, with greater accuracy, which implied that the memory monitoring process was cued;

TASK 3.

the translation of original data depended upon an immediate memory store, the rote recall of knowledge and a further reference to a permanent memory store for the translation of knowledge into equivalent terms,

TASK 4.

the recognition of translation took less time, with greater accuracy, which implied that the memory monitoring process was cued,

TASK 5.

the generalisation of original data was dependent upon the ability to recall knowledge and translate knowledge against a permanent store of concepts, in order to extrapolate an abstraction of the original data.

The relatively low efficiency of performance, suggested that the operation of the complex task was unskilled and that subjects lacked the relavent permanent store of concepts.

TASK 6.

Analysis was difficult to place within the hierarchical schema. It depended upon the recall of original data from an immediate memory store, the recall of concepts from a more permanent memory store and the application of these concepts explicitly in a 'novel' situation. The complexity of the operation was reflected in the time taken to perform it, which places the task on level with that of generalisation. The general efficiency of analysis compared with the inefficiency of generalisation, was probably the result of the learning programme. The task can be considered as a case of reproductive (convergent) rather than productive (divergent) activity, since it depended on the application of previously learnt sets of concepts.

2. Reducing scores, as a result of the increasing level of sentence complexity, the syntactic and semantic sentence distortions, as well as the increasing level of task complexity, within the experimental population, indicated a general conservatism. This conservatism resulted in an inability to adjust to effective monitoring levels, and was reflected in the reading protocols. This conservatism could stem from an inadequate store of cognitive skills and cognitive knowledge, within the area of genetics or the inability to apply these skills and knowledge. This implies the need for the development of a training scheme at the sentence level, within which an explicit awareness of the individual's task definition, reading strategy and internal store is to be encouraged in order to learn effectively. The need to operate at the individual level, stresses the importance of learner participation.

Another aspect of the phenomenon of conservatism in learning which requires investigation, is the development of appropriate aptitude tests, in order to diagnose the individual causes for conservatism. Remedial action could then be taken. In the opinion of the experimenter, this conservatism is a major factor contributing to the assortment of ability rating in a school class, and the systematic intervention of learning processes could raise the ability rating of most students. This view was tested empirically in Unit 7, Experiment 5.

3. As inferred from the data of Experiment 3, Unit 3, task definition appears to be a personally creative operational plan which is derived from the stimulus situation, including both the instructional directives and the text, but is also largely influenced by the initial state or predisposition of the learner. Frequently, there is a misalignment between the learner's plan and the instructional objectives, resulting in inefficient reading outcomes. The plan of a 'beginner' or an expert may bring about the same post learning result, but they will differ considerably.

The expert may have read the sentence through once smoothly, the beginner may have read the sentence several times exploring the syntactic constituents and generating meanings, from which he can develop a structured understanding of the material.

4. High scores with less specific demands on sub-skills, in the recognition of original data and the recognition of the translation of the original data, in Tasks 2 and 4, is seen as a factor of major educational importance, since the multiple choice recognition form of evaluating the outcome of learning is, for a variety of practical reasons, encouraged in most institutions. It is suggested, that a constant use of this form of testing to the exclusion of other types of test, could transfer to the general learning set of the individual. This conclusion is in line with that, which was inferred from the data on learning for Objective Tests, practised at the macro level in Experiment 3, Unit 3.

5. The introduction of errors into a sentence to disrupt its constituent structure, as by redistributing the verbs, resulted in greater difficulty in assimilating the sentence, to a well formed alternative. In order to interpret the syntactically distorted sentences, the subjects had to accommodate their monitoring activity (or change their tactic), so that the original syntactic structure was resynthesized.

The introduction of semantic errors as in the semantically distorted sentence, without disturbing the essential syntactic structure, did not affect the capacity to recognise, these syntactic structures, as shown by the high performance in Task 6.

These findings relate to those of Gladney & Krulee (1967), who showed that the introduction of errors in verbs, prepositions and noun determiners in sentences, resulted in greater difficulty than if errors were introduced arbitrarily. They concluded, that certain classes of words function as markers in outlining the basic syntactic structure of sentences.

6. The syntactic and semantic content of a sentence appeared to be distinctive entities, but in relation to the operation of sub-skills, these entities are bound in a complicated relationship. Syntax analysis was not affected by reducing the semantic content and, while the experimental population was able to analyse the syntax effectively, subjects were unable to generalise effectively. However, in order to recognise maximally the semantic content of a complex verbal unit in verbal matter, the recognition of the syntax was of critical importance. Similarly, in order to learn semantically distorted complex sentences effectively, the syntax was used as a framework for a more rote type of learning.

There is considerable discussion on this syntax/semantic relationship within the field of psycholinguists, and it is suggested that further explorations at this molecular level of sentence monitoring in relation to learning, might serve to clarify some of the problems concerned. These findings relate to the hypotheses of Miller (1962) and Katz and Fodor (1963). The interpretation of meaning in its fullest sense, depends upon a 'combinatorial power' or knowledge of 'projection rules', (Unit 1, 1.2.2.) which control the relationship between syntactic and semantic constituents of a sentence.

7. The psychological implications of such linguistic discoveries as syntactic categories, kernel sentences and transforms (Chomsky 1957), are factors of both crucial and challenging investigation.

The data of Experiment 4 is cited as solid empirical evidence, for the psychological reality of syntactic categories. These categories appear to affect the process of memorisation of new verbal material. The more complex the learning task in terms of higher learning abilities, or the more complex the syntactic structure of the sentence, the more elaborate the processing of syntactic categories required, for an effective reading-to-learn outcome.

The hypothesis is made, that in order to interpret a sentence, the constituent structure of that sentence must be generated by the reader. This dependedon a recognition of the syntactic categories and of the semantic relations between them. Miller (1962) argues that in ordinary conversation, the functional unit of speech perception is usually larger than a single word or a single morpheme and more nearly the size and shape of a syntactic constituent. The findings of this reported experiment, particularly in relation to the C category of sentence complexity, are comparable with those of Miller on the way in which students repeated sentences of very complicated syntactic structure. In the first repetition, their intonation was characteristic of a list of unrelated phrases, with very poor recall. The second time, the intonation was often similar to the first, but the recall was more accurate. In the third and fourth repetitions, the sentence was repeated in larger syntactic categories, which Miller relates to an 'Aha' experience and the recall is considerably more accurate.

Miller concludes, that sentences are not arbitrary chains of verbal responses, but that they have a complex inner structure of their own. The syntactic structure of a sentence imposes groupings, that govern the interactions between the meanings of the words, in that sentence. Sentences are hierarchically organized. As the 3 dimensional space underlying the 2 dimensional pattern on the retina is induced, so a syntactic structure underlying the linear string of sounds in a sentence is induced. Miller considers, that the generation and interpretation of syntactic constituents has a psychological foundation in the 'combinatorial power' of the human mind.

8. Finally, the fact that there appears to be a paucity of research dealing with the identification of sub-skills in operational terms suggestedthat what has been done in this investigation should be viewed as an initial attempt in the area. Although care was taken in the methodology of the study, it undoubtedly can be improved upon.

5.5 SUMMARY

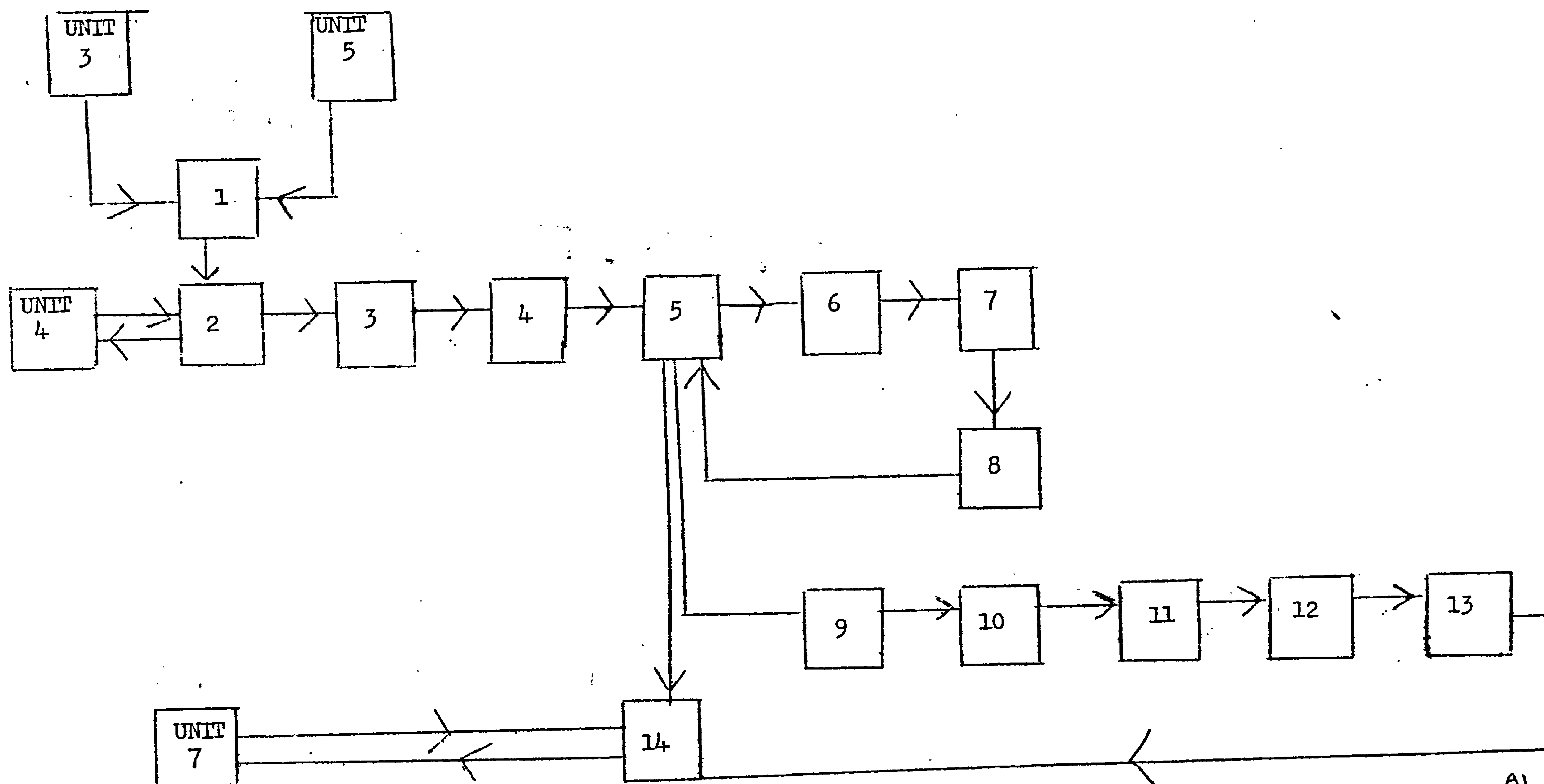
The learner's definition of the task and the complexity of meaning structure was explored at the sentence level. There was a general conservatism in the accommodation of monitoring activity, in order to meet the varied demands of the set learning tasks, on sentences of increasing complexity. However, it was possible to show that patterns of reading related to the type of learning which was achieved. The detailed analysis of effective patterns was used as the basis for designing part of the training session, used in the pilot study reported in Unit 7. The experimental data provided information about the molecular structure of reading and of the complicated relationship between the syntactic structure and semantic content of verbal material. The smaller the meaning unit the less elaborate the processing required for all tasks and conversely the larger and more complex the meaning unit, the more elaborate the processing required, for each task. However, as reading skill increases (as a result of the more efficient application of learnt skills and the development of a more adequate cognitive structure in that intellectual field), there is evidence that a smooth even pattern of reading can be associated with complex internal structuring.

On the basis of their total overall scores on all tasks, the experimental population were divided into three separate performance groupings;

1. The highest scoring group produced reading records which showed that each of them adjusted their pattern of reading to cope with changes in both the task and the structure of the material.
2. The medium scoring group varied in their partial inability to adapt their method of reading. Some failed on certain tasks, whilst others found particular sentence structures difficult to deal with. In each case failure could be associated with the recorded pattern of reading.
3. The low scoring group uniformly showed no ability to adapt their methods of reading.

This experiment yielded startling support to the idea that Advanced Level students are unskilled in the process of reading-to-learn, at the sentence level. It also showed how patterns of reading might be used to diagnose specific weaknesses in reading-to-learn skills.

A STRUCTURED GENERIC FLOW DIAGRAM OF UNIT 6.



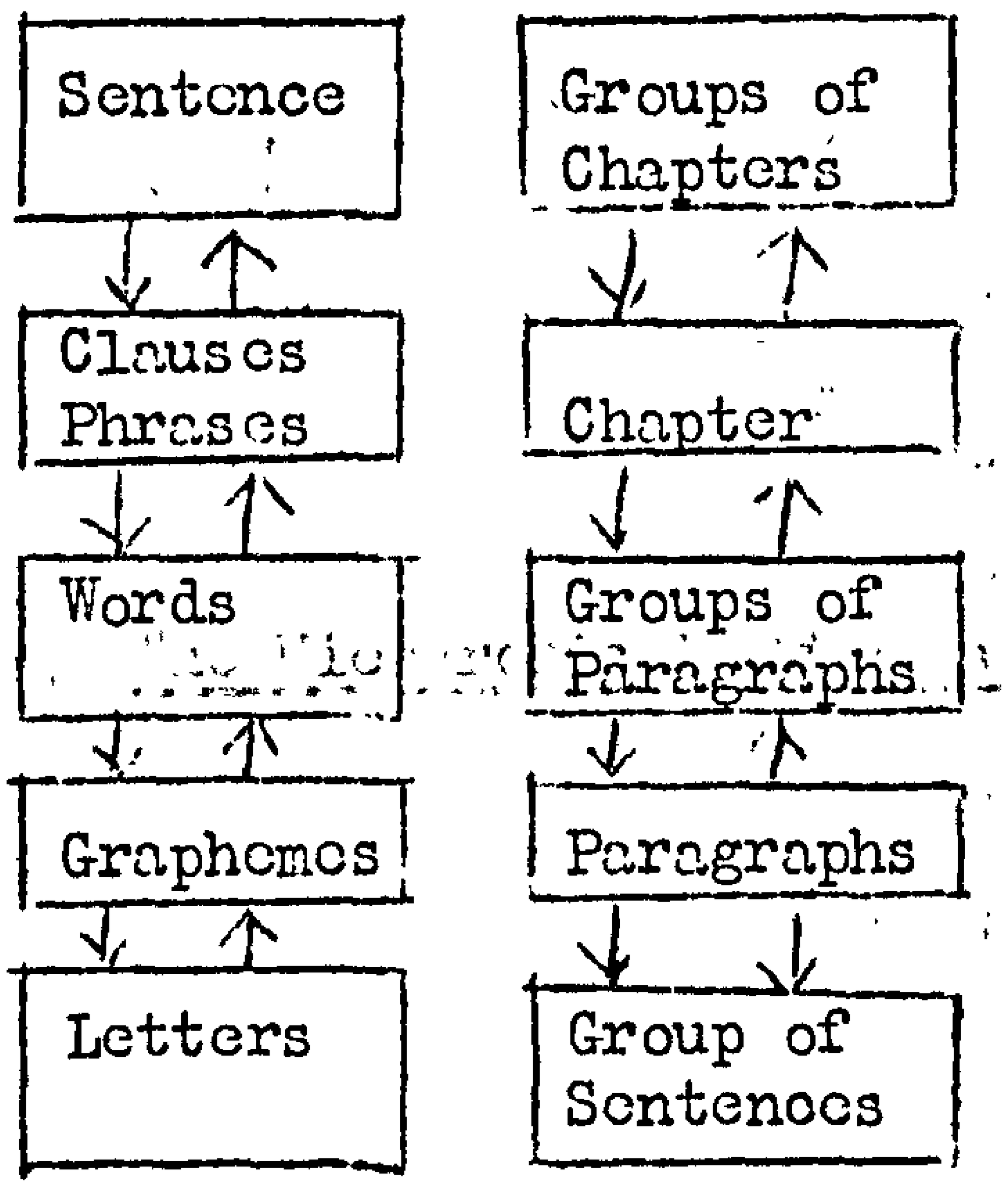
UNIT 6. Theoretical Discussion (2) A Model of the Learner - Towards a Synthesis.

1. An assessment of the results of the experiments on the reading of chapter-size texts (Unit 3), and separate sentences (Unit 5), provided a mass of evidence to support the hypothesis that reading-to-learn is an active process involving the generation of meaning. The patterns of activity revealed in the reading records suggest that some sort of search or 'matching' activity is taking place. The sequence of tactics within the strategies implies that a total learning event depends upon a cumulative activity, in which successive stages are dependent on the results of what has already taken place. For example, in Unit 3, Experiment 3, the read for 'specifics' often follows a 'smooth' exploratory read; the 'search' read often follows the read for 'specifics'; the review 'thinking' period often follows the read for 'specifics' and/or the search read; a 'smooth' review read often terminates the strategy. In Unit 5 Experiment 4, 'search' reads of various kinds often follow a 'smooth' sentence read and are often followed by a 'smooth' sentence read.

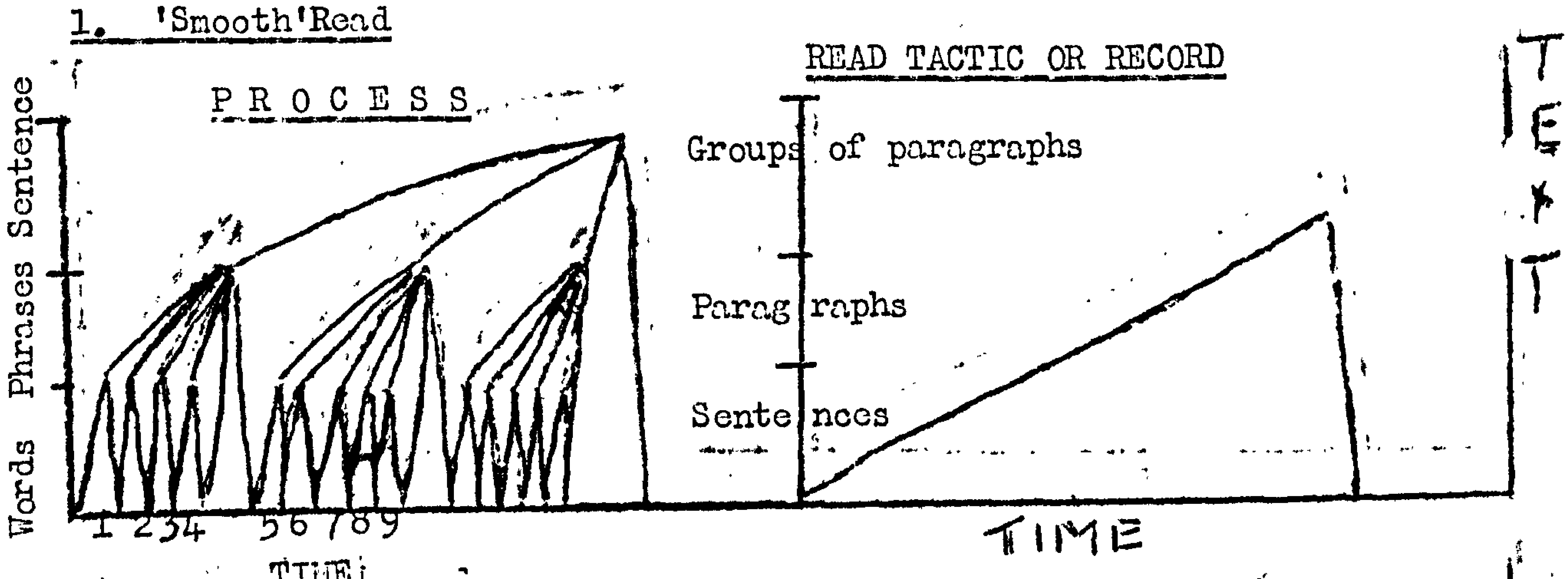
2. When the ongoing process of reading results in a 'smooth' record it is suggested that the Cognitive Structure is being 'matched' onto the text. Match leads to closure and allows the reading to continue. If the criteria underlying this 'matching' is adequate, the reader 'understands' the text. If it is totally inadequate, the reader will remain unaware of his lack of 'understanding' until asked to give specific responses. In either case no drastic revision of the Cognitive Structure is taking place. This activity can be equated with the assimilation process defined by Piaget. When a reader hesitates and produces a 'specific' read record, it is suggested that the individual has a sense of mismatch between what he or she feels is in the text, and what he or she can generate in terms of meaning immediately from the text.

This sense of mismatch leads the reader to stop and generate new meanings and/or re-read sections of the text until 'match' is achieved. The closure resulting from this matching allows the reader to proceed to the next part of the text.

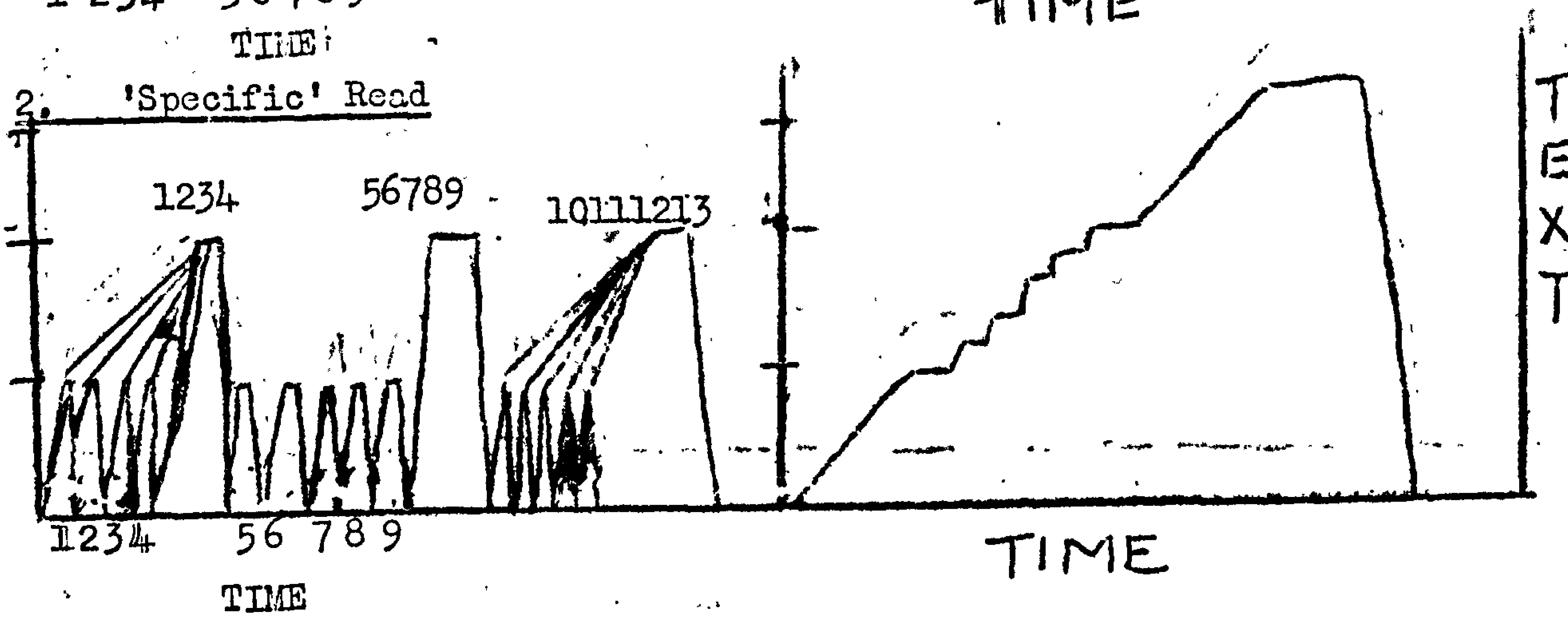
3. It is useful to consider the process of reading as being organised at a series of levels. In the sentence experiment (Unit 5, Experiment 4), words, phrases, clauses and the whole sentence could each be a separate cause of hesitation and/or backtracking. In the larger chapter-size text, sentences, paragraphs, groups of paragraphs or the whole text could equally lead to disruption of the 'smooth' read. The diagrams which follow show how monitoring (revealing mismatch) at various levels involves combining the results of a series of closures at a lower level. The 'smooth' read which is thought to result from 'match' indicates that closure is easily achieved at all levels. Hesitations result from mismatch, that involves difficulty in combining the established closures at lower levels. Search reads or backtracking can illustrate when an earlier closure can be re-opened or queried as a result of abortive attempts to combine larger size meaning units.



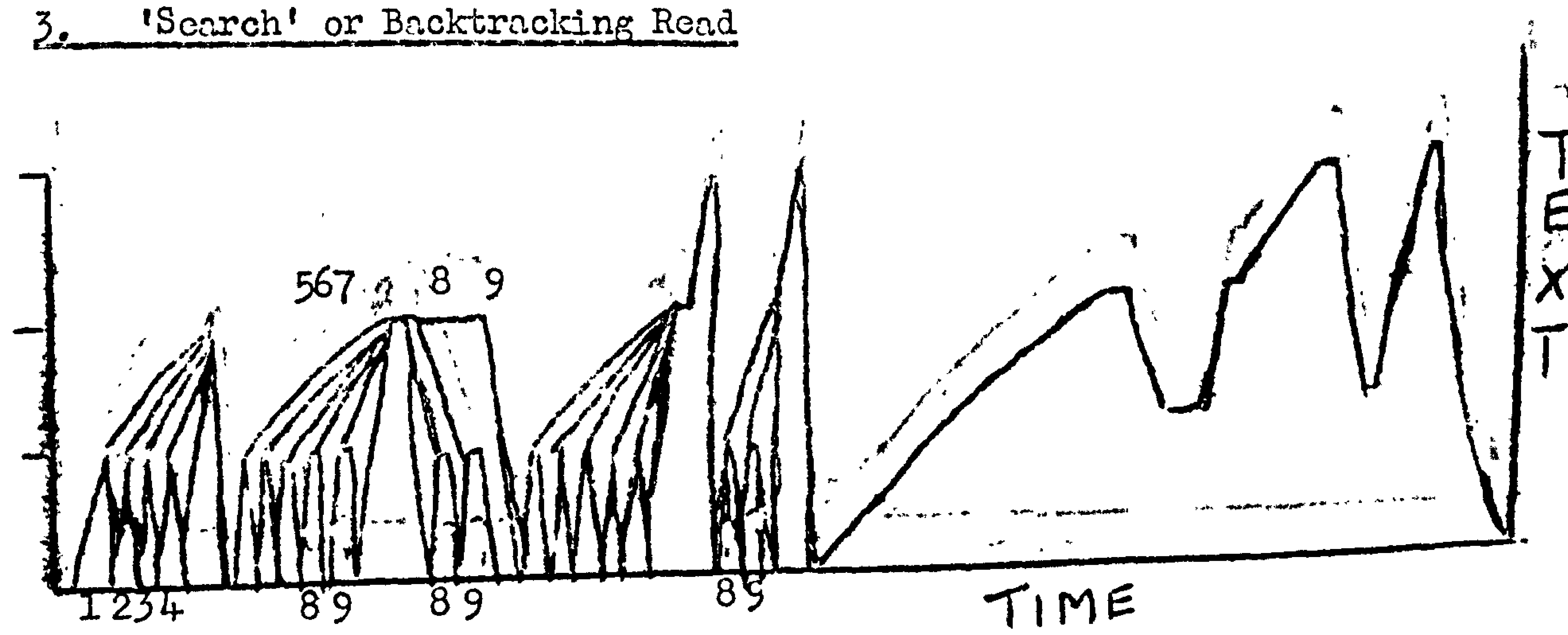
1. 'Smooth'Read



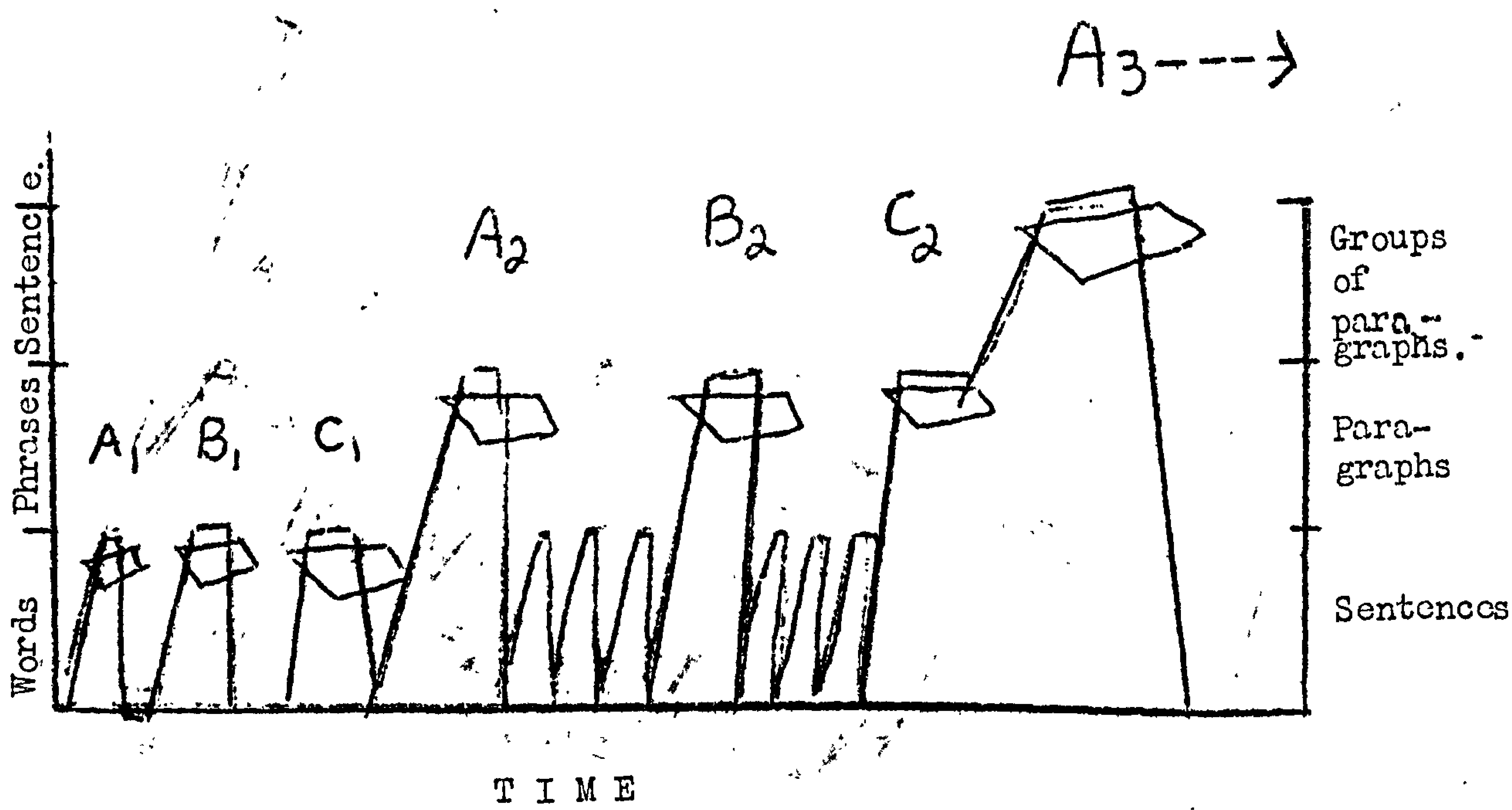
2. 'Specific' Read



3. 'Search' or Backtracking Read

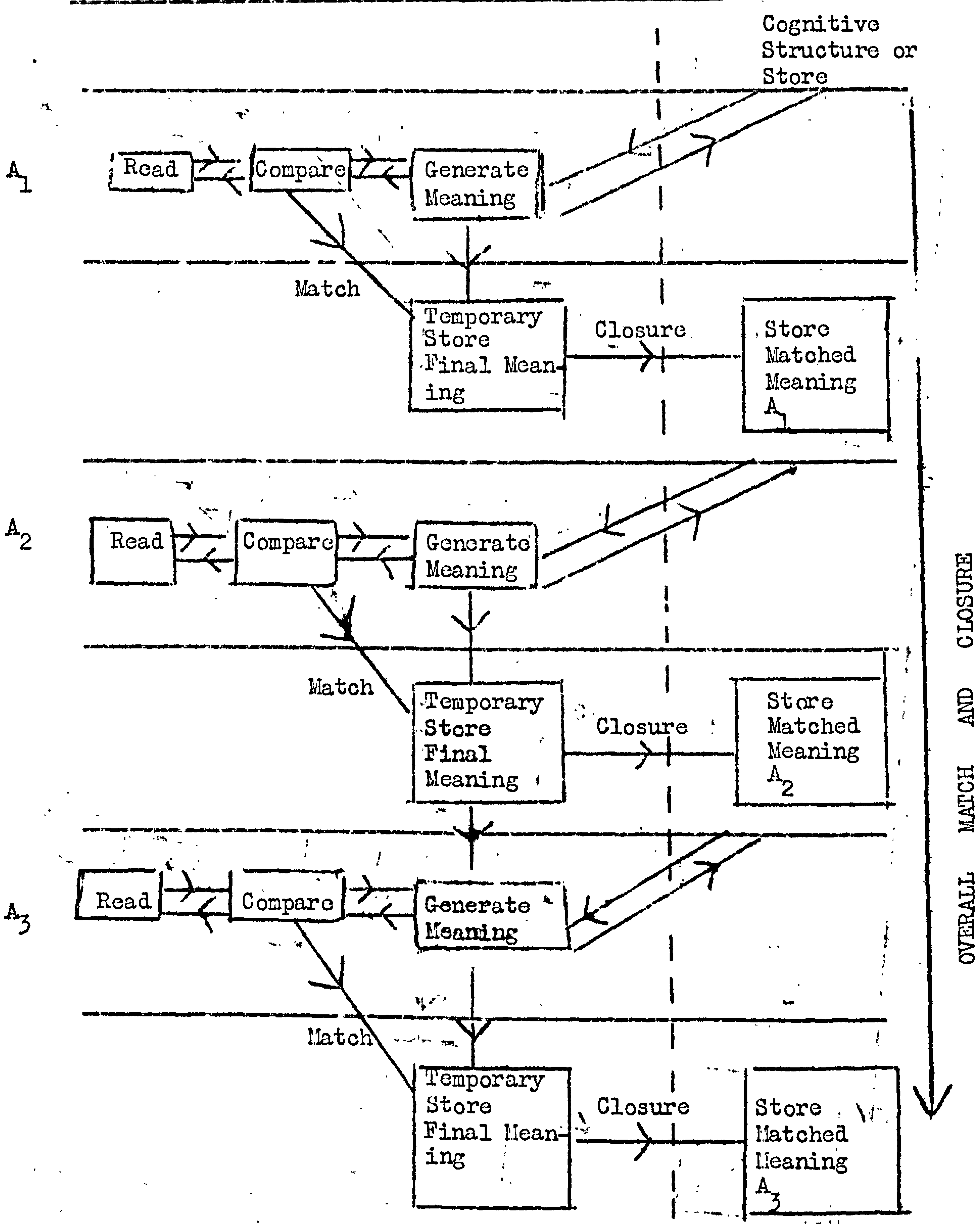


4. Although the study of meaning and reading is best thought of as hierarchy organised at a number of levels, it is possible to consider what is going on at any one level, at any one time. The diagram which follows shows three cross sections through the hierarchy.



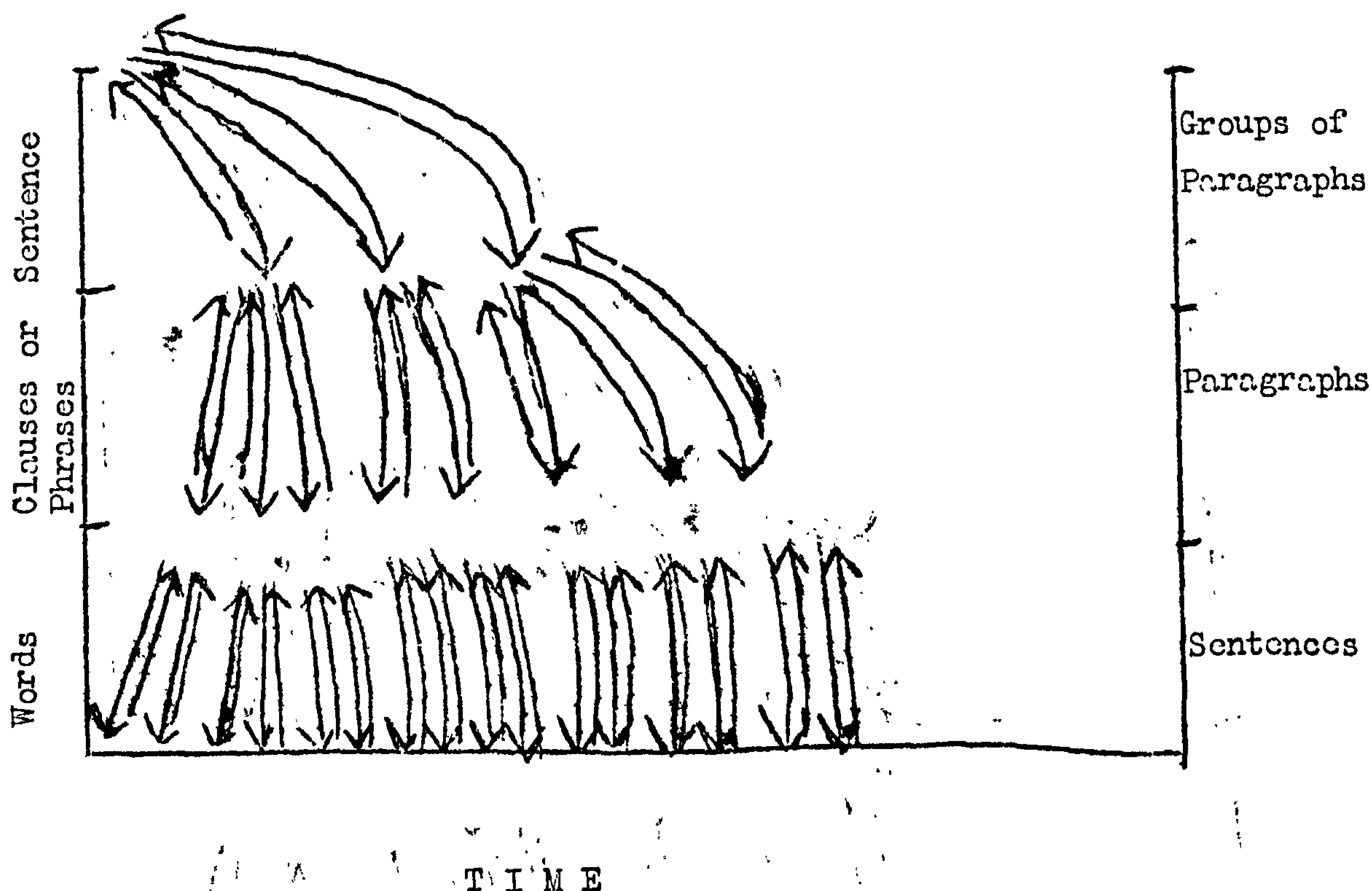
A, B and C at any level are successive matchings, resulting in closure. Each matching involves a read, a compare, a generation of meaning and a storage of matched meaning. The diagram which follows shows this.

A MODEL OF SUCCESSIVE CLOSURES IN READING-TO-LEARN

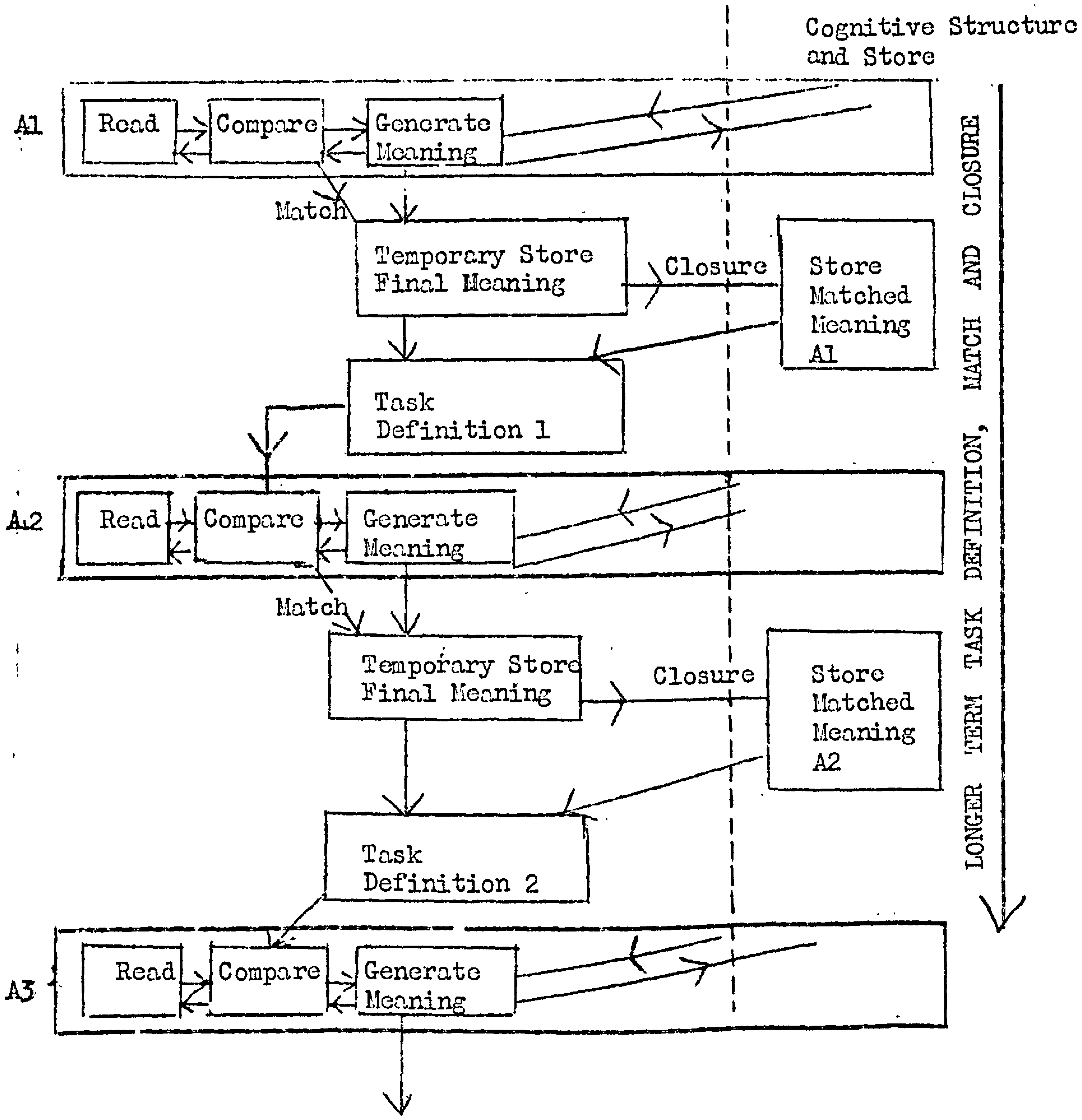


Each matching results from generating meaning out of the store or Cognitive Structure, which the eye movements map onto the text. Mismatch involves changes in the generated meaning and in the mapping of it onto the text. The final meaning which matches is stored as the meaning of that part of the text. Where the stored meaning units at one level are not well integrated with the stored meaning units at a higher level in the hierarchy, restriction of 'understanding' is likely to be the result, and the retrieval of the meaning units is likely to decline over a period of time.

5. In the preceding diagram, the basis on which the comparison is made is unspecified. It is suggested that it derives from the longer term 'compare' operations taking place at the higher level of organisation. Ultimately, the higher order 'compare' represents the reader's overall <u>Task Definition</u>. This can be reviewed between successive readings of the text. In other words, the process of Task Definition is <u>dynamic</u> and <u>interactive</u>.



The diagram which follows illustrates how the concept of Task Definition can be incorporated into a model of the reading-to-learn process.



A MODEL OF SUCCESSIVE CLOSURE AND TASK DEFINITION IN READING-TO-LEARN

This model of reading-to-learn can be considered as a hierarchically organised multi-level process. It represents the dynamic interaction between the individual's internal and external environment. A reading strategy formed of the tactics which reflect the interim responses and the learning outcome or performance which reflects the terminal response (Unit 1, 1.2.3.) represent the results of this interaction.

6. In reading-to-learn for chapter summarisation (Unit 3 Experiment 3), and for sentence generalisation (Unit 5 Experiment 4), the reading strategies can be accounted for as follows:-

(i) First Read

A 'smooth' exploratory read generates mismatch, the structure and details of which feed back to govern the pattern of activity which follows.

(ii) Second Read

This is characterised by hesitations and small back and fore samplings which relate to 'small unit' monitoring, involving efforts at closures in terms of specifics. When this is complete, it terminates the first overall closure level. However, meaning generation so far is not compatible with the long-term self-generated task definition, and the learner embarks on the next stage of activity. This may involve a review of 'specifics' as a precursor for the activity which follows.

(iii) Third Read

This is represented by a 'structured' read involving 'large unit' monitoring, when efforts are made in terms of closures relating to the co-ordination of 'specifics' into larger concepts, and these into generalisations and theories. This may involve two or more intermediate levels of closure before overall closure at a higher level takes place.

A reassessment of store against the long-term task definition at this stage results in a further period of activity. This frequently involves a period of review when the learner evaluates the most relevant items in terms of the summary or generalisation. He then checks this by means of a written draft.

(iv) Fourth Read

This represents a 'smooth' optimal read so that an overall closure takes place encompassing all subsidiary levels of closure operating against an overall monitoring process. The learner is now ready to perform his terminal response of the learning activity or learning output.

7. It follows, therefore, that effective learning depends upon a flexible monitoring system operating with a complex state of interacting internal conditions. The hypothesis was made in the preceding theoretical discussion (Unit 4) that the internal 'conditions' within the learner consist of a number of dynamically related factors. Specifically, these include a Cognitive Structure, which represents a hierarchical organisation of knowledge in a given field, and a Cognitive store of Learning Skills, a self-generated definition of the task, motivation and monitoring in terms of the interim and overall learning activity. The reading strategy must, therefore, reflect a complex multi-dimensional interactive process, operating within a given time-span.

8. The overall definition of the task gradually differentiates into shorter-term goals, each of which reflect a set of criteria that form the basis for the compare operation. At the sentence level Chomsky suggests that one set of criteria is the deep structure of the language. Within the matrix of one task, one skill, and one sentence, it was possible to identify two aspects of the monitoring activity in some detail:-

1. Syntactic recognition - monitoring (i.e. checking against an internal store) of letters, graphemes, words, phrases, clauses and sentences.
2. Semantic recognition - monitoring (i.e. checking against an internal store) of specifics, more generalised concepts and the most generalised concepts.

These two ways of monitoring are interrelated. For example, a young child learning to read may only be capable of syntactic monitoring in terms of letters and words or phrases, and his corresponding semantic monitoring may be in terms of small units of specifics. Evidence reported by other researchers suggests a genetic interdependence of structure and meaning (Piaget 1937, Werner and Kaplan 1950, Brown and Berko 1960). On the other hand, a sophisticated adult reader operating in a field of knowledge in which his internal store includes a well developed Cognitive Structure, and with a highly organised store of Learning Skills, is capable of syntactic monitoring at the level of a complex fifty word sentence, or at a larger level of paragraphs or chapters. The semantic monitoring level will be related to this in terms of equivalently large units, incorporating 'Specifics', as well as 'Universals and Abstractions.' A reader falling in between these two extremes may need to be continually adjusting his monitoring tactics in order to maintain match, within interim sequences and overall. This involves an adjustment of syntactic monitoring between the sentence to the clause, phrase or word, which permits a corresponding adjustment in semantic monitoring for checking against the appropriate internal store. Such flexibility in the monitoring system was essential in the transition from A and B to C levels of sentence complexity in Experiment 4, and in the sentence, paragraph and chapter complexity of Experiment 3 in relation to the learning tasks set.

9. The configuration of reading behaviour is predominantly temporal; it is the sequence of motions, which maps the reader's cognitive

representation into an appropriate pattern of activity. The total pattern of activity can be described at the molar level as a reading strategy, (an individual's read record or protocol) and the units, (the read types) which make up this pattern can be described at the molecular level as reading tactics (skills). The process of reading is thus organised simultaneously at different levels of complexity. The kind of ambiguity that results, when all the levels are not known (not under control by the learner), has been made explicit in the experimental studies reported. Control of the elemental units making up the psycholinguistic hierarchy (phoneme-word-phrase-clause-sentence-paragraph-chapter) is essential for an efficient reading outcome.

10. The hypothesis is made that reading-to-learn is, therefore, a hierarchical process that controls the order in which a sequence of operations is performed. This conception of the process relates to a Plan in Miller's terms (1960). The Image within which the plan operates (Miller 1960), consists in part of the Cognitive Structure and Cognitive Learning Skill (Unit 4, Theoretical Discussion (1)), that the individual has acquired in his lifetime. The Value system of the learner, which represents another aspect of the Image is outside the scope of this dissertation except in a tangential sense. Value systems interact with the other factors, which form the internal environment, to determine the process of reading for learning.

11. A central problem of this research project being reported is to explore the relation between the external stimulus situation, the internal representations (the Image and the Plan) and the terminal response. The Image and the Plan are not mutually exclusive categories of the representation. A Plan which results in a reading strategy can be learnt and becomes part of the Image. Cognitive Structure, Cognitive Skill and Values are incorporated into the Plan, otherwise it could not

provide a basis for guiding reading behaviour. Restructuring the Cognitive Structure and reorganising the Cognitive Skills during learning results in a change in the Image. This is brought about by the execution of the Plan. Changes in the Cognitive Structure and Cognitive Skills affect changes in the Plan.

12. Learner task definition is interpreted as a Plan which is monitored simultaneously at several levels of complexity within a hierarchical process and controls the order in which a sequence of operations is performed. The outcome of the Plan is the reading strategy. A Plan is generated from an interaction between the external stimulus situation, including both the instructional directives and the text, and the Image, including Cognitive Structure and Cognitive Skill. The Image, which includes everything the individual has learnt, forms part of the total internal environment. The physiological and emotional processes of an individual which give rise to basic needs or drives, contribute to the total internal environment. The relationship between these body processes and an individual's Image and Plan is entirely open to conjecture. This relationship must be explored for a full understanding of the individually creative process of Learner Task Definition.

13. An outline of the present state of the author's interpretation of a model of the student as a learner through the medium of reading is schematised overleaf.

A CYBERNETIC MODEL OF LEARNING BY READING

STIMULUS SITUATION
EXTERNALLY SET GOAL

Learning Task or Instructional Directives, defined in terms of a particular performance expectation.

INTERNAL ENVIRONMENT
or
CONDITIONS WITHIN THE LEARNER

Image — Everything an individual has learnt

Cognitive Structure

Cognitive Skill

Plan — Learnt Goals

Self definition of task

Physiological and Emotional Processes

Basic needs, drives or goals

MOTIVATION

MONITORING LEVEL

STIMULUS SITUATION
THE LEARNING MATERIAL

Expository material characterised by its intrinsic hierarchical syntantic and semantic structure

INTERIM RESPONSES

Reading Strategy

tactics, 'smooth', 'specific' and 'search' reads and non-reading review sessions.

TERMINAL RESPONSE

Learning outcome or Performance

Relative change in intellectual behaviour

14. <u>Taking account of the complexity of the reading-to-learn process, it can be inferred that it is a highly individual activity. Each individual varies in his internal state of 'conditions' and, therefore, in the monitoring system which he brings to operate within a given time span.</u> It follows that the learner knows most about what he is trying to do, and how he is trying to do it, and must take control of his own learning process. To enable him to do so efficiently, each facet of the process must be made explicit. The final experiment reported in this dissertation (Unit 7) represents a pilot study in which the learner is provided with some explicit information at the molar (strategy) and molecular (tactic) levels in order to encourage him to improve the efficiency of his learning by reading: in other words, to encourage him to increase the complexity of his internal representation, his <u>Image</u> and <u>Plan</u>.

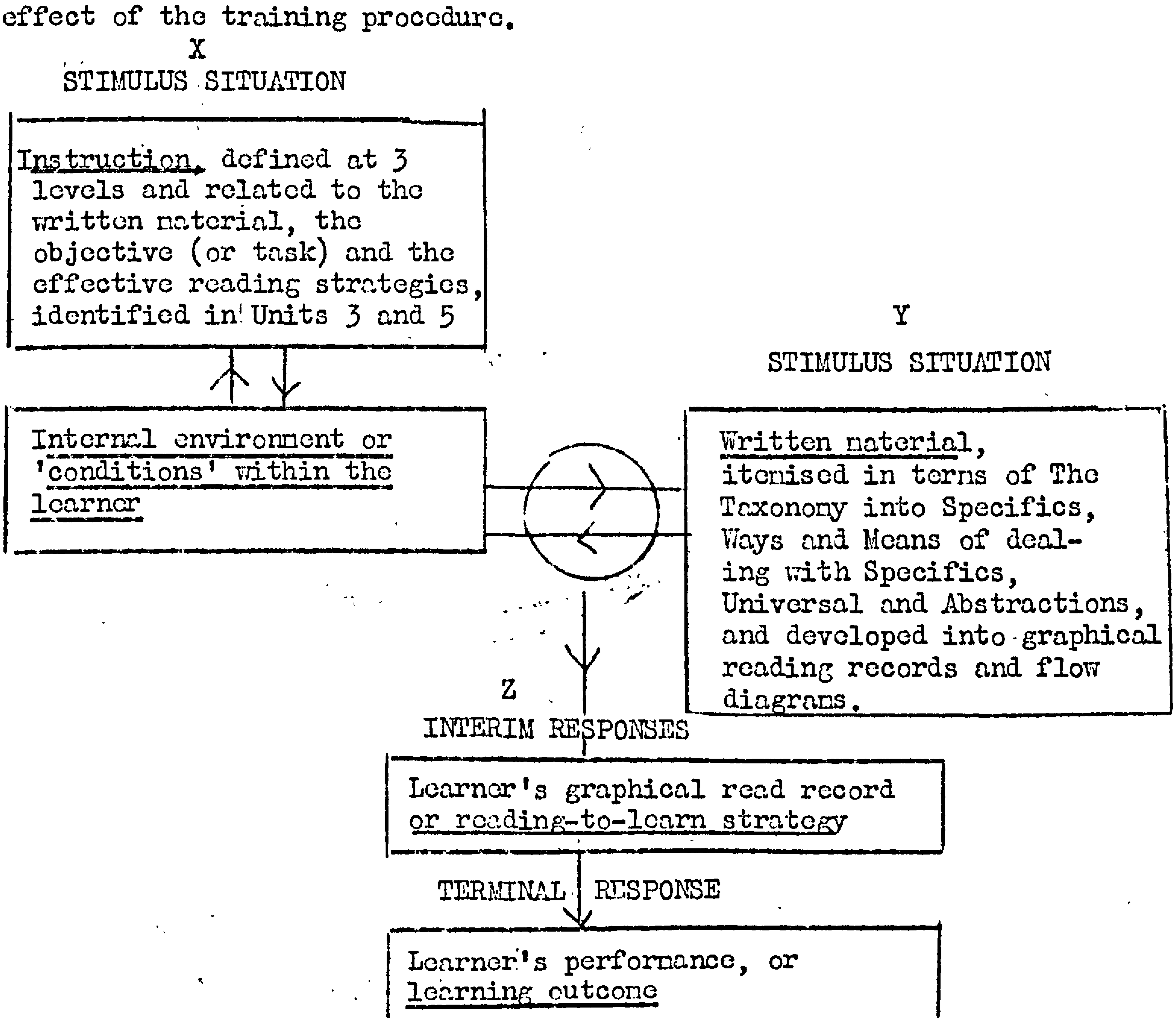
UNIT 7 Application of the Model

7.1 General Introduction

The input and output learning activities evaluated in Units 3 and 5 open up possibilities of training in the skills of reading-to-learn. This evaluation formed the basis of the model building activity reported in Units 4 and 6. These practical and theoretical aspects of the research activity interact in the development of a training procedure. The embryo of this training procedure is tested empirically in a pilot study designed to improve the effectiveness and range of the reading-to-learn process.

It has been inferred that efficient learning activity depends upon an explicit operational task definition. Instruction aimed at improving the effectiveness of an individual's operational task definition formed the kernel of the training. Bruner (1961) and Nedelsky (1967) have suggested that a training should involve several levels of instruction. At the first level of instruction the learner should be provided with detailed instructions relating to the overall task, while at the second level more general instructions should be provided and, finally, only the overall learning goal should be given. It is assumed that as a result of this training the overall task becomes associated with all the specific details of instruction relating to it. At this final level, the learner should be in a position to assess his task definition and to monitor the material to be learnt accordingly. This proposition has influenced the design of the pilot study, since it aligns with the theoretical model developed in Units 4 and 6, within which the importance of self-organised learning is recognised. The learner will make use of the instruction at a level useful for him.

The diagram which follows summarises the external conditions of learning, made explicit to the learner within the instructions which constitutedthe training procedure. This diagram refers to the model of the learner developed in Units 4 and 6. These instructions aim to increase the learner's awareness of his operational plan (or reading-to-learn strategy), in relation to the objective (or task) and the written material. The independent variables x and y (the stimulus situation) and the dependent variables z (the interim responses) constitute observables, which were under control during the training procedure. The aim of the Pilot Study was to measure any changes in the learner's reading-to-learn strategy and learning outcomes, as a result of the training. The assumption was that any changes in strategy and outcomes would reflect changes in the operational task definition. Experiment 5, the Pilot Study, was designed to assess the immediate effect and short-term transfer effect of the training procedure.



The independent variables X and Y, and the dependent variable Z which are made explicit during training

7.2 The Instructional Procedures (Training)

An outline of the basic principles which governed the rationale for the development of the instructional procedures is presented in Unit 2 (General Experimental Method - 2.7., The Training Technique). A training chart was constructed for each of the two training sessions (Sessions 2 and 3), and this chart was hung on the wall in front of the learner. The charts were thus easily and quickly available for consultation throughout the training sessions. The instructions and visual guides, printed and drawn on typing and graph paper, were glued on to a firm hardboard backing. The first training session (Session 2 of the Pilot Study), consisted of instruction for reading-to-learn at the sentence level. The second training session (Session 3 of the Pilot Study) consisted of instruction for reading-to-learn at the chapter level. The instructions and guides for the training sessions (Session 2 at the sentence level, Session 3 at the chapter level) within the Pilot Study are presented in the following pages.

SESSION 2 SENTENCE ANALYSIS

PHASE	SIMPLE INSTRUCTION	LEVELS OF INSTRUCTION: DETAILED INSTRUCTION	LEVELS OF INSTRUCTION: VISUAL GUIDE
1	EXPLORATORY READ	i.e. Read through at a fairly even pace, noting mentally any areas (words or phrases) of difficulty.	CHART A
2	Read through IN DETAIL in order to get each sentence sub-unit clearly understood.	i.e. You can use clauses as a framework for this activity. After reading each clause, attempt to formulate the meaning of the clause in your own words. If you are not sure how to detect clauses, go through the teaching programme available. IF YOU FIND IT DIFFICULT to derive meaning using clauses as sub-units, use smaller units (PHRASES) INSTEAD. If a particular word or a group of words is unfamiliar to you, this is the time to consult a reference book or ask the experimenter.	CHART B
3	Read through to INTERRELATE the sentence sub-units you have been work - ing on.	i.e. Prepare a flow diagram of the sentence linking each sub-unit according to their semantic relationships.	See CHART C and CHART D
4	PAUSE to REVIEW	i.e. Check your meaning generation by assimilating the whole sentence meaning into your own words.	

SESSION 2 SENTENCE ANALYSIS (cont.)

5	Read through whole sentence to check your meaning.	i.e. Read through fairly evenly, checking the meaning. If you have pursued phases 1, 2, 3 and 4 successfully your read should be smooth and even, <u>if it is not REPEAT phase 2 and 3</u>.	See CHART A
6	Attempt to GENERALISE the sentence.	i.e. Abstract the meaning in general terms, (e.g. discuss with the experimenter) cat, dog → pets → cat, dog, cow → domesticated animals → mammals bread, potato, rice → carbohydrate eggs, milk, fish → protein carbohydrate, protein → food Idiocy, Cretinism, Mongolism → Physical and mental Abnormalities → Behaviouristically defective	

CHART A

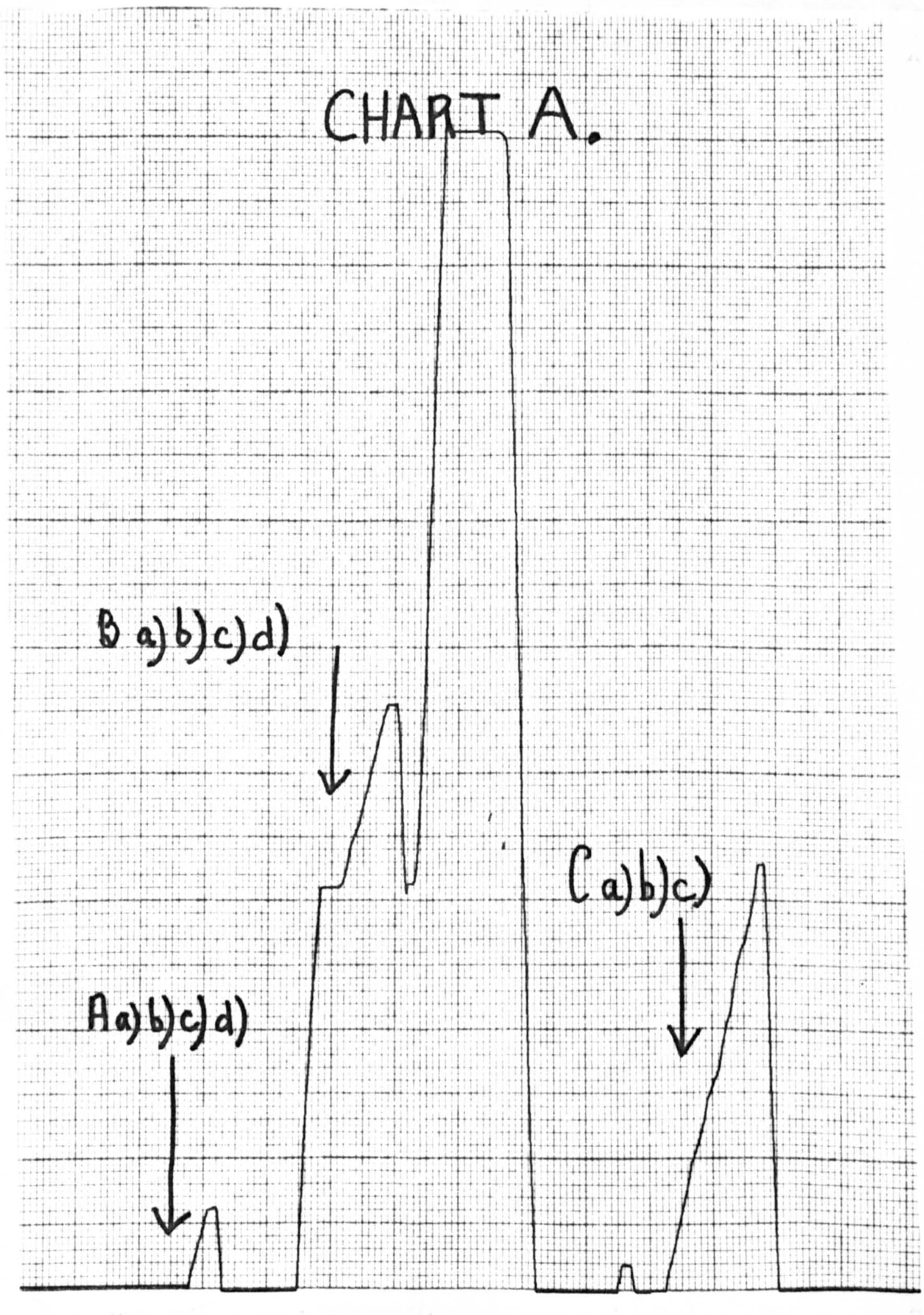
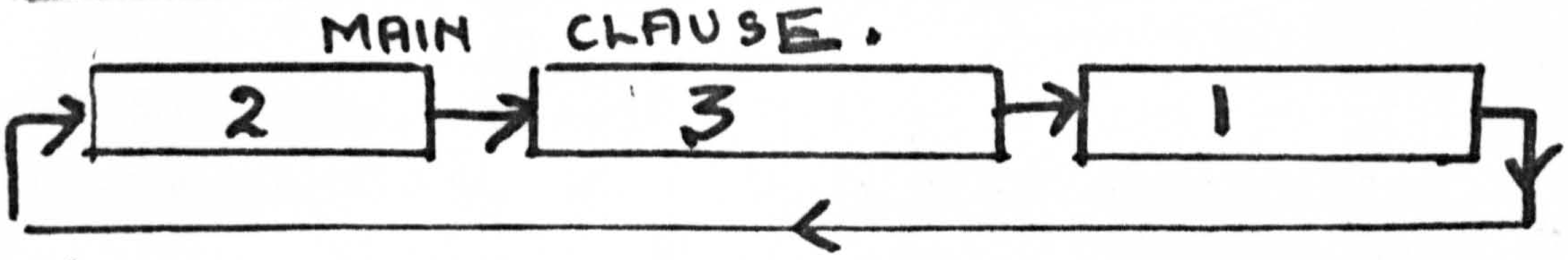


CHART C

A. a)

1 MAIN 2 CLAUSE 3

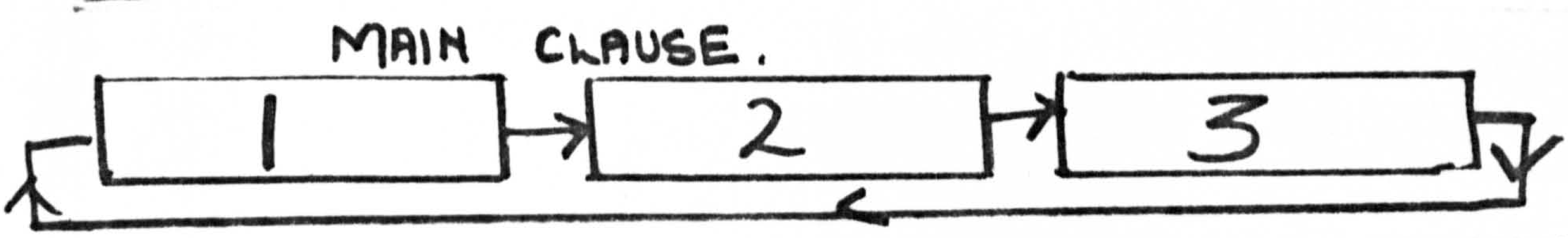
For a century, | The gene existed | virtually in the abstract.



b)

1 MAIN 2 CLAUSE 3

The strands of DN. | are built up of | nucleotide molecules.



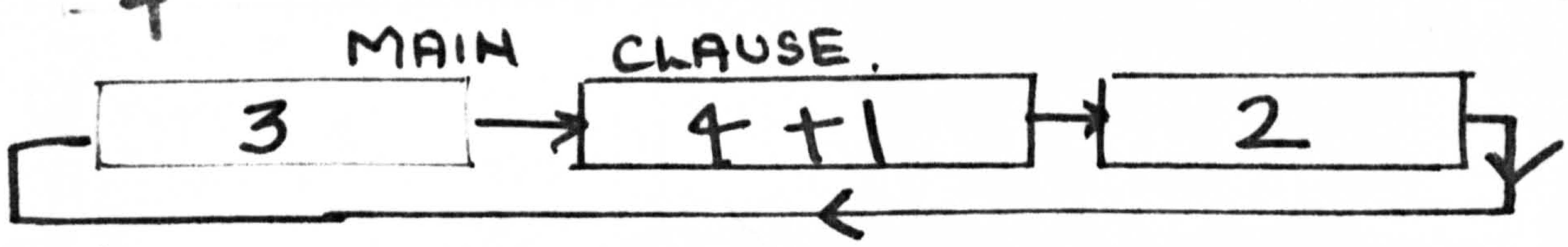
c)

1 MAIN 2 CLAUSE 3

used

Indeed | by adding an antibiotic, | protein chain termination | can be.

4



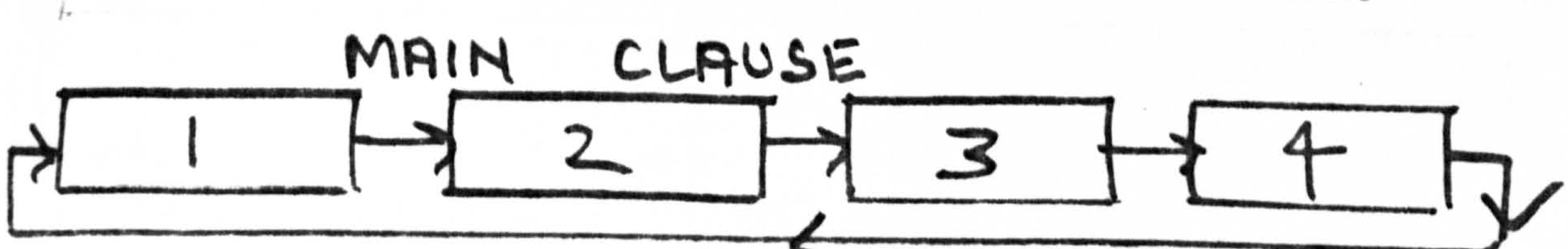
d)

1 MAIN CLAUSE 2

Another variability | undergoes whole organisms

3 4

within galaxies | after exposure velocities.



B. a)

1 2 3

During metamorphosis | in the silkworm | a brain hormone

4 5 6

stimulates a gland | in the prothorax | to secrete PGH,

7

which stimulates growth.

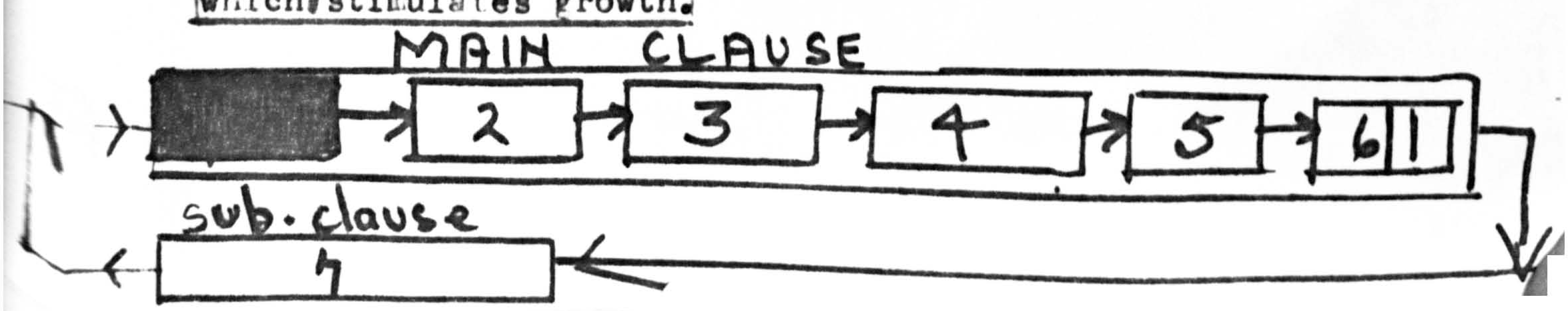
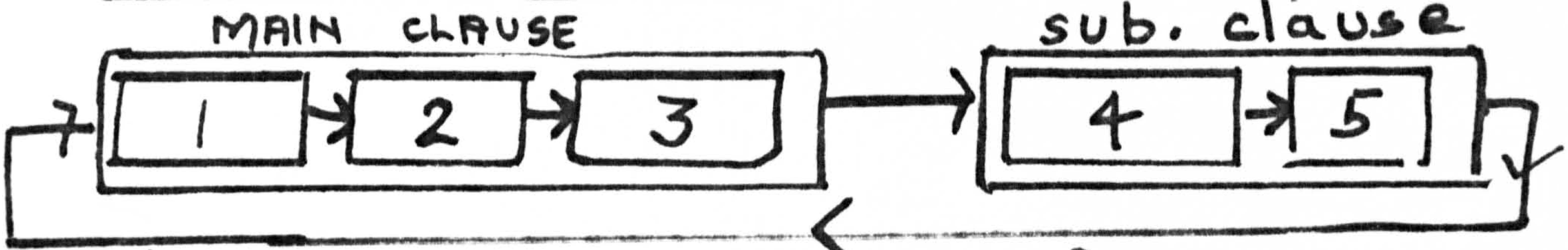


CHART C (cont.)

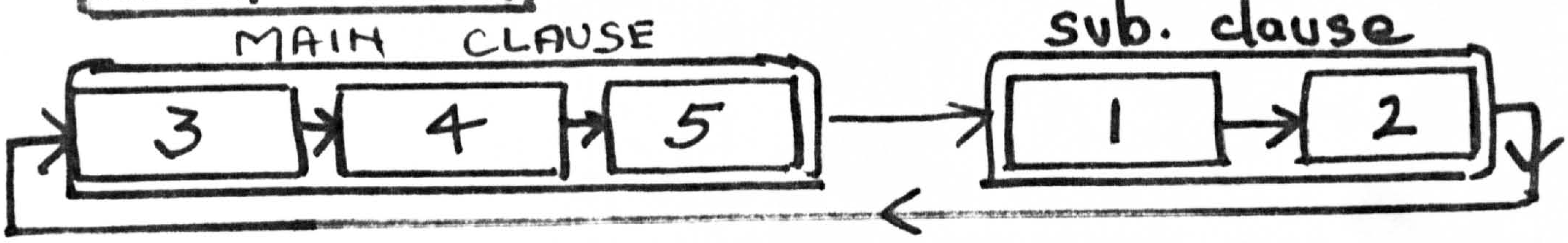
b)

A virus interfering substance called interferon is formed in appreciable quantities when heat activated influenza virus is incubated in suitable cells.



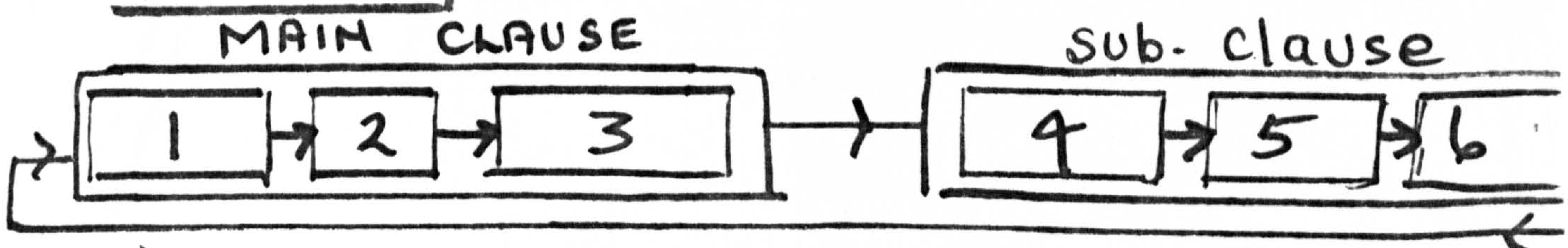
c)

When energy rich phosphate bonds are provided, many of the organic compounds occurring in all living cells can only be formed.



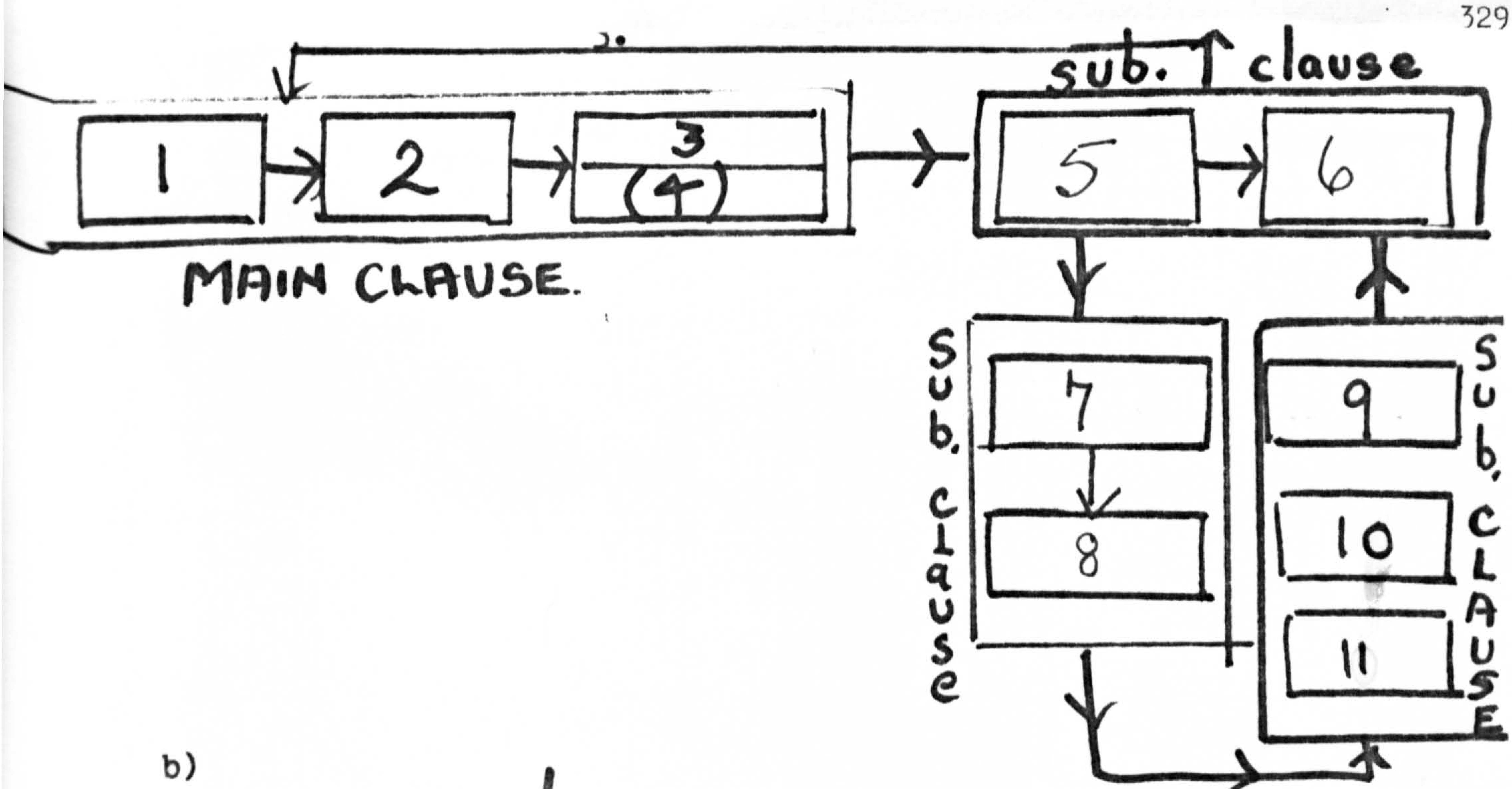
d)

Enlightened Proteins have special machinery to start generating special problems because daughter constructions synthesize experimenters into the architecture of molecules.



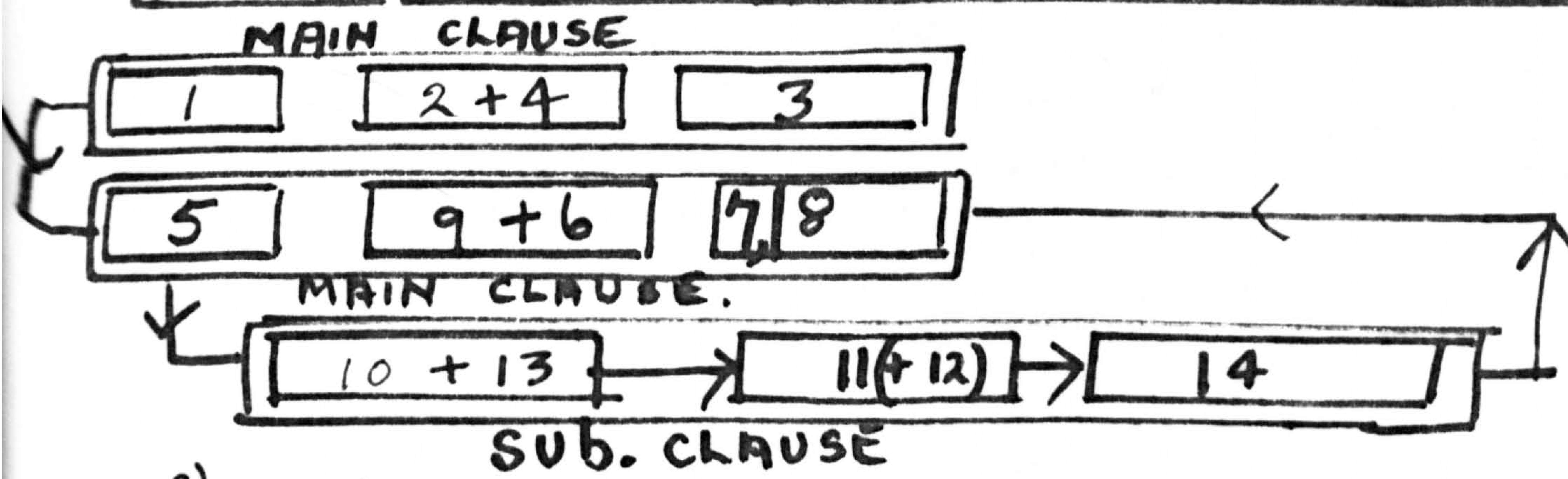
C. a)

The message contained in DNA is first transcribed into the similar molecule called 'messenger' RNA, (genetic material is RNA in some viruses), which has four kinds of bases as side groups; three are identical with those found in DNA, Codenine, guanine cytabine but the fourth is uracil instead of thymine.



b)

1 The composition of m·ny of the code triplets | 2 had
3 by actual experiment | 4 been determined
5 and the technique | 6 evalu·ted, | 7 to synthesize polypeptide chains
8 in a cell free system | 9 w·s | which 10
11 by breaking open cells of the colon bacillus | 12 (Escherich'a Cali)
13 was made | 14 and extracting from the machinery of protein synthesis



c)

1 Human populations | 2 disturb large amounts of genes
3 which between selection is lethal | 4 for their german ancestry
5 and also in southern climates | 6 alleles might happen to deviate
7 as the migration was genetically sound | 8 unless generations of
tribal history | 9 had become very deep black | 10 or all frequencies
must adapt, | 11 it could compensate.

CHART C (cont.)

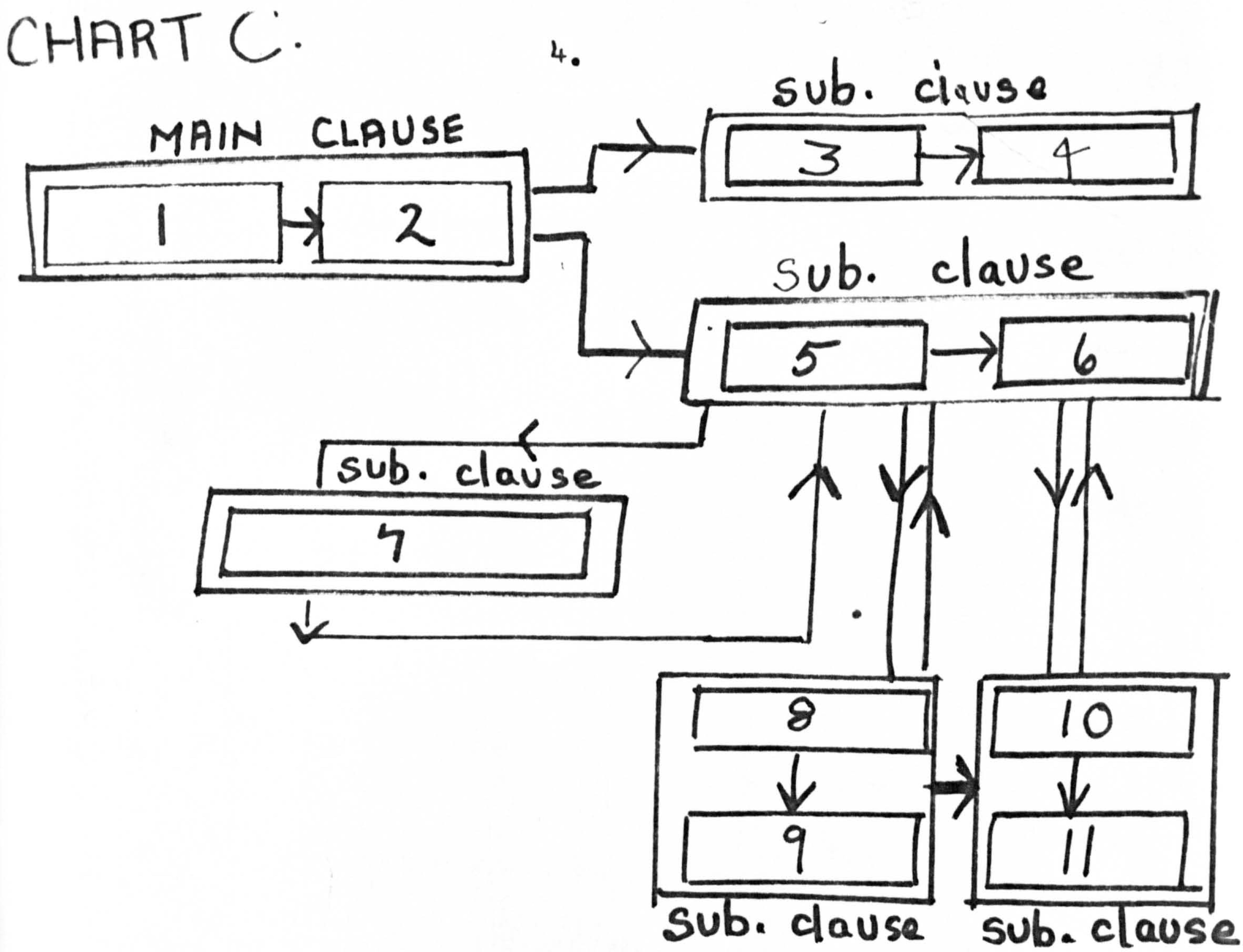
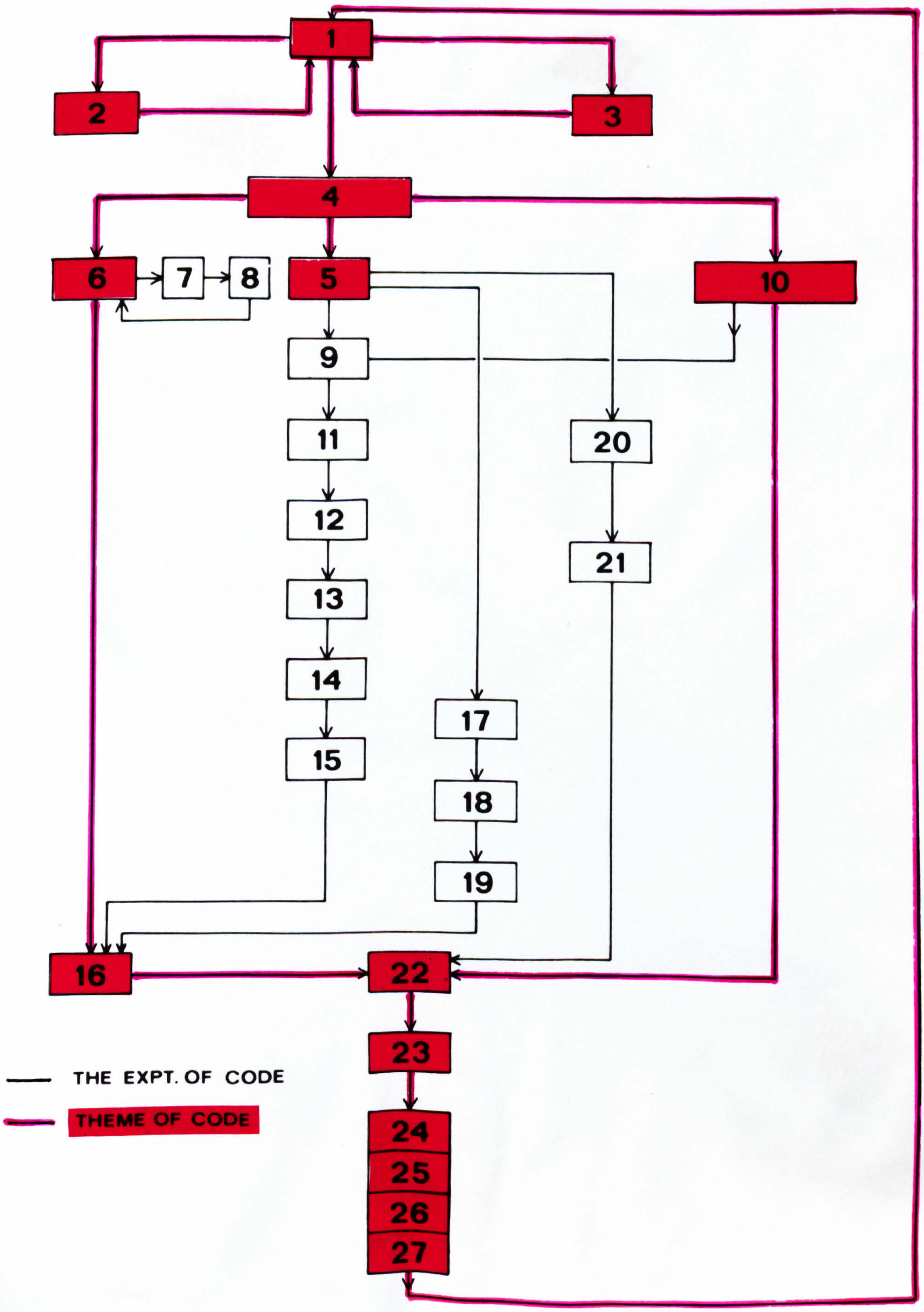


CHART C.
4.
MAIN CLAUSE
1
2
sub. clause
3
4
sub. clause
5
6
sub. clause
7
8
9
10
11
sub. clause
sub. clause

A STRUCTURED FLOW DIAGRAM OF THE TEXT,

'THE REVIEW OF THE GENETIC CODE'.



Experiment 5. The Pilot Study - An Empirical Study: Application of the Model to the Educational Problem.

7.3 Experimental Method

The experimental population consisted of 12 Advanced Level Biology students. Six students volunteered from the top science stream of a Grammar School and six students volunteered from the only stream in a Technical School.

The students were asked to fill in three separate questionnaires at different stages of the study. One questionnaire was given at the commencement of the study, one immediately after the study was completed and one three months later. The three questionnaires are presented in Appendix D, 7.3. The questionnaires were designed to cover a wide range of information, such as, school performance, as assessed by the teaching staff and as assessed by the students, idiosyncratic learning activities relating to school work, the usefulness of the training and the extent it was subsequently practised in school learning activities.

The pilot study was divided into four sessions per subject at weekly intervals. At the commencement of each session the activities pursued in earlier sessions were discussed and reviewed.

Session 1: A non-training session

1. The objective and instructional directive were presented to the subject, the learning activity was recorded on the reading recorder and the summary was analysed in terms of items.

Session 2: A training session

2. This was based on the sub-skills of reading-to-learn at the sentence level.

Session 3: A training session

3. This was based on the skills of summarisation at the chapter level.

Session 4: A non-training session

4. The objective and instructional directives were presented to the subject, the learning activity was recorded on the recorder and the summary was analysed in terms of items.

In the training sessions (2 and 3), the learner was asked to use all levels of the training regardless of his personal needs. It was considered that a more accurate 'before' and 'after' comparison could be made. Ultimately, it was hoped to extend the pilot study so that the learner could react more freely within the training and select the level of guidance suitable for him. This was, however, outside the scope of the present pilot study.

In the non-training sessions (1 and 4), the subjects were told that they should summarise the text provided on the reading recorder. The subjects were further instructed that this summary should not take the form of a highly abstract outline but should consist of a substantive report presenting the main points and the interrelationship between these to form a systematic view.

Two matched Texts, A and B, were used in sessions 1 and 4. The matching related to their intrinsic organisation in terms of Specifics, Ways and Means of dealing with Specifics and Universals and Abstractions. The distribution of items in each category was approximately similar (Appendix A). The intellectual content of Texts A and B were entirely unrelated. The value of the training sessions in affecting changes in reading protocols and performance could thus be fairly judged. Any overwhelming preference for one text over the other in either sessions 1 or 4 was taken into account within the following experimental design.

A Diagrammatic Representation of the Experimental Design

Session 1 1 week Interval	NO TRAINING	GROUP A Text A 6 Subjects	GROUP B Text B 6 Subjects
Session 2 1 week Interval	TRAINING		
Session 3 1 week Interval	TRAINING		
Session 4	NO TRAINING	Text B	Text A

The Learning Material

Texts A and B used in Sessions 1 and 4, consisted of abridged articles of approximately 3,800 and 3,450 words respectively from "Scientific American." Text A reviewed the Role of Light in Photosynthesis and Text B reviewed the Mechanism of Immunity. Further details of the texts are given in Unit 2 (2.3), and their itemised analysis are presented in Appendix A, 2.6.1. The texts contained information beyond the range of knowledge expected in an Advanced Level course and none of the subjects had read the articles before. To maximise ego involvement, the subjects were informed that the texts related to their Advanced Level course, and that their individual performance and reading records would be presented to them within the study.

In Session 2 (a training session), the sentences used in the training of reading-to-learn at the sentence level were selected from those used in Experiment 4. These consisted of: 4, 10 word, 1 clause;

4, 20 word, 2 clause and 3, 50 word, 4 clause sentences. These sentences are shown in the instructional procedures (7.2).

In Session 3 (a training session), the text used consisted of "The 'Genetic Code' Review" from "Scientific American", which was also used in Experiment 3. Details concerning the use of this text in the training session are presented in the instructional procedures (7.2).

Evaluation of the Summaries

For an effective comparison of the summaries three criteria of measurement were used. These stemmed from the development of evaluation techniques, which were assessed in Experiment 1 (Unit 3). Details concerning the methodology of evaluation are presented in Unit 2, under the heading: "Task Evaluation Techniques" (2.6). The three criteria are listed below:-

1. The Total Item Score — This was assessed by evaluating the total number of items recorded in the summary, as a percentage of the total items in the original text.

2. The Measure of Performance — This was assessed by evaluating the total number of 'Universals and Abstractions' recorded in the summary as a percentage of the total number of 'Universals and Abstractions' in the original text.

3. The Measure of Selection — This was assessed by evaluating the total number of 'Universals and Abstractions' recorded in the summary as a percentage of the total item scores recorded in the summary.

The time taken to complete each summary was also recorded.

Evaluation of the Training

In order to evaluate the immediate and short-term transfer effect of the training the summaries (time and score) in the two non-training sessions (Sessions 1 and 4), and in the training session for summarisation (Session 3) were compared. An assessment was then made of the relationship between the learning outcomes and the reading records in each session.

7.4 Results and Discussion

7.4.1 Evaluation of the Matched Texts

Inspection of Tables 1, 2 and 3 indicates that Texts A and Text B were fairly equally matched in terms of the behaviour of the experimental population.

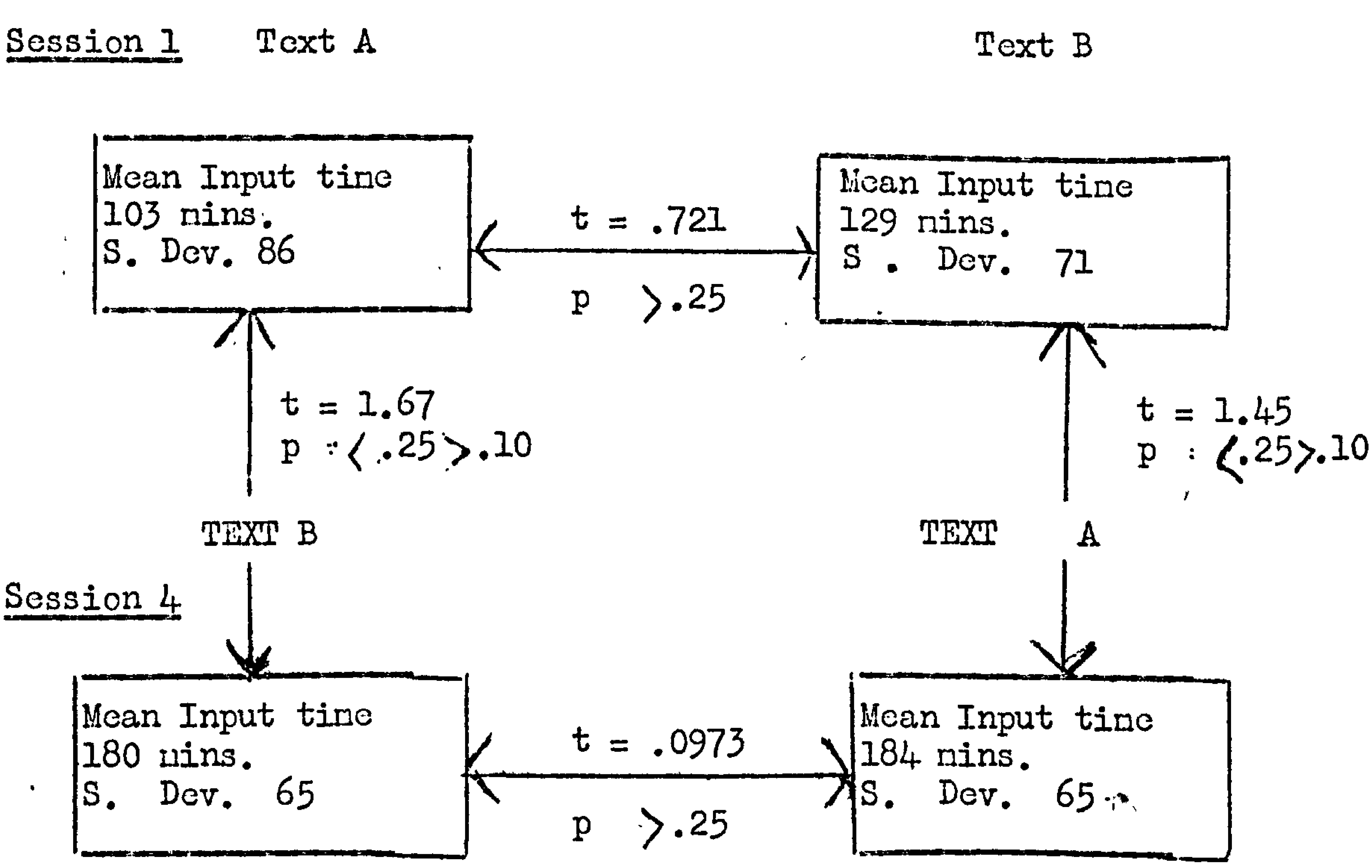


TABLE 1

The mean Input time in minutes per 100 lines and standard deviation for the experimental population in Sessions 1 and 4.

TEXT A

Mean Performance
Score 53.5
S.Dev. 24.6

t = .727
p = .25

TEXT B

Mean Performance
Score 64.0
S. Dev. 18.4

t = 1.69
p <.25 >.10

t = 1.68
p <.25 >.10

TEXT B

Mean Performance
Score 72.66
S. Dev. 13.1

t = .826
p = .25

TEXT A

Mean Performance
Score 79.16
S. Dev. 7.57

TABLE 2

The mean Performance score and standard deviation for the experimental population in the first and fourth session.

Session

TEXT A

Mean Selectivity
Score 42
S. Dev. 9.85

t = .8128
p > .25

TEXT B

Mean Selectivity
Score 47
S. Dev. 9.6

t = 3.969
p = .01

t = 2.490
p = .05

TEXT B

Mean Selectivity
Score 67
S. Dev. 9.26

t = .2801
p >.25

TEXT A

Mean Selectivity
Score 65
S. Dev. 13

TABLE 3

The mean Selectivity score and standard deviation for the experimental population in the first and fourth session.

It can be seen that there was no significant difference in the Mean Input time, Selectivity and Performance scores between Groups A and B in Session 1. This also applied to Groups A and B in Session 4. These tables also indicate that the experimental population tended to increase in Input time and to improve the Performance and Selectivity scores after training.

7.4.2. A Preliminary Analysis of Input and Output Behaviour

Tables 4, 5, 6, 7 and 8 show the subject frequency distribution for Input/time (reading), Output (summary) time, Total Item Score, Performance and Selectivity scores.

TABLE 4

Time in Minutes per 100 lines	Session 1 No training	Session 3 Training	Session 4 No training
50	2	-	1
51 - 100	5	-	3
101 - 150	2	1	4
151 - 200	0	1	1
201 - 250	2	3	3
251 - 300	1	-	-
301 - 350	-	2	-
351 - 400	-	2	-
401 - 450	-	-	-
451 - 500	-	3	

The subject frequency distribution for Input time in Sessions 1, 3 and 4.

TABLE 5

Time in Minutes	Session 1 No training	Session 3 Training	Session 4 No training
10	-	-	-
11 - 20	1	-	-
21 - 30	1	2	1
31 - 40	2	1	2
41 - 50	3	6	5
51 - 60	1	2	4
61 - 70	2	1	-
71 - 80	1	-	-
81 - 90	1	-	-
91 - 100	-	-	-

The subject frequency distribution for Summary time in Sessions 1, 3 and 4.

TABLE 6

Item Score Percent	Session 1 No training	Session 3 Training	Session 4 No training
10	-	-	-
11 - 20	-	-	-
21 - 30	1	-	-
31 - 40	2	-	1
41 - 50	3	-	7
51 - 60	3	5	4
61 - 70	-	7	-
71 - 80	1	-	-
81 - 90	2	-	-
91 - 100	-	-	-

The subject Frequency for Total Item score (percent) in Sessions 1, 3 and 4.

TABLE 7

Performance Score Percent	Session 1 No training	Session 3 Training	Session 4 No training
10	-	-	-
11 - 20	1	-	-
21 - 30	-	-	-
31 - 40	2	-	-
41 - 50	2	-	-
51 - 60	-	-	1
61 - 70	2	1	2
71 - 80	3	1	6
81 - 90	2	5	2
91 - 100	-	5	1

The subject Frequency for Performance score in Sessions 1, 3 and 4.

TABLE 8

Selectivity Score Percent	Session 1 No training	Session 3 Training	Session 4 No training
10	-	-	-
11 - 20	-	-	-
21 - 30	-	-	-
31 - 40	6	-	-
41 - 50	2	-	1
51 - 60	3	1	2
61 - 70	1	-	5
71 - 80	-	2	4
81 - 90	-	6	-
91 - 100	-	3	-

The subject frequency for Selectivity score in Sessions 1, 3 and 4.

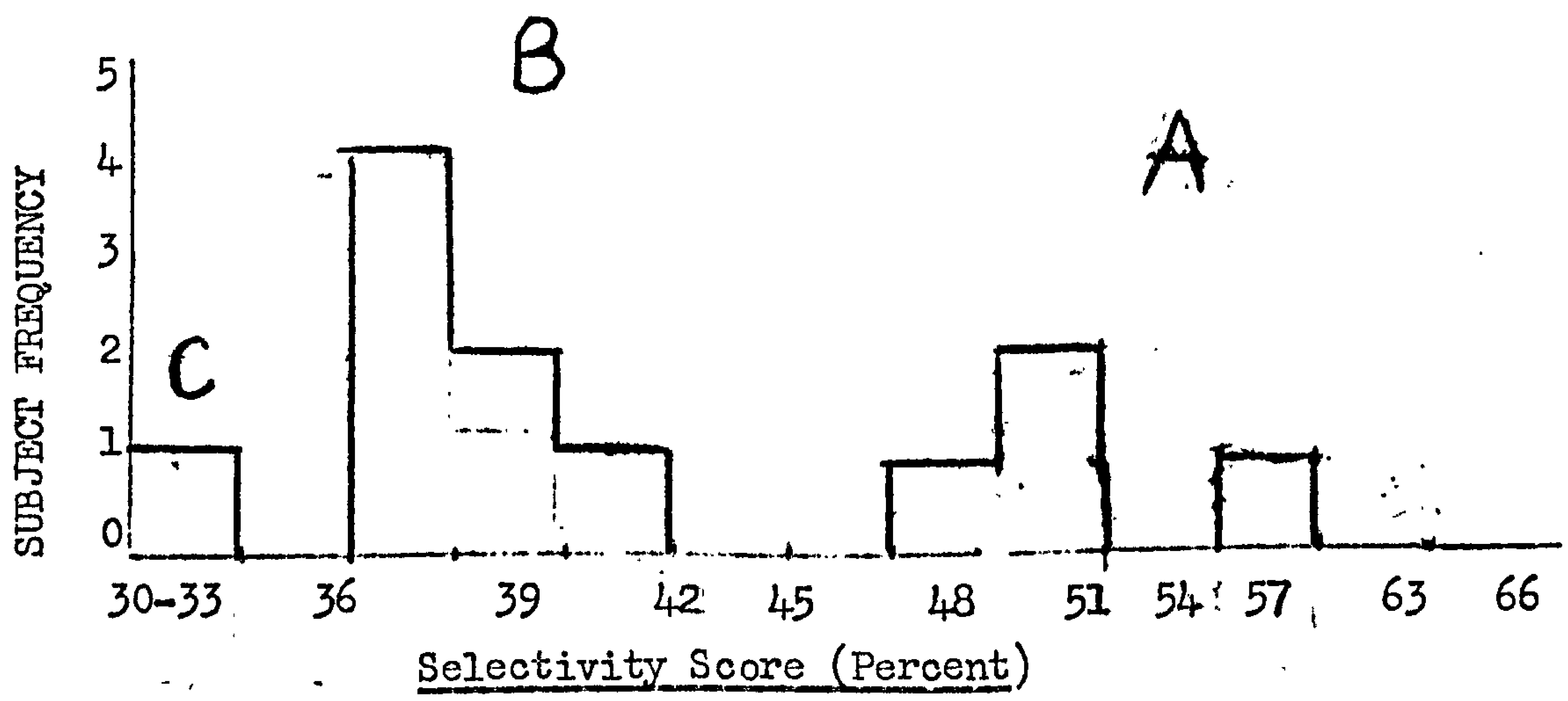
It was apparent that the effect of training on the post-training session in the experimental population in terms of Input time was to increase clustering, with a central tendency around 200 minutes, compared with a central tendency around 100 minutes in the pre-training session. The widely spread distribution in the training session showed that subjects reacted differently to the guides in terms of Input time. Again, the effect of training on the post-training session in terms of Summary time was to increase the clustering of the population, with a central tendency around 50 minutes, compared with 40-60 minutes in the pre-training session. The effect of training on the post-training session in terms of Total Item score was the marked clustering, with a central tendency at 50%. The Total Item score has moved down in the post-training session, compared with the training session. The Performance score shows a clustering with a central tendency at 80% in the post-training session. This represents an upward shift of score compared with the pretraining session. However, there was some downward shift compared with the training session. The Selectivity score shows an upward shift in the post-training session compared with the pre-training session, but a downward shift compared with the training session.

To sum up, the effect of training on the experimental population was a general tendency to increase Input time, Performance and Selectivity scores and to centralise Summary time and Total Item score. Compared with the training session however, the experimental population has shown a tendency to decrease Input time, Total Item score, Performance and Selectivity scores in the post-training session.

7.4.3. The Classification of Subjects on Performance

The raw item scores for the experimental population are presented in Appendix D, 7.4.3. Inspection of the histogram of Selectivity score in Session 1 as shown in Table 9, indicates some differentiation of the population into sub-groups A, B and C.

TABLE 9



The Selectivity Frequency Distribution in Session 1.

Table 10 shows that the subjects can be grouped according to the distribution of their Selectivity score, Total Item score and Performance score into four sub-groups A, B_1 and B_2 and C.

Sub-Group A — 4 subjects with the highest Selection score were, therefore, classified as efficient selection types (EST).

Sub-Group B_1 — 3 subjects with the highest Total Item score were, therefore, classified as mass producer types (MPT).

Sub-Group B_2 — 4 subjects with a low Performance score and an average Total Item score were, therefore, classified as inefficient selection types (IST).

Sub-Group C — 1 subject with the lowest Total Item score, Performance score and Selection score, was, therefore, classified as very inefficient selection type (IST).

Sub-Group B_2 — was further differentiated into:-

Sub-Group B_{2a} — 2 subjects with a higher Performance score than

Sub-Group B_{2b} — 2 subjects with a lower Performance score.

TABLE 10

Subject		Selection Score			Total Item Score			Performance Score		
Sub-Group		Session 1	Session 3	Session 4	Session 1	Session 3	Session 4	Session 1	Session 3	Session 4
A	10	62	93	75	55	61	48	77	98	93
	8	57	93	78	51	53	40	66	88	80
	4	55	88	79	50	59	48	71	90	86
	1	52	91	75	46	63	48	62	100	82
B_1	2	39	77	64	86	67	55	86	88	80
	11	42	75	52	84	61	54	80	79	72
	9	45	85	66	75	58	47	77	85	80
B_{2a}	7	40	85	65	55	59	46	50	86	77
	6	37	84	63	50	68	48	48	98	68
B_{2b}	5	39	86	57	36	62	54	32	92	70
	12	39	86	63	36	56	45	32	85	73
C	3	31	60	42	23	62	52	18	65	50
		Related t- test significant probability beyond 0.001			Related t- test not significant probability 0.25			Related t- test significant probability beyond 0.001		

The distribution of subjects according to Selection, Total Item and Performance scores in Sessions 1, 3 and 4.

7.4.4. An Assessment of Changes in Performance in the Three Sessions

Training increases Selectivity scores and Performance scores and although some loss occurs between the training session (3) and the post training session (4), the changes between the pretraining session (1) and the post-training session (4) are still highly significant.

Table 11 shows that the Mean Selectivity score of the experimental population in Sessions 1, 3 and 4 were significantly different. The score was highest in the training session and comparison of the pre and post-training scores shows that an improvement in Selectivity has occurred after training.

TABLE 11

Session	Mean	Standard Deviation	t value	p value
1	44	9.839	1 and 3 9.549	1 and 3 p $<.001$
3	83	9.807	3 and 4 4.271	3 and 4 p $>.02<.001$
4	65	11.024	1 and 4 4.714	1 and 4 p $<.001$

The mean Selectivity score, standard deviation and t and p values for the experimental population in Sessions 1, 3 and 4

Table 12 shows the difference in Selectivity, Total Item and Performance scores between Session 1 (pre-training) and Session 4 (post-training).

TABLE 12

Subjects		Difference in Selectivity Score	Difference in Total Item Score	Difference in Performance Score
Sub-Groups		Sessions 1-4	Sessions 1-4	Sessions 1-4
A	10	+ 13	- 7	+ 16
	8	+ 21	- 11	+ 14
	4	+ 24	- 2	+ 15
	1	+ 23	+ 2	+ 20
B_1	2	+ 25	- 31	- 6
	11	+ 10	- 30	- 8
	9	+ 21	- 28	+ 3
B_{2a}	7	+ 25	- 9	+ 27
	6	+ 26	- 2	+ 20
B_{2b}	5	+ 18	+ 18	+ 38
	12	+ 24	+ 9	+ 41
C	3	+ 11	+ 29	+ 32

The difference in Selectivity, Total Item and Performance scores between Sessions 1 and 4.

Inspection of this Table shows that changes were not uniform throughout the population in terms of the three criteria used for evaluating the summary performance.

Sub-Group A (EST) This Group showed improvement in Selectivity and Performance scores, while reducing their Total Item scores.

Sub-Group B_1 (MPT) This Group showed improvement in Selectivity scores but reduced their Performance scores and Total Item scores.

Sub-Group B_{2a} (IST) This Group showed improvement in Selectivity and Performance scores. while reducing their Total Item scores. This Group followed the same pattern of behavioural change as Group A.

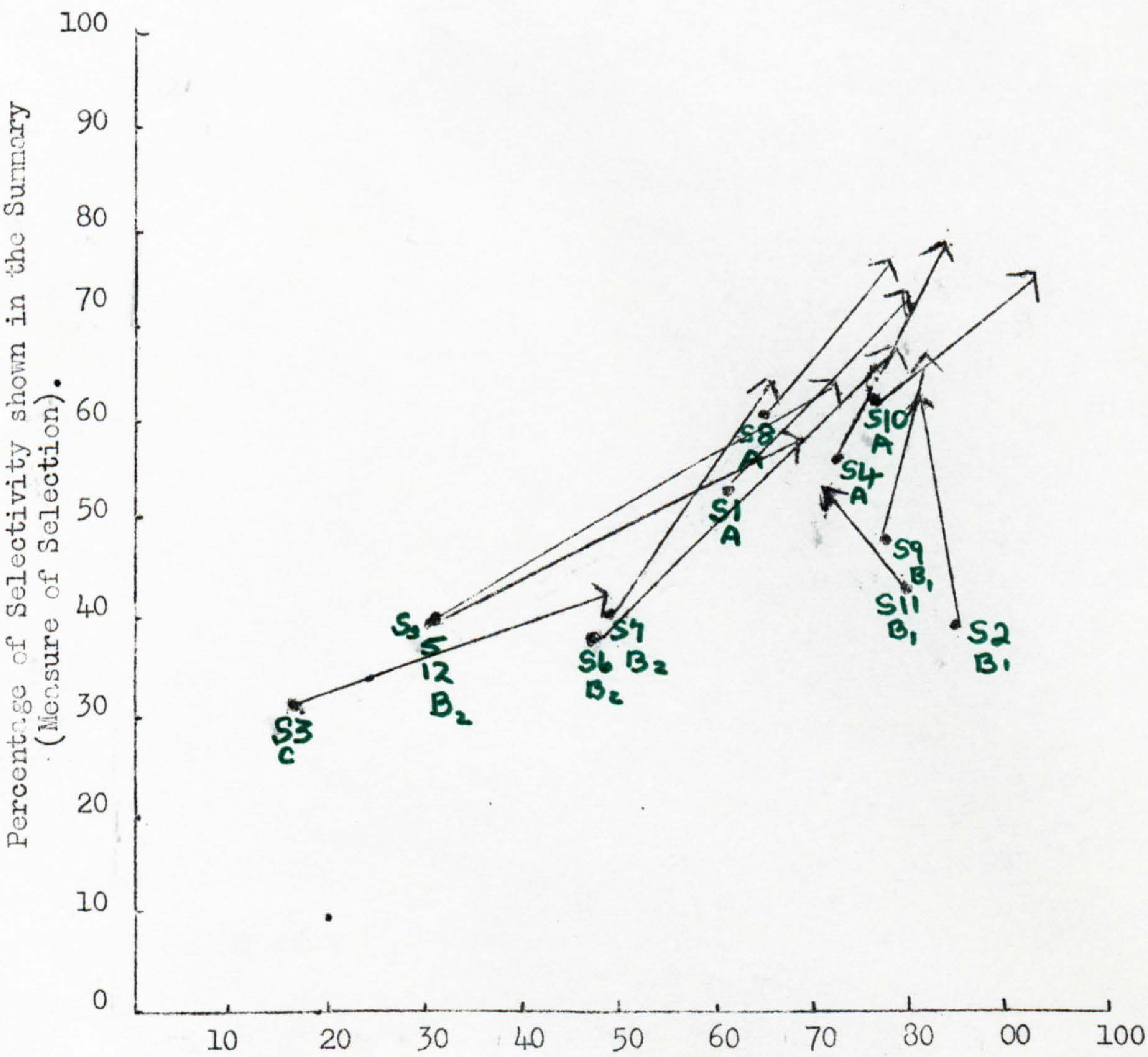
Sub-Group B_{2b} (IST) This Group showed improvement in Selectivity, Performance and Total Item scores.

Sub-Group C (VIST) This Group showed some improvement in Selectivity and considerable improvement in Performance and Total Item scores.

Further inspection of Table 10 shows that Group A (EST) subjects improved within their task definition and became more efficient Selectors as a result of training. Group B_1 (MPT) and B_2 (IST) subjects showed changes in their Selectivity score, Total Item score and Performance score in Session 4 (post-training), which matched the performance of subjects in Group A (EST) in Session 1 (pre-training). This indicated that those three subjects in Group B_1 who had defined their task as Mass Producers in the pre-training session redefined their task and became efficient Selectors (EST), in the post-training session. Those four subjects in Group B_2 who had defined their task as Selectors, but whose Selectivity and Performance scores were low in the pre-training session, had improved within their definition in the post-training session. The one subject in Group C who had defined his task as an Abstractor, but whose Selectivity, Performance scores and Total Item scores were very low in the pre-training session had to some extent redefined his task in the post-training session, since although he showed improvement in Selection and Performance scores, he also showed considerable increase in Total Item score.

A graphical representation of the improvement shown by the experimental population as a result of training, is whosn in Table 13. The Selectivity Score was plotted against the Performance Score, for each subject in Sessions 1 and 4.

TABLE 13. A graphical representation of changes in summary performance based on Selectivity and Performance scores in Session 1 (pre-training) and Session 4 (post-training).



Percentage of high level items identified in the Summary.

(Measure of Performance).

This graphical result can be compared with the similar graphical result showing changes in the experimental population which took place as a result of increased familiarity with the intellectual content of the learning material, but without any training, as shown in Table 11 of Experiment 1 (Unit 3, 3.3.4). This comparison clearly shows the value of training. Only a minority of subjects improved their Selection and Performance scores as a result of familiarity with the learning materials. This emphasises the validity of one of the basic assumptions of this reported study (Unit 1, 1.1.4), namely, that a systematic intervention of the process of reading-to-learn can improve the efficiency of the process. This raises the question of the role of such training within an education programme, and this issue is discussed in the Final Discussion (Unit 8). This improvement in summary performance was accompanied by significant changes in Output Time, Input Time and in the Reading Protocols. Again, these changes were not uniform throughout the experimental population.

7.4.5 An Analysis of Input and Output Time

The raw time score for each subject is shown in Appendix D,7.4.5. In order to assess the relationship between the time taken in each session, the input time for each subject was expressed as a percentage of the total number of knowledge items in each text. The number of items and the length of the text wererelated. Text A was approximately 3,800 words and contained 114 items. Text B was approximately 3,450 words and contained 101 items. The training text was approximately 3,100 words and contained 90 items. The individual input time and the mean input time for Sessions 1, 3 and 4 is shown in Table 14.

TABLE 14

SUB-GROUP	Session 1	Session 3	Session 4
EST A	97 106 95 93	244 171 206 129	161 109 117 97
MPT B_1	270 250 210	389 464 353	284 254 258
IST B_2	69 82 104 46	483 322 230 454	191 180 129 181
VIST C	33	342	223
Mean Dev.	121.25 77	315.58 119.4	192.4 62.63

Session 1 – Session 3: $t = 4.56$, $p < .001$

Session 3 – Session 4: $t = 3.04$, $p = .01$

Session 1 – Session 4: $t = 2.45$, $p < .05 > .02$

The individual input time and standard deviation for the experimental population in Sessions 1, 3 and 4.

Table 15 shows the individual difference in input time between Sessions 1 and 3 (pre-training and training), Sessions 1 and 4 (pre-training and post-training), Sessions 3 and 4 (training and post-training). Related t tests show that the experimental population spent significantly different times on the Input activity in the pre-training, training and post-training sessions.

TABLE 15

SUB-GROUP	SESSION 1 and 3 Pretraining & Training			SESSION 1 and 4 Pretraining and Post-Training			SESSION 3 and 4 Training and Post-Training		
		Mean Diff.	Dev.		Mean Diff.	Dev.		Mean Diff.	Dev.
EST A	147	+194.33	125.7	64	+62	63.8	-83	-133.58	82.02
	65			3			-62		
	111			22			-89		
	36			4			-32		
MPT B_1	119	related $t = 5.127$		14	related $t = 3.26$		-105	related $t = 5.419$	
	214			4			-210		
	143			48			- 95		
IST B_2	414	$p < .001$		122	$p < .01$		-292	$p < .001$	
	240			98			-142		
	126			25			-101		
	408			151			-273		
VIST C	309			190			-119		

The individual difference in input time, mean difference, standard deviation and related t tests for the experimental population in Sessions 1, 3 and 4.

The EST (A), MPT (B_1), IST (B_2) and VIST (C) sub-groups identified in the pretraining session (1), according to the summary score rating showed sub-group differences in input time. Further inspection of Table 14 shows that in the pretraining session ;

the EST sub-group spent more time than the IST sub-group and the VIST sub-group on Input time;

the EST sub-group spent less time than the MPT sub-group;

the IST sub-group spent longer than the VIST sub-group and less than the MPT on Input time and

the MPT sub-group spent longer than the EST, IST and VIST sub-groups on Input time.

Sub-group differences were also noted for output time as shown in Table 16.

TABLE 16

Sub-Group	Session 1 Pretraining	Session 3 Training	Session 4 Post Training
EST (A)	77 58 47 46	41 25 34 21	50 35 45 28
MPT (B_1)	89 65 64	45 50 45	55 60 48
IST (B_2)	40 48 31 25	52 69 48 50	42 52 45 35
VIST(C)	17	51	54

The individual summary time in minutes for the experimental population in Sessions 1, 3 and 4.

The EST sub-group tended to spend longer than the IST, and the VIST sub-groups, and less than the MPT sub-group on Output time; the IST sub-group spent less than the MPT and more than the VIST sub-group on Output time;
the MPT tended to spend more than the EST, IST and VIST sub-groups on Output time.

A comparison of the input time and output time for each sub-group in Sessions 1, 3 and 4 shows that differences in changes of behaviour (as represented by time) can be identified. Further inspection of Table 10 shows that;

the EST and IST sub-groups spent longer on Input time in the training and post-training sessions. Input time was reduced from the training to the post-training session,
the MPT sub-group spent longer on their Input time in the training session, but there was no conspicuous difference in Input time in the pre-and post-training session;
the VIST subject spent ten times longer on her Input time in the training session and seven times longer in the post-training session.

Further inspection of Table 16 shows that;

the EST sub-group reduced their summary time in the training and post-training sessions, but increased their summary time from the training to the post-training session,
the IST sub-group increased their summary time in the training session, but did not change their summary time conspicuously in the post-training session,
the MPT sub-group reduced their summary time in the training and post-training sessions,
the VIST sub-group increased her summary time in the training and post-training sessions.

Changes in the input and output time and in summary performance after training can be summed up as follows;

<u>the EST(A) sub-group</u> tended to increase their input time, decrease their summary time and improve within their task definition as Selectors,

<u>the MPT(B_1) sub-group</u> tended to increase their input time, decreased their summary time and improvedtheir summary performance and became Selectors as a result of a change in task definition,

<u>the IST(B_2) sub-group</u> increased their input time considerably and tended to increase their summary time and improve within their task definition as Selectors,

<u>the VIST(C) sub-group</u> increased her input time and summary time considerably and improves her summary performance and became a Selector as a result of a change in task definition.

Inspection of the individual reading records shows how these changes can be related to changes in the operational task definition.

7.4.6. An Analysis of the Reading Records

An analysis of the reading protocols of subjects in the pre-training, training and post-training sessions showed that marked changes in reading-to-learn tactics had taken place. The charts which follow show how the individual subjects in the EST, MPT, IST and VIST sub-groups have changed their tactics within the consecutive sessions of the Pilot Study.

Inspection of these charts indicates that in the post training session:

the EST sub-group elaborate existing tactics in particular the search tactic showing back-tracking between large units of the text,

the MPT sub-group re-assessed existing tactics and introduced new tactics - the data processing and review periods became more concerned with selection of relevant items than with massive memorisation of most items — the search tactic showing back-tracking between large units of the text was introduced,

the IST sub-group elaborate existing tactics and introduce new tactics - the data processing tactic became longer and the search tactic and review tactic were introduced,

the VIST sub-group introduces four new tactics - the long data processing tactic, the search tactic, the review smooth read tactic and the non-reading review tactic.

Changes in reading tactics in the consecutive sessions which resulted in an improvement in summary performance reflected changes in the operational task definition and could be related to changes in input time. The EST sub-group accommodated the elaboration of existing tactics without any conspicuous changes in input time. The MPT sub-group accommodated the re-assessment of existing tactics and the introduction of new tactics without any conspicuous change in input time. The IST sub-group accommodated the elaboration of existing tactics and the introduction of new tactics with a conspicuous change in input time. The VIST sub-group accommodated the introduction of new tactics with a very conspicuous change in input time.

It is of interest to note that while summary performance and the operational task definition (in terms of tactics) became more uniform in the experimental population as a result of training, the sub-groups could still be identified in terms of input time. Re inspection of Table 10 shows that the IST sub-group took longer than the EST sub-group, the MPT and the VIST sub-groups took longer than the IST and EST sub-groups. This indicates that changes in task definition, which involve the operation of new tactics, requires time and suggests that further practise is needed before the input time becomes an indicator of a behaviouristically homogenous population.

7.4.7. A Correlation Test

The difference in rank between Selectivity score and the change in Input time from the training to the post-training session in the experimental population showed a positive correlation (Spearman's Rho 0.9196 significant at p = .01). The less difference in Input time between training session and post-training session, the better the performance. Table 17 shows this for the 12 subjects making up the experimental population.

TABLE 17

Selectivity score in Session 4	78	79	75	75	66	65	64	63	42	52	63	57
Loss in Input Time, Session 3 and 4	32	62	83	89	95	101	105	142	144	210	273	292
Spearman's = 0.9196 n = 12 . probability = .01												

The correlation between Selectivity score in Session 4 and the loss in Input time between the training session (3) and the post-training session (4).

It was apparent that the disruption in learning strategy brought about by the training needed to be maintained at this early stage in the post-training. This emphasises the importance of sustained practise during a training procedure, and relates to the three stages of skill acquisition, enumerated in Unit 1, 1.2.3. Thus, initially during training it seems essential to maintain input time. However, the problem is to speed up input activity without loss of performance. This depends on further practise in order to effectively speed up each read tactic within the reading-to-learn strategy.

7.4.8. The Relationship between S_s Score and School Streaming

The relationship between the classification of subjects according to their performance in the pre-and post-training session and school streaming is shown in Table 18.

TABLE 18

SCHOOL	SESSION	NUMBER OF SUBJECTS	E S T		I S T		
			UPPER	LOWER	IST	MPT	VIST
Top stream	Pre-training	6	-	4	2	-	-
Grammar School	Post-training	6	4	2	-	-	-
Only stream	Pre-training	6	-	-	2	3	1
Technical School	Post-training	6	-	5	1	-	-

The relationship between the classification of S_s according to their performance in the pre-and post-training session and school streaming.

In view of the relatively small population any conclusion should be made with extreme care. The exclusion of EST (efficient summary type) in the Technical School stream,and the exclusion of the MPT (mass production type) and VIST (very inefficient summary type) in the top stream of the Grammar School in the pre-training session was interesting. After training the four Grammar School EST subjects maintained their lead and were regrouped in the upper division of that sub-group. The two Grammar School IST S_s and the five Technical School IST S_s were regrouped in the lower division of the EST sub-group. One Technical School VIST S remained inefficient but did shift into a higher order inefficient sub-group.

7.5 General Conclusion

1. Session 1 - There were differences in input time, reading tactics and performance within the experimental population according to the subjects' definition of the task. The subjects could be classified as follows:-

a) Efficient summary type (EST)
b) Mass production type (MPT)
c) Inefficient summary type (IST)
d) Very inefficient summary type (VIST)

2. Session 3 - The Training. There was a greater uniformity in reading protocols and performance. In comparison with Session 1, all subjects took longer on their input activity, but some took less on their output activity. All subjects showed an improvement in performance, although the extent of this depended upon their classification in Session 1.

3. Session 4 - A comparison of the input times, summary times, read tactics and summary performance between Sessions 1 and 4 showed a tendency to greater uniformity in behaviour after training.

4. The "efficient summary type" (EST) subjects were less effective

in Session 1 than in Sessions 3 and 4. The"inefficient summary type" (IST) subjects all improved in that they were all effective at summarising in Session 4, although in all cases this improvement was not maintained as effectively as in Session 3. The "very inefficient summary type" (VIST) and the "mass production type" (MPT) subjects showed improvement compared with their performance in Session 1, but none of these subjects maintained the improvement made in Session 3.

5. Improvements in performance as a result of training were related to distinctive changes in reading protocols. These changes could be associated with the acquisition of tactics similar to "efficient summary type" protocols, identified in Session 1.

In the EST subjects' changes in protocols involved an improvement of the original reading protocol pattern without any fundamental changes.

In the IST and VIST subjects' new read patterns or tactics were adopted within the reading-to-learn strategy.

In the MPT subjects' original read patterns or tactics were substituted by new read patterns or tactics.

6. Comparisons between mean input and output times in Sessions 1 and 4 showed that, "effective summary type" subjects tended to increase their input times and decreased their output times; the "inefficient summary type" subjects increased their input time and tended to increase their output times; the "mass production type" subjects maintained their input and reduced their output times; the"very ineffective summary type" subject increased her input time seven times and increased her output time three times.

7. A training procedure for reading-to-learn disrupted established learning activities on a short-term basis, and this was associated with an improvement in performance, although the extent of this was variable

within the population. A conscious monitoring of the learning process which took place during training slowed down learning input activity. The degree of improvement related to the 'conditions' within the learner which operate at an individual level and which determined the task definition. No effort was made to assess these individual predispositions or entering behaviour in this Pilot Study.

8. The less the difference in Input time between the training and post-training session, the better the Selectivity score in the summary. In the early stages of training, it seems apparent that it was essential to control Input activity at the conscious explicit level. The possibility is considered that further training and longer-term practise could result in a gradual diminishing of conscious control of the learning process, while maintaining the improvement in performance. Such a change within the behaviour pattern would mean that the input time would decrease. Reading-to-learn efficiency would then be reflected in an effective task performance in the shortest possible time.

9. The distribution of the students from the top Grammar and the only Technical School stream, according to their performance in the pre-and post-training sessions, showed that Grammar School students could summarise better than the Technical School students before training. After training, 5 ~~and~~ of the 6 Technical School students summarised at the same level of efficiency as 4 Grammar School students in the pre-training session. The 1 remaining Technical School student did show a marked improvement after training. The 4 top Grammar School students showed a significant improvement and maintained their lead within the experimental population after training.

10. Feedback of information during the training was useful in increasing students' awareness of the process of reading-to-learn. Training appeared to influence task definition with the result that the operational plan was more optimally aligned to producing an effective

performance.

11. An Assessment of Responses to Questionnaires

Response to questionnaires presented at the beginning and end of the study indicated that students welcome overwhelmingly an opportunity to learn how to learn more effectively. All subjects remarked that they would

try to apply the techniques learnt within their everyday curriculum, but requested further supervision. All students reported that they felt their performance had improved and that they had enjoyed the last session best. Some subjects reported retaining a clear overall 'picture' of their summary weeks later pertaining to Session 4 but had, in fact, forgotten most of their summary pertaining to Session 1.

7.6 SUMMARY

In the pre-training session, the experimental population showed a wide range of performance both in terms of the effectiveness of the summaries and of the patterns of reading. These clearly related one to the other. It was possible to classify subjects into efficient summary types (EST) and inefficient summary types (IST). The inefficient summary types could be distinguished into mass production types (MPT), inefficient summary typesIST) and a very inefficient summary type. (VIST). After the training sessions at the sentence and chapter level, everyone improved in their summaries, but the extent of the improvement differed. These differences in improvement could be related to the classification of subjects in the pre-training session. The EST subjects increased their Selectivity and Performance scores. The IST subjects increased their Selectivity and Performance scores, but this improvement did not match that of the EST subjects. The MPT subjects increased their Selectivity but tended to decrease their Performance scores. The VIST subject increased her Selectivity score slightly and her Performance score considerably.

7.7 A Need to Elaborate and Extend the Pilot Study

The conclusions of the Pilot Study emphasise the need for a more comprehensive evaluation of training. This evaluation depends upon four interrelated studies:-

1. Further Development of the Instructional Procedure.
2. Further Equipment Development.
3. Further Technique Development.
4. Further Field Validation Studies.

1. The Instructional Procedure (Training)

(i) A longer-term instructional procedure would allow for a more adequate transfer of learning skills, especially amongst the less effective students. The repetition of training over a longer time-span would re-alert the student to the learning tactics offered, and patterns of changing behaviour and improvement would be under learner control for a longer term of practice. The three phases of learning specifically, cognition, fixation and automation (Fitts 1962) Unit 1,1.2.3.) would be more likely to be assimilated into the 'internal score'. Within this longer training span the possibility of speeding up the input process which has been slowed down by training would become more feasible.

(ii) A single programme of training for everyone was not only wasteful but provided too rigid an external control on learning. Each individual differed in the existing structure of learning skill and knowledge. A more effective programme based upon the fact that students require individual instruction is essential. Such a programme would aim at diverting control from the externally controlled situation to the learner in a gradual sequence. This might be achieved by developing a progressive system of diagnosis and training which each student could use selectively. Each would move from diagnosis into a specific type of training, back to further diagnosis and further training according to the individual need. Such a system would lead to greater economy for the better learners and greater success for the poorer learners than that which was achieved in the undiscriminating mass training attempted in the Pilot Study. The diagnosis would be based upon the identification of effective learning strategies and the objective assessment of performance within a range of externally set tasks. The training would provide continuous feed-back of the learner's protocol and performance in relation to the instructional directives. The increased awareness of the process of reading-to-learn, coupled with explicit instructional directives relating to the externally set task, would set up an ecological framework within which the individual could determine his rate of progress. A general plan for individual training is presented below:-

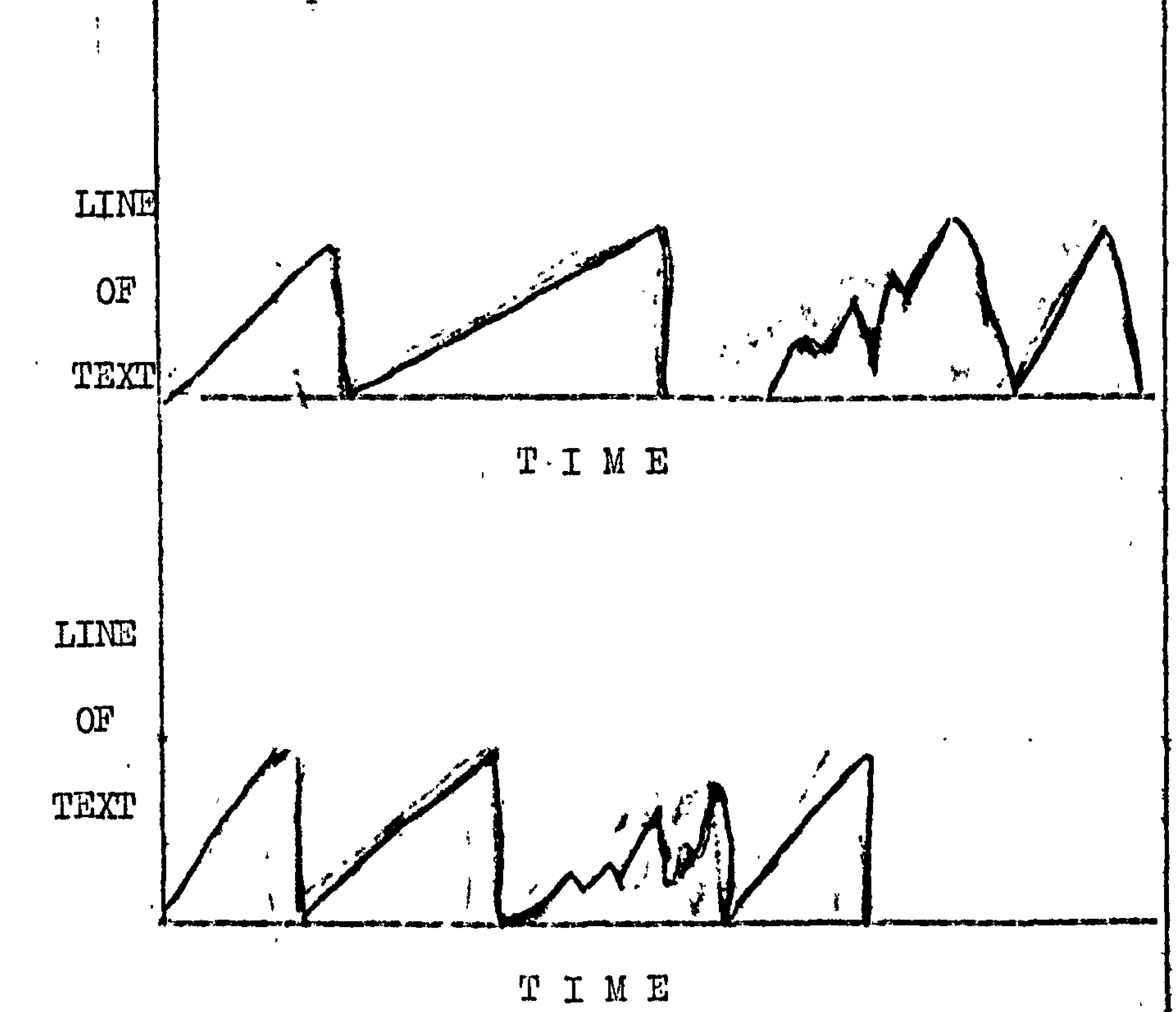
PROPOSED INDIVIDUAL TRAINING

PHASE	INSTRUCTION	AIM
1	Answer Questionnaire on reading method.	To evaluate the entering behaviour or 'store' of reading skills and to encourage awareness of reading-to-learn as a process.
2	Instruction to 'learn' text. Externally set task very generally defined. Analysis of reading protocol and broad screening of performance within a variety of tests.	To diagnose learner definition in relation to learner skills and knowledge.
3	To provide feedback of reading protocol and performance in Phase 2.	To make aware any inadequacies in tactics and performance.

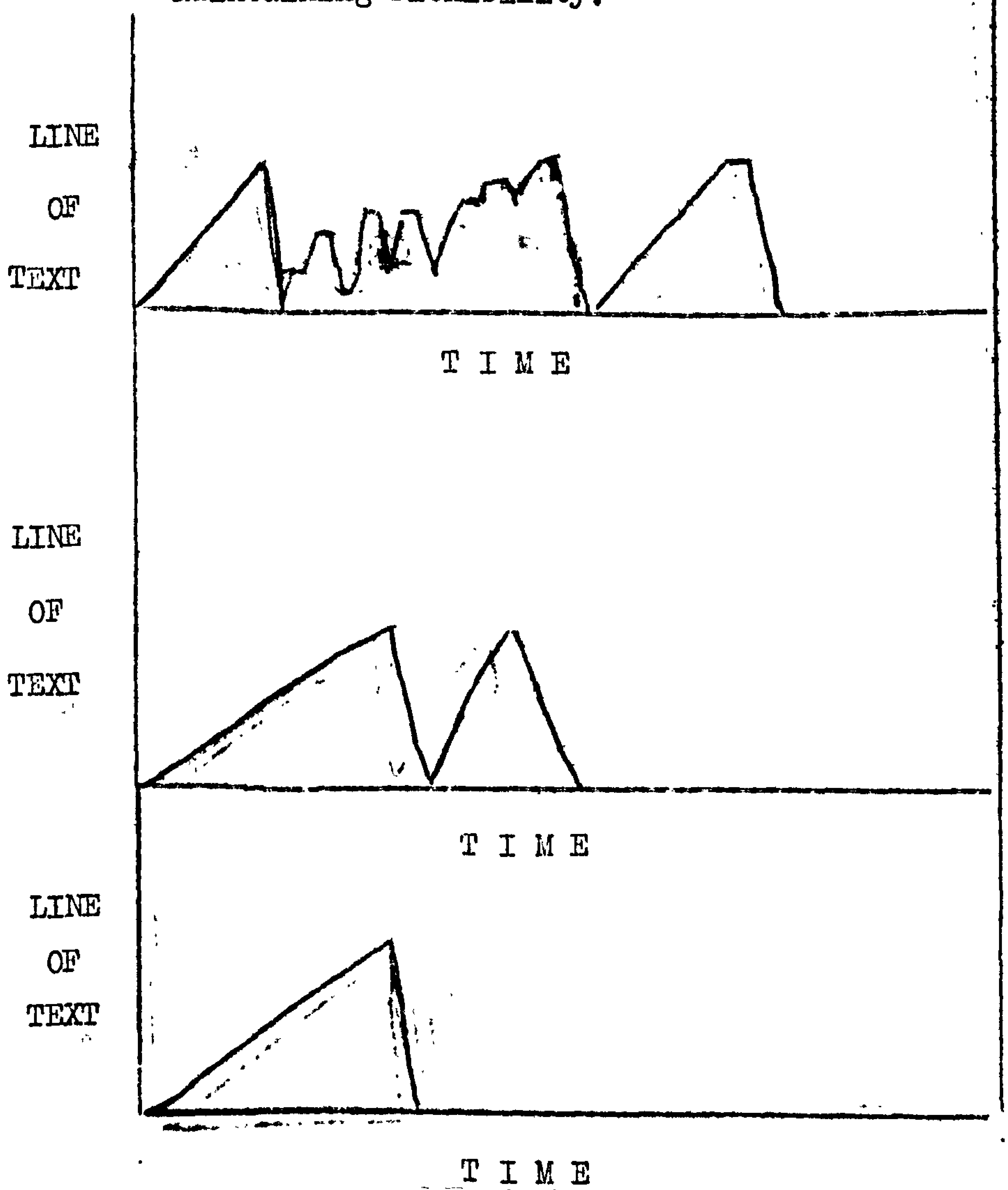
PHASE	INSTRUCTION	AIM
4	Instruction on how to read similar texts for different purposes. Set up a sequential training scheme based upon clearly defined externally set learning tasks and appropriate 'control' reading strategies, at 3 levels of definition. To introduce interim phases of learner controlled diagnosis within which an optinal training path is pursued. Externally set tasks to consist broadly of:- 1 Objective Tests related to knowledge in terms of Specifics, Universals and Abstractions. 2 Objective Tests related to other abilities such as, comprehension, analysis, synthesis application. 3 To select the Universals and Abstractions within a text and to write a summary. 4 To perform a number of other 'essay type' tasks which demand a processing of the text in terms of its hierarchical organisation.	To develop the concept of how specific learning strategies relate to specific tasks and to increase explicitly the individual's range of reading tactics and learning skills.
5	Instruction on how to read similar texts within one strategy for two or more purposes. (To perform efficiently on a combination of two or more of the tasks enumerated in Phase 4).	To increase the flexibility of strategies in relation to performance.
6	Sequential instruction for the increase in the speed of input processes, while maintaining the quality of the output.	To develop the concept of <u>speed</u> in relation to <u>quality</u> and <u>flexibility</u> of performance. To show that this concept is dependent upon the acquisition of an internally, hierarchically organised store of cognitive skills and cognitive structure.

(6 continued)

a) To shorten input time within the framework of specific tactics



b) To condense and simplify tactics while maintaining flexibility.



2. Equipment Development

A.(i) Refinements of methods of presenting the written information on the continuous stationery.

(ii) Development of a reading machine which would operate on the basis of a book form rather than on continuous stationery. This would increase the scope of the training, which is limited at present to the selected psychological and biological texts typed on the continuous stationery.

B. (i) Automation of various manual adjustments which have to be made on the plotter of the reading recorder which govern scale in relation to length of text.

(ii) Refinement of techniques for adjusting the stationery in the recorder and for exchanging the stationery easily and quickly.

C. Development of techniques for linking the information provided by the reading recorder to a computer (on a time sharing basis) which not only displays the protocols graphically via alphanumeric graphic display, but also provides numerical data in terms of time relating to the input/output process. The original method used was unnecessarily complicated and time consuming, involving magnetic and paper tapes.

D. Methods of developing computer programmes for analysing reading records and for developing the graphic display as an interactive device for student training in the use of reading as a learning skill.

3. Technique Development

(a) The charting technique for explicating the 'meaning structure' of the material requires further exploration, standardisation and development so that its use can be extended over a wider range of subject matter. Up to the present time, the technique has been restricted to scientific texts. The application of the technique to social science, literature and history requires exploration. A study group was formed to evaluate the hierarchical structure of a Thurber fable and tentative studies have shown that the technique has to be extended to accommodate extra dimensions of meaning. The use of cybernetics for the analysis of language is currently being explored. Literature findings suggest that this technique, while at the embryonic phase, has considerable potential.

(b) Assessment techniques of learning. The learning tasks which have so far been set and assessed in this programme of research have been of two kinds. Objective tests, demanding brief responses or multiple choice were used and those tested the acquisition of knowledge only. Other types of Objective tests, such as, matching pairs and other kinds of objective testing relating to such abilities as comprehension, evaluation, application analysis and synthesis, as defined in The Taxonomy, have not been explored. The essay-type task of summary composition was hierarchically evaluated in terms of the Universals and Abstractions in the text. Other essay-type tasks with a corresponding hierarchical assessment have not been developed. Learning assessments which have been formulated by the College Examination Board, (C.E.B.) and the B.S.C.S. Comprehensive Final Examination (B.S.C.G.) take into account the following activities:-

1. Ways of assessing, comparisons of viewpoints, comparisons of factual information relating to several theoretical assumptions.
2. Ways of relating specifics to a hypothesis.
3. Ways of handling quantitative relationships.
4. Ways of interpreting cause and effect relationships.
5. Ways of interpreting experimental data.

A hierarchical evaluation of the learning material in relation to the above activities would explicate a 'meaning structure' which could be used as a charting technique for the assessment of essay-type responses. Since the College Board has developed Achievements Tests (Objective Tests) based on the activities enumerated above, it would be pertinent to compare methods of learning which relate to essay-type tests and objective tests, geared to assess the same abilities. This study would be of particular interest in view of the learning methods and performances evaluated in this reported investigation. The empirical work reported has shown clearly that assessment procedures seriously influence learning methods. There is considerable literature at present available on assessment procedures which can be reviewed, so that a wide variety of learning tasks and assessments can be incorporated into the research strategy.

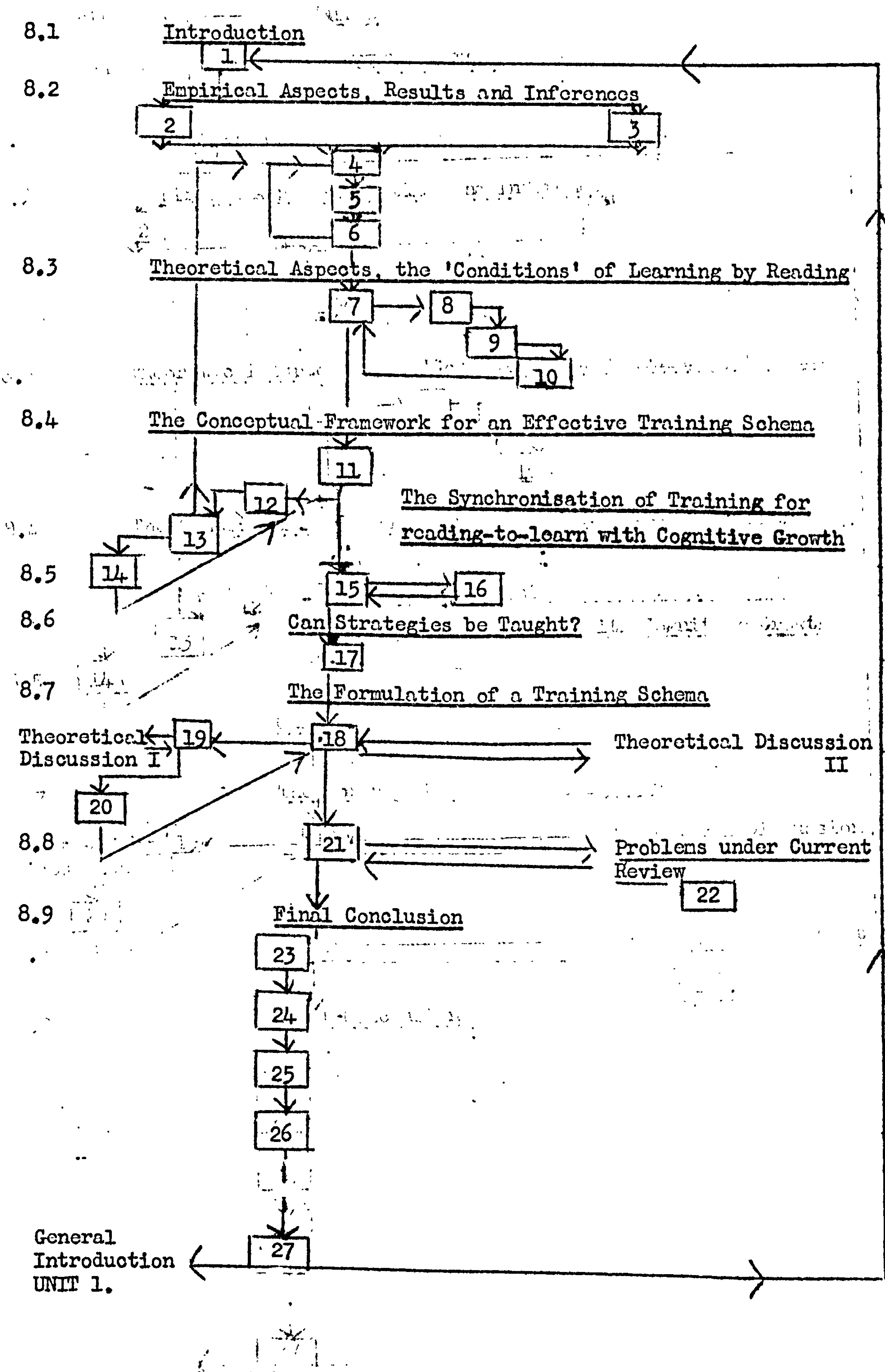
4. Field Validation Studies

a) A further study involving different age and ability groups in which each student is offered individual training in reading-to-learn tactics, should be explored. It would also be of considerable educational value to concentrate training on the bottom quartile of student performance and to compare subsequent performance with matched groups. As new learning assessment techniques are developed, these should be included in the training methods of the field validation study.

b) An interactive computer graphic method of training could be made available to students. Comparative experiments would explore the potentialities of this technique as a method of training in reading-to-learn skills and as a method for developing and evaluating techniques which could be used with the ordinary reading recorder.

Units 1 - 7 → UNIT 8

FINAL DISCUSSION - A STRUCTURED GENERIC FLOW DIAGRAM



UNIT 8. Final Discussion. An Assessment of the Practical and Theoretical Outcomes - Towards an Analysis and Synthesis

8.1 Introduction

1. The attainment of effective learner controlled flexibility in reading-to-learn, which was defined as the ultimate goal of the research project (Unit 1, 1.2.3) has been explored and partially achieved. This depended on the identification of sub-goals, each of which represented one dimension of the general goal directed activity, (Unit 1, 1.2.3.). Whilst these sub-goals have to some extent been achieved, the research activity has also served to clarify a number of associated theoretical and practical educational issues that need further study.

Sub-Goal 1 - The Exploration of Reading Strategies

Methods of reading-for-learning have been related to effectiveness of learning outcomes. Various types of learning tasks have been identified at the chapter and sentence level in terms of operational plans or strategies. (Unit 3, Experiments 1, 2 and 3. Unit 5, Experiment 4).

Sub-Goal 2 - The Exploration of the Structure of Written Material

The structure of written material, which provides the substrate for learning has been investigated in terms of the knowledge category of Bloom (1956). Scientific texts have been analysed into Specifics, Ways and Means of Dealing with Specifics, and Universals and Abstractions. Flow diagrams of the Generic Relationships within the texts have been developed. (Unit 2).

Sub-Goal 3 - The Exploration of Task Definition

The external and internal 'conditions' which influence the generation of Task Definition during reading-to-learn have been identified. The external 'conditions' consisted of the Instructional Directives and the Written Material. The internal 'conditions' consisted of the

Cognitive Structure, or the internal representations of the learner. A model of learning by reading is being developed. (Unit 4, 6 and 8).

Sub-Goal 4 - The Exploration of an Instructional Procedure in Reading-to-Learn.

A training schema for improving the range and effectiveness of reading-to-learn has been piloted. (Unit 3, Experiment 3, Group D. Unit 7: The Pilot Study).

It remains to evaluate the practical and theoretical aspects identified within this project for the purpose of assessing their contribution to a solution of the problem (Unit 1, 1.2 - Statement of the Problem), of inefficiency in reading-to-learn, and to identify possible next steps both in theoretical issues and in the development of more flexible and effective training procedures.

8.2 Empirical Aspects, Results and Inferences

2. The findings have confirmed the assumption that reading is a complex process. When recorded in detail, reading behaviour yields much more evidence about the exact nature of certain learning processes than had previously been recognised. Different patterns of reading produced different learning outcomes. It was possible to relate the learning of small units of knowledge or 'specifics' to hesitations at particular points in the pattern of reading and note-taking. Search patterns revealed the development of an understanding of the larger structural properties of the text in terms of themes and generalisations. The record of the process of reading (tactics and strategy) could often be used to predict what type of learning had taken place. It was more difficult to predict what type of learning had taken place from a 'smooth' read record. It depended on the relationship of this reading tactic with the other reading tactics, which formed part of a total strategy. Exploratory, review and passive reading processes were inferred. The

'smooth' read was the least effective observeable record of the process, which was taking place during reading. Further explorations of the technological devices used in the syntactic and semantic distortion of sentences in Experiment 4 could serve to determine more specifically the type of learning which was taking place during 'smooth' reading. Measurement of the reading rate could also serve to differentiate the type of learning taking place in the tactic of 'smooth' reading.

3. Reading-to-learn at the molecular (tactic) and Molar (strategy) level was dependent upon external and internal variables or 'conditions'. The external conditions were determined largely by the stimulus situation, which consisted of the instructional directives and the written material. These independent variables became dynamically interrelated in a learner controlled ongoing process during reading. The pattern of reading or strategy which an individual generated seemed to depend on his definition of the learning task, not only in general terms but in terms of the operational plan which he brought to bear. Instructional directives influenced this definition, but did not wholly determine it. Some individuals accepted the directives but were not able to translate them into an effective operational plan. Others persisted with their own plan in the expectation that the result would at least partially meet the instructions. Thus task definition can be seen as a personally creative operational plan which is derived from the stimulus situation, including both directives and the text, but is also largely influenced by the initial conditions of the learner. The plans of a beginner and an expert may bring about the same learning outcome, but they will differ considerably. The expert may merely have to read the text once in order to 'check' its content. The beginner may have to read it six times, working out a new vocabulary and building this up into meanings from which he can develop a structured understanding of the material

presented. Instructional directives based on assessment procedures, such as, objective tests and essays, influenced the individual learner's definition of the task, and the more skilled or competent the learner, the more likely was he to develop a reading plan which was optimal for the tests he expected to receive. Reading in an optimally effective manner for an essay-type answer produced learning which enabled the reader to cope effectively with objective tests. The reverse was not the case. Students reading in an optimally effective way for objective tests did not cope effectively with essay-type tests that involved the development of structure; nor did they retain the information as effectively over long periods.

4. A conclusion that has emerged from the analysis of the experimental data is, that any solution to the 'reading-to-learn problem' depends upon an assessment of the relationship between reading strategies (as far as these reflect on operational plan or self-generated task definition), and learning outcomes. Optimally effective alignment between the externally set task, or instructional directive, and the internally generated task definition leading to an effective learning outcome, was by no means a universal occurrence in the experimental population. Similarly, optimally effective alignment between what the learner said his reading purpose was (general task definition), and what he achieved in terms of learning outcome, was not a universal occurrence in the experimental population. The hypothesis is made that within the 'learning population' a major misalignment exists between the variables which determine the input and output activities of learning by reading. Empirical findings indicate that by making explicit the process of reading to learn, this situation can be remedied. This indication supports one of the basic introductory assumptions that a systematic intervention of the process of learning can affect its ecology to benefit

the learner. It is further emphasised that all the subjects who participated in this project represented the top 20% of the educational population. All had been selected for higher education. An investigation of the learning tactics and strategies in the botton quartiles of the educational population could reveal conspicuous misalignments between instructional directives, learner task definition and learning outcomes.

5. The type of mismatch which develops between the externally set task, and the internally generated task definition on the one hand, and between what the learner says his purpose is and what he achieves on the other hand, depends upon the implicit evaluative system which the learner brings to the task. This system of monitoring the learning process is partly determined by the learner's interpretation of what is expected of him, and of what he expects of himself, and partly by the organisation of his knowledge and reading skills.

6. The individual's 'operational' definition of the learning task may differ from what he says he is trying to do, but it can be inferred from the tactics and strategy underlying his pattern of reading. In some instances the operational task definition is so tightly circumscribed, and the monitoring system so rigid and restricted, that learning behaviour follows the same pattern for all set tasks and is, therefore, often not optimally effective. Some students had no strategic definition of learning, with the consequence that their learning behaviour lacked a general organisation and patterns of reading were uniformly of the 'smooth' type and very little learning of any kind took place. Some students rigidly defined the learning task as nothing more than a data processing of the rote type, identifying all items of information without any attempt at a hierarchical interpretation of the textual organisation. In both instances, the continuing impression was the lack of higher organisation in terms of the items of the text which was reflected in the

learning strategies. These students were generally confused when asked to discuss learning skills, reading tactics and text organisation. The few students who generated a reasonable match between the set task and their operational definition at the molecular and molar level, were more explicitly aware of their learning strategies. Such students were able to adapt their behaviour in order to be effective on rote types and comprehension types of learning tasks. Many students have a tendency to defend their learning tactics and overvalue the types of learning which can be achieved by their existing skills and undervalue those which are outside the range of their existing competence. However, it can be inferred from the pilot study training that when learning tactics and strategies outside their existing range are made explicit to students, this defensiveness can be overcome. Existing learning tactics become disrupted and new skills can be achieved.

8.3 Theoretical Aspects: The 'Conditions' of Learning by Reading

7. The theoretical aspects of the project have been concerned with the identification of internal and external 'conditions', which determine learning outcomes and with the interaction between these 'conditions', which result in the generation of value systems and operational plans. The use of cybernetic language within a neo-connectionist-cognitive framework (Unit 1, Theoretical Review) has been useful in a model building activity of learning by reading. It has made possible a positivistic approach to an attempt to explain what takes place inside the learner. Events within the skull are not inherently unobserveable, they depend on the development of adequate techniques (e.g. the reading recorder). As Broadbent (1958) points out in analogy, "it is rather like mountains on the other side of the moon, which are perfectly meaningful but rather difficult to test. The mountains are difficult to observe for reasons which are technological." The records of the tactics and strategies

of learning by reading are a step towards overcoming this technological barrier. The records present observables from which a valid causal inference about the learning process can be made. Strategies present the intersection between the stimulus and the terminal response situation. Strategies present useful implements in a remedial training programme planned to increase the range and effectiveness of 'reading-to-learn', since they can be used to predict learner task definition and learning outcomes.

8. Inferences concerning the reading-to-learn process, based on observations of the stimulus situation, strategies and learning outcomes discount the stochastic conception of the process put forward by the connectionists (Unit 1, 1.2.2).

Within this stochastic tradition, Morton (1964) relates the speed of reading, as measured by eye movements, to the contextual constraints in a passage. Contextual constraints were determined by the order of approximation to English, which were constructed by the method of Shannon (1951) and Miller (1950). Slow readers increased their speed of reading up to the fifth order, fast readers further increased their speed to the sixth order. Morton and others hypothesized that fast readers used contextual cues more efficiently. The data from the reading records can be interpreted in a similar manner, but at a different level. Readers who read the text once smoothly and effectively used contextual cues more efficiently than readers who read the text several times. However, the contextual cues are of a different order to those considered by Morton. Readers of the scientific texts presented in this reported empirical work were differentiated, according to their use of contextual cues relating to the semantic hierarchical organisation of the texts. Few were able to explore the range of specifics, ways and means of dealing with specifics, and universals and abstractions in a text, in one continuous read. Others were forced to explore the text several times.

It is hypothesized that the kind of contextual cues used by good readers relate not only to the statistical approximations of the language but also to the semantic organisation of their internal store, the Cognitive Structure or Cognitive Schemata. (Theoretical Discussion 1 and 2). The more organised the internal store in relation to the external hierarchical organisation of the text, the more efficient is the reader in making use of the contextual cues and in generating match. Likewise, the less organised the store, the less efficient is the reader in making use of the contextual cues and in generating match. Morton also reported that the number of both forward and regressive eye movements decreased with increase in contextual constraints and with the increase of speed reading, and that fast readers were superior to slow readers in this respect. Again, a similar interpretation can be made from the reading records. The more 'difficult' a reader found the text, the more explorations he had to make within the text, in order to 'understand' it. Such explorations consisted of hesitations, as well as backward and forward explorations of the paragraphs. The easier a reader found a text, the less explorations he had to make in order to understand it. Morton's evidence from eye movement data for the constant length of the fixation pause in fast and slow readers on passages of all orders of contextual constraints, shows that the duration of the fixation is not what distinguishes readers. Slow readers make larger numbers of fixations with smaller saccades (eye span), fast readers make smaller number of fixations with larger saccades Our studies suggest that the size of the saccade is related to the internal mediation process or Cognitive Structure of the reader, emphasising the central role of the reader in generating an operational plan. It is inferred that the internal mediation process or Cognitive Structure is hierarchical, conceptual, highly elaborate, idiosyncratic and generative. It depends on an interaction between the internal and external environment.

9. The physiological basis for this Cognitive Structure is hard to recognise in the light of present knowledge. The unlikely physiology of the gestaltists has produced neglect of their psychological achievements. Hebb's hypothetical constructs based on physiological terms lays itself open to disproof, by further physiological research. Psychology is, however, an area large enough to form an autonomous science, and hypothetical constructs about psychological processes of verbal learning should be based within the framework of language and the user of the language. Miller (1965) has emphasised the importance of realising the complexity of verbal behaviour. He enumerates seven aspects of human language that should clearly be understood by any psychologist who plans to develop hypothetical constructs about verbal behaviour. The outcome of this seven point assessment of language is an inevitable emphasis on the mentalistic and generative aspects of the Image and Plan. According to Miller, the language of communication theory alone is inadequate to account for it. Miller's language applies to the results of this research project which emphasise the overall organisational properties of Cognitive Structure rather than the more detailed physiological approach.

10. Problems, which the findings of this dissertation have seemed to emphasise at the theoretical level, are:-

a) What is the relationship between the Image and the Plan?
b) What is the relationship between the storage of information (knowledge), and capabilities (skills)?
c) What is the relationship between short and long term memory stores?
d) What is the relationship between problem solving activity and the hierarchy of knowledge and skills?

Piaget argues that the hierarchy of skill is a separate entity from knowledge and develops in ages and stages. Gagné argues that knowledge and skills are dynamically related and interdependent. In the light of its general educational emphasis, the findings described in this dissertation favour this latter view. These viewpoints have bearing on the metaphysical aspects of the nature of reality. Is the internally generated Plan (or skills in action), which is part of the Image, a structured reality only within the learner, or does it reflect and operate on an external environment (in the case of reading-to-learn, the text and the instructional directives) which is also structured? In the case of the latter alternative, what is the nature of the interaction between the internal and external world of structure?

8.4 <u>The Conceptual Framework for an Effective Training Scheme (or Instructional Procedure).</u>

11. <u>The development of an effective Training Programme needs to take the nature of the interaction between the learner and his environment (the text and the instructional directives) into account.</u> The hypothetical constructs of Piaget and Bruner relate to an external environment, which is structured. These researchers argue that intellectual growth depends upon a mastery of knowledge and skill, which are transmitted with varying efficiency by the culture, the growth of the use of language being a prime example. According to Bruner, <u>Cognitive Growth</u> is as much from the 'outside in' as the 'inside out'. Cognitive 'reality' is an <u>internalisation</u> of the individuals experience and <u>interaction</u> with the outside world. Piaget argues that development of the <u>Cognitive Schema</u> is the result of <u>a continuous interaction</u> of the child with his environment. It depends on <u>maturation, social interaction, physical activity</u> and most important, <u>the process of equilibriation or self-control.</u> The more the learner is in control of his perceptual and behavioural activities, the more he is able to create new relationships and resynthesise his Cognitive Schema.

If the constructs of Bruner and Piaget are valid, then a training schema for improving the effectiveness of reading-to-learn, based on making the learner's interaction with his external environment explicit to him also becomes valid.

12. Thomas (1962-1968) argues that, during intellectual growth, self organisation and control develop hierarchically, resulting in and being the result of a hierarchically organised system; a dynamic perceptual and behavioural set. The Dynamic set and Value system of an individual interact. Sometimes externally communicated values can come to influence the Set. Sometimes interaction with reality based on the Set results in the development and revision of Values. The interaction between the Value system and the Dynamic Set often become stabilised and rather impervious to change. The Value system reinforces the Set and the selectivity of perception and behaviour embodied in the Set validates the Value system. This self-perpetuating system results in a 'closed loop' interaction between the Image, Plan and the external environment. Like its components, Dynamic Set is hierarchical. It operates in terms of short, medium and long-term activities. According to Thomas, the lowest level of short-term activity involves the scanning of a sequence of high probability elements,(the probability being set by the subjective context in which the scanning takes place.) The scanning of these elements is organised by a higher level of Cognitive Structure into larger units, which may themselves be of higher or lower probability. If they are of low probability then more feedback is required to confirm their validity, and Thomas argues that feedback can be equivalent to consciousness (Sylvan Tompkins). If they are of high probability, a higher level of organisation groups them into larger units, which are reviewed as a whole, thus setting the level of consciousness at higher levels of organisation, such as, reading complex sentences,

a paragraph or chapter, the probability becomes so low that significant time is required for the scanning and review to take place and the activity becomes classified as 'thinking'. Thus, what at one stage of development may require 'thinking out' may at a later stage become 'directly perceived'. The obverse is equally true. What for some purposes is directly perceived as a unit may require to be broken into smaller units and reconstructed. If the range of probability is increased, then the probability of any particular meaning is decreased, more checking is required and therefore what had previously been an immediate perception becomes a longer conscious process of looking.

Thus in reading, a person can be aware of individual words, phrases, sentences or the semantic context of whole sections of text. Disruption of our expectations at higher levels leads to awareness of the component parts.

13. The general malaise in reading-to-learn can be accounted for by the hypothesis, that the long-term goal or learning outcome, and the operational plan which relates to this, do not match. As a result of instructional directives, the learner may say he is reading for composing a summary, but, in fact, his operational plan or strategy indicates the scanning of small units of information or 'specifics' only, and his achievement in terms of learning outcome consists of success in objective tests only, or the mass production of information. At worst, the learner may say he is reading for composing a summary, but his operational plan or Strategy indicates that no scanning of meaning units is taking place at any level, in other words he is monitoring at the lower level of grapheme/phoneme decoding. The value of a training schema depends on its power to alert the individual to this dilemma and to enable him to overcome it. The training must take into account the need to interfere with an individual's Value System and Dynamic Set in order that he can enrich it.

14. The 'whole', which is the unit under review at a particular time must match the short and long-term goal, or learning outcome, if the activity is to be effective. The learner must be encouraged to scan lower units in the hierarchy, which he has assumed to be those of high probability, in order to assess how these units match to his long-term goal, and also to develop skills to deal with the scanning of low probability units so that these can be reviewed as a 'whole'. If his goal is to learn 'specifics', then his scanning activity must monitor 'specifics' in the text. If his goal is 'to summarise', then his scanning activity must monitor the interrelationships between larger meaning units of the text. Depending on his knowledge and capability (Image), this long term goal may involve a short term goal of sub-scanning for 'specifics' so that these become incorporated into units of high probability. What to an adult reader may be units of high probability and therefore not scanned, may in a child be units of low probability and require scanning. Similarly, what to one adult may be units of high probability and not scanned, may to another adult, whose knowledge and capabilities (Image) in that external situation is of low hierarchical order, be units of low probability and require scanning. The 'whole' which is under conscious review at one particular time, may be of high or low probability in the hierarchy of knowledge and skills, which constitute the Image or Cognitive Structure. In hypothesising that the process of reading is a cognitive thinking process, then the identification of strategies of reading the 'how' of the reading/thinking act in relation to the 'why' of different strategies for different purposes must reflect the Cognitive Structure, Dynamic Set and Value Systems of the learner. An identification of strategies which represent the interaction of the learner with the stimulus situation in relation to Learning Outcomes provides the implementation system for a training schema.

8.5 The Synchronisation of Training for Reading-to-Learn with Cognitive Growth

15. Increase in reading task complexity most likely requires a cognitive functioning that develops from stage to stage in maturity similar to the stages that Piaget and Bruner have identified. During the age of formal operations (adolescence), reading becomes a vicarious learning experience; abstractions can be conceptualised without the need for empirical evidence. Training adolescents in reading-to-learn could be of tremendous pedagogic value in promoting an elaborate internal differentiation of the individual's interaction with his environment. Training at this stage could synchronise with the mastery of self-equilibration or cognitive control, and would, therefore, encourage the formulation of a potentially elaborate and flexible Dynamic Set and Value System in which Task Definition and Learning Outcomes were operationally linked in an optimal way. In terms of reading-to-learn, the elaboration of the syntactic and semantic organisation of the symbolic internal representation would be effectively aligned to equally elaborate and highly organised information retrieval skills, or operational plans, linked to specific learning outcomes. The obverse also holds; Restriction of the syntactic and semantic environments during the period of intellectual growth as the researches of Bernstein and others (Literature Review Unit 1.2.2) have shown limits symbolic internal representation, as well as retrieval skills (or operational plans) and results in ineffective linkage with instructional directives, which relate to long-term, highly elaborate learning outcomes. Cognitive growth depends on language, which provides the external implementation system which enables an individual to represent the complexity of the social environment in which he lives, and to manipulate it in an integrated way. The integrated Plans of Miller, Galanter and Pribram (1968) reflect routines and sub-routines

that an individual learns in the course of mastering the structure of the social environment. Operational Plans depend on patterns that come from the 'outside in'. Training adults effectively on a long term basis would depend on whether the formulation of a Dynamic Set and Value System becomes permanently stabilised as a result possibly of the ageing phenomenon so that no further elaboration can take place. Morton (1960) found that after six months there was a statistically significant drop in reading efficiency in an adult training group. Pandkan (1959) found that the rate of comprehension falls off considerably above the age of 40 years, though not the rate of reading.

16. The findings of the empirical sections show that the reading behaviour of an individual as representative of his Value System and personality dynamics or Cognitive Style (Thomas 1962), is potentially changeable. Cognitive Style can be seen as an entity capable of change. The conservatism in accommodation to sentence complexity and task complexity, and the rigid reading behaviour of some subjects in Experiment 4 (the sentence experiment), could be interpreted as symptomatic of their Cognitive Style. The 'mass producers' and 'poor selectors' in Experiment 5 (the pilot study), can be interpreted similarly. Training changed the reading-to-learn behaviour of these subjects on a short term basis. These 'mass producers' and 'poor selectors' were notably from an impoverished educational environment, which was restrictive to intellectual growth. Research within the lower quartiles of the educational population is needed to identify how Value Systems and Cognitive Styles are represented in reading-to-learn behaviour, and to test whether this behaviour is open to change on the basis of short and long-term evaluation.

8.6 Can Strategies be Taught?

17. The pilot study showed that on the basis of a short-term evaluation, strategies of reading, which relate to effective learning outcomes, can be taught. Bruner (1964) claims that strategies of thinking

concept attainment and problem solving must be learnt and, therefore, can be taught. A significant study by Taba (1964) was concerned with teaching strategies of thought processes. Her multidimensional analysis of classroom transactions in terms of measurable changes in levels of thinking showed that children can learn to make inferences, to generalise and to make logical assumptions if they receive systematic instruction. As strategies of thinking, concept attainment and problem solving must be learnt and can be taught, so strategies for effective reading-to-learn must be learnt and can be taught. Evidence from the pilot study strongly supports this assumption.

8.7 The Formulation of a Training Schema

18. The practical aspects of relating strategies of reading to learning outcomes, and the theoretical aspect of constructing a model of learning by reading need to be incorporated within a training schema, if this is to be effective. Some of the conditions which need to be taken into account within a conceptual framework of an effective training schema have been discussed in the preceding paragraphs. It becomes clear that in order to improve learner task definition in relation to learning outcomes, it is essential to develop a language system common to instructor and the learner. Within this system a learner can be guided in such a way that his total reading-to-learn activity is under his explicit control. In the pilot training scheme, this language depended on relating the hierarchy of tasks or goals on the one hand, and performance, on the other hand. The empirical findings imply that this relationship is operationally linked in the form of observeable strategies. It is hypothesised that the tasks and the skills required to perform these tasks are hierarchically organised. To perform a task a learner must have subordinate capabilities, and to perform a superordinate task in the hierarchy the learner must be guided by means of instructions. Attaining the superordinate task depends on the recall and selection of subordinate capabilities and on instructions. The empirical findings of this dissertation have served to identify effective ways of achieving some of the

tasks within the hierarchy of tasks, which relate to reading-to-learn outcomes at the sentence and chapter level. A hierarchical model of the reading-to-learn tasks has been inferred from the strategies identified.

A HIERARCHY OF READING-TO-LEARN TASKS

RESYNTHESIS OF KNOWLEDGE STRUCTURE OF TEXT

RETRIEVAL

7. Problem Solving. Selection from sets of capabilities in hierarchy (1-6) for the purpose of accomplishing one specific task on one specific text, i.e. to manipulate the text in a controlled but flexible way. This tests the power and speed of reading.

6. Evaluation. A critical reaction to the author's choice of words and meanings by comparing generated meanings with self experience and beliefs, and reorganise into a new synthesis in literature, style, humour, pathos: in science, validity of hypothesis, models, theories.

5. Extrapolation. To be aware of the limits of the original knowledge structure and the possible limits to which it can be extended, by the selection of units of meaning which are related at any one level of the hierarchy of knowledge structure and by making inferences from experience outside the knowledge structure and reorganise into a new structure.

4. Interpretation. To understand the interrelationships between the types of units of meaning in the knowledge structure by the selection of units of meaning which are related within one level of the hierarchy or knowledge structure and reorganise into a new structure, (in own words) translation.

Translation of original units of meaning into new knowledge structure ie. translation from one verbal form to another.

Recognition and Recall of types of units of meaning on a hierarchy of knowledge structure; by the identification of the recalled/recognised units into types of units.

Recognition and Recall of Units of meaning as in original knowledge structure.

RECOGNITION

3. Recognition of groups of words as types of units of meaning related in a hierarchy.

Specifics, Ways & means of dealing with Specifics,
Specifics, Concepts,
Universals & Abstractions Principles

2. Recognition of groups of words as units of meaning/units of syntax.

Semantics Units of Knowledge | Syntax, Subject/Predicate, Clauses, Right Recursive; Deep Structure; Kernels and Transforms.

1. Recognition of printed word - syntax/semantics

DECODING

Grapheme/phoneme Correspondence

At each level of the hierarchy (Decoding, Recognition and Retrieval), the learner is generating match and closure, depending on his task definition in relation to the learning outcome and on his Cognitive Structure (as discussed in Unit 6, Theoretical Discussion 2.). The training attempts to guide the learner to identify in explicit terms the nature of the match, or mismatch, and to provide him with instructions to learn a new set of skills, which he can consciously manipulate to generate match and closure.

19. Since the tasks and the corresponding skills or capabilities are hierarchically organised, the training is also conceived of as packaged into a hierarchy of modules. The ultimate task or goal in the hierarchy of training modules is to enable the learner to manipulate the printed material in a controlled, but flexible way in relation to his task definition and terminal performance. This behaviour involves the recall and selection of capabilities within the hierarchy, and their integration as a result of instruction into an effective operational plan. Depending on the entering state of each learner, any superordinate task in the hierarchy of capabilities may need to be learnt in this way.

20. Training at any one given level needs to take Glaser's teaching model into account (Unit 1, 1.2.3). Specifically, this involves assessing the entering behaviour, proceeding with instructional procedures and evaluating the performance. Reference to the model of the student as a learner, through the medium of reading (discussed and developed in Unit 4, Theoretical Discussion 1) emphasises the need to take the stimulus situation, terminal response situation and capabilities or Cognitive Structure of the learner into account. The learner must be capable of identifying:

1) The elements in the stimulus situation.
2) The elements in the terminal performance.

He must be able to

3) Recall previously learnt capabilities.

4) Make use of instructions.

The function of instruction is thus seen as a means of increasing awareness of the stimulation situation, learning outcome and learner capabilities. A hierarchy of instruction needs to be developed which takes the learner from a more general level of instruction to a more specific level, and back again according to his needs. In the pilot training, and in the training which is being elaborated for further research activities, these instructions are based on strategies which identified effective ways of achieving learning outcomes. Currently the author is exploring the problems raised by the need to develop a hierarchically organised, learner-controlled programme of selective diagnosis and instruction. The empirical work suggests that feedback of the reading record is a useful tool within this learner-controlled programme.

21. A system of training in reading-to-learn effectively, which is being advocated, is aimed at making learning by reading a vicarious experience. Reading effectively can free the individual (as some individuals have freed themselves in the past) from the more rigid high powered spoon feeding, which often exemplifies the traditional classroom experience. Spoon feeding leads to restriction of cognitive growth, since the responses and the stimulus situation are under teacher control. The system of learner-controlled instruction being advocated operates by increasing the learner awareness and control of the stimulus and response situation in relation to his capabilities at any given time. At each superordinate stage in the hierarchy of tasks and capabilities the learner is encouraged to recall and select existing capabilities and learns a new capability. This activity can be described as vertical transfer. The hypothesis is made that during vertical transfer an important type of learning, which can be defined as productive learning, is taking place

and that Cognitive Structure becomes elaborated in terms of its hierarchy. The repetition of a capability already learnt on the same type of written material can be regarded as horizontal transfer. The hypothesis is made that during horizontal transfer reproductive learning is taking place, and there is no upward elaboration of the Cognitive Structure in terms of a hierarchy.

8.8 Some of the Problems which are currently under Review in relation to the Final Training Programme

22.(a)It seems necessary to distinguish between the hierarchy of tasks in a reading-to-learn training programme and the hierarchical presentation of the tasks in the training. In other words, part, whole or progressive part practice (Unit 1, 1.2.3.). The problem which needs to be considered is whether a training module should be based on one capability in the hierarchy, so that a 'learning set' for that capability is achieved, or whether a training module should incorporate each capability in the hierarchy, so that a 'general learning set' is achieved? The author is currently searching the literature for any leads on this problem.

(b) Our whole research effort at the Centre for the Study of Human Learning recognises the importance of self-organisation in any training. This raises the problem of developing an effective self-evaluating diagnosis in the training programme, which is currently being explored. It also raises the problem of levels of instruction and feedback of information. A system of three levels of instruction from the general to the specific in relation to the terminal performance, and system of learner-controlled diagnosis at each level is being further developed.

(c) It is further recognised that there is a need to increase the level of syntactic and semantic complexity at each capability level, viz. from sentence to paragraph to chapter to book, and from Specifics to Concepts to Principles. The intention is to hold each constant within a particular training module.

(d) The question currently under discussion is whether the hierarchy of training modules depends on an increasing familiarity with a particular cognitive area, i.e. knowledge area. Since internal representation in the form of capabilities and knowledge is not clearly differentiated, it is difficult to assess whether training in the hierarchy of reading skills can be achieved on semantically unrelated texts.

(e) An approach to empirical research put forward by Vygotsky (1969) is being considered, namely, that the right course to follow is to recognise units as the functional entities of the training modules. The effectiveness of a training module depends on the criterion, that, as a unit, it contains all the basic properties of the whole reading-to-learn process. In other words, that Decoding, Recognition and Retrieval activities function, within the unit. This unit, unlike the elements from which it is built, contains the basic properties of the total process.

(f) It is essential to distinguish our cognitive approach training from the more applied or physical approach to the improvement of reading skills, practised in a number of existing reading-to-learn courses. This more fundamental psychological approach to the improvement of reading skills (based on a psychological model of the process), is aimed at improving the causes of reading difficulty. The assumption is that if the causes are rectified, the effects will look after themselves, for example, regression, sub-vocalisation, word-by-word reading, ineffective skimming and scanning techniques.

8.9 Final Conclusion

23. To benefit from their educational experience, school pupils and college students must learn to abstract patterns of meaning from written and spoken language. This development is essential for a

technological society which depends upon imagination and invention. 'Intelligence' is no longer regarded as a rigid concept. Bruner (1966) emphasises that the development of man's ratiocinative capacities is open to the influence of the physical and social environment. Learning by reading is still a very much hit or miss affair. This preliminary research into the process of reading-to-learn has provided a psychological basis for the development of instructional procedures, which enable strategies of reading to be learnt so that cognitive effectiveness is elevated. A rigid system of instruction at best produces literate robots. We need no longer wait for 'superior' students to discover strategies of learning by reading, clumsily, slowly and painstakingly by examining the writings of 'scholars' in an attempt to determine their modes of functioning, and in the meantime, see the less able students either drop out or become semi-literate robots.

24. If reading is akin to thinking and represents a means of generating meaning systems, and if science is a search for relationships, then the science of reading-to-learn requires that the construction of concepts and principles, vicariously using language, without the need for empirical evidence, is central. Twentieth Century education cannot be satisfied with passive reading accomplished through passive processes and directed by passive teaching. Reading must be a thinking act and it needs to be taught in that way. If thought has its roots in action, then reading does too, within a developmental interactionist neo-connectionist-cognitive theory of learning.

25. This Final Discussion has served to bring together the empirical findings and theoretical model building activity of the research project. Its goal was to evaluate the empirical findings in the light of the development of the theoretical concepts. It served to emphasise that the growth and development of the former depended on a need for the further

growth and development of the latter.

26. The evaluation has clarified a number of practical and theoretical issues which stem from the original sub-goals of the research project (Unit 1, 1.2.3.), and which need further study. Specifically, these issues can be enumerated in the following sequence:-

(1) To identify the types of learning taking place during the execution of a 'smooth' read tactic.

(2) To investigate the relationship between the speed of reading and learning outcomes.

(3) To explore learner task definition, reading strategies and learning outcomes in terms of the instructional directives and the expository material, in the lower quartiles of the educational population.

(4) To examine the variety of implicitly set learning tasks, which form part of the educational curriculum, in terms of learner task definition, strategies of reading and learning outcomes. Within the classroom, responses to objective tests, and the selection of 'main ideas' in summary form are only two types of activities which are demanded of the student in reading-to-learn situations. Other comprehension tasks include the translation or paraphrase of knowledge from one verbal form to another; the interpretation of cause and effect, compare and contrast relationships, as well as the order of trends and sequences in time, and the order of objectives or purposes. Extrapolation tasks demand the awareness of the limits of the intrinsic organisational knowledge structure of the expository material and the generation of inferences from the students' experience outside the material, in order to synthesise a new organisational structure. Evaluative tasks rely upon a critical reappraisal of the intrinsic organisational knowledge structure of

the written material by checking this against self-experience and beliefs. In scientific texts this involves testing the validity of arguments, hypotheses, models and theories. In literature it involves testing the validity of style, irony, humour and pathos.

(5) The differentiation of types of learning tasks described above demands refinements in the analysis of written material. Items need to be identified in terms of the variety of organisational structures described above. Flow diagrams need to be constructed which indicate the relationships between the various organisational structures which characterise a text.

(6) A wide variety of different expository materials need to be explored in order to determine the intrinsic organisational structures which characterise them. In scientific texts, the organisational structure of chapters in textbooks, reports of empirical findings and reviews need further exploration. In literature, the organisational structure of novels, plays, poetry and essays need to be explored.

(7) In the Training Programme, the shifting of control from tutor to learner needs to be made more explicit. This might be achieved by developing a progressive system of self-diagnosis and training, which each student can use selectively. Each would move from a self-diagnosis into a specific type of training module and back to further self-diagnosis, and so on. The role of levels of instruction in the training modules needs further exploration. The problem of 'synchronising' the timing of training with cognitive growth also needs further exploration.

(8) Within a theoretical model building activity of the reading-to-learn process, the identification of Cognitive Structure needs to be made more explicit at the psychological level, and ultimately needs to be made explicit at the physiological level. What is the retrieval and storage relationship between internally represented knowledge of

language, which is hierarchically organised, and internally represented reading-to-learn skill, which is also hierarchically organised? What is the lreationship between short and long-term memory retrieval stores? How do open-ended problem solving activities relate to Cognitive Structure?

27. This assessment of the practical educational and theoretical outcomes of the research project has thus served to open up new cycles of practical and theoretical activity, and, in so doing, has emphasised the assumption made in the General Introduction (Unit 1, 1.1), that the whole process of a research investigation is a dynamic ongoing cyclical process, the equilibrium of which is always changing, at any one moment in time, according to the efforts of research.

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