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AGE, SOCIOECONOMIC STATUS AND PATTERNS OF COGNITIVE ABILITY

by

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A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Age, Socioeconomic Status and Patterns of Cognitive Abilities" submitted by Geoffrey Neale Molloy in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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Date 14th May 1973

ABSTRACT

The present study examined some relationships pertaining to socioeconomic status (SES) and patterns of cognitive ability among school children selected from Grades 1 and 4. The primary purpose of the investigation was to compare the relative merits of two conceptually divergent models of intellectual functioning in accounting for individual differences in problem solving strategies. Specifically, the focus of this comparison centred on Jensen's hierarchical theory of two levels of cognitive ability, in contrast to the Luria scheme, positing two parallel modes of processing information.

A battery of tasks, consisting of measures of both Luria's simultaneous and successive syntheses and Jensen's Levels I (memory) and II (reasoning) ability, was administered to all participating children. The test scores were subsequently factor analyzed separately for each age level, so that the results would provide a major test of the process versus 'ability' models. These results were clearly supportive of the simultaneous-successive process distinction and provided no confirmation for the theory of hierarchical abilities. Thus, it was argued that the processes of simultaneous and successive syntheses describe problem solving strategies more appropriately than memory and reasoning.

The magnitude of the correlations between Level I and Level II tasks were similar for low and for middle SES groups. However, this would be at variance with derivations from a major hypothesis of the Levels theory--memory is normally distributed in the two SES groups, but reasoning has more middle SES than low SES scorers at the higher range.

This finding could be attributed to the fact that the environmental conditions of children participating in this study differ less widely in terms of cultural advantage-disadvantage than the milieu from which Jensen's original data were gathered.

Nevertheless, some of Jensen's more general points regarding SES performance differences tend to be confirmed; the low SES children were more handicapped in Level II (reasoning) tasks than in Level I (memory) when compared with the middle SES children. But contrary to expectations, the test scores of the two SES groups were much more disparate in Grade 1 than in Grade 4. With the exception of performance in picture vocabulary, differences between SES groups at Grade 4 were negligible. The increasing congruence between the SES groups was particularly evident when strategy preferences were examined by analyzing the factor scores of the two SES samples in each grade. At Grade 1, high SES children demonstrated a clear preference for the simultaneous mode, whereas, at Grade 4, preference for a particular mode was not related to SES. These levelling trends were taken to imply that schooling exerts a modifying influence on problem solving strategies.

A major implication of the present results is that the process of simultaneous and successive syntheses represent viable individual difference variables which are relatively independent of conventional indices of ability (IQ). Hence, viewed broadly, the Luria model provides a new dimension to the consideration of 'aptitude x instruction interactions', particularly for children who appear to derive little benefit from conventional methods of instruction.

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CHAPTER I

INTRODUCTION

The assessment of ability has been at the forefront of educational concern since Binet's work at the turn of the century. This concern has centred on an almost exclusive preoccupation with explaining individual differences within a predictor-criterion framework. The most popular measure of ability has been IQ. But Biggs (1968, 1969) notes that the IQ score, while providing a useful measure of general intelligence, confounds the possibility of identifying specific skills or qualitative differences in coding information. Such a score is merely a power or quantitative measure giving no clue as to why differences in these measures occur. Biggs' basic point is that IQ tests do not begin to tap the many forms of cognitive variation present in the repertoire of all children.

Recently, however, interest has shifted from a unidimensional view of general intelligence to a consideration of individual variation in the manner in which children characteristically approach cognitive problems. These differences are explained in terms of cognitive styles. Specifically, cognitive styles relate to individual differences in 'modes of perceiving, remembering and thinking, or as distinct ways of apprehending, storing, transforming and utilizing information' (Kogan, 1971, p. 244). While abilities also involve the preceding properties, there is an essential difference in emphasis. Abilities are power measures; they concern variations in level of skill, or the more and less of performance. Cognitive styles, on the other hand, refer to individual differences in the manner and form of cognition. Both abilities and cognitive styles cause individual differences in the performance of cognitive tasks. Both could also characterize differences between groups. This is particularly relevant when groups are contrasted on socioeconomic status (SES). A direct relation is commonly found between SES and performance on standardized intelligence tests. Obviously there are large differences within SES groups, but generally, IQ increases with ascending SES. Research in this domain has been mainly confined to the delineation of quantitative relationships between SES and cognitive task performance rather than an investigation into the possible underlying processes contributing to these differences. A greater understanding of the nature of performance differences linked to SES would facilitate the design of instructional techniques which could capitalize on the strengths found in children of a certain SES category.

The study of mental abilities is associated with a long tradition. A hierarchical model for the structure of these abilities dates back to the pioneer work of Burt (1949), which he has recently summarized (Burt, 1972). Other British psychologists, including McFarlane-Smith (1964) and Vernon (1969), advocate a hierarchical or group factor model which successively divides into more specialized types of ability. In the proposed hierarchy, reasoning and abstraction occupy a higher rank than memory. This thinking is reflected in Jensen's (1970) recent work.

Jensen hypothesizes a two-tiered, hierarchically arranged structure of mental abilities which he calls Level I and Level II. Level I or associative learning ability is presumed to be independent of socioeconomic status (SES), whereas Level II or reasoning ability is functionally related to the SES variable: viz., performance on Level II tasks improves with ascending SES.

Extrapolating from these assumptions, Jensen claims that a major factor contributing to the apparent inability of culturally disadvantaged (low SES) children to profit from classroom instruction stems from a teaching approach whereby the acquisition of basic skills is heavily dependent on abstract conceptual abilities (Level II). In the normal classroom, low SES children who are below average in Level II ability are subjected to an environment of increasing disadvantage. With increasing school experience, classroom instruction becomes progressively conceptual and these children are, in effect, operating on an extinction schedule. Too often, culturally disadvantaged children are reinforced for effort rather than success, and as a consequence the behaviours necessary for learning are not reinforced and the learning environment assumes the properties of conditioned inhibitors.

Jensen argues that the extinction schedule could be circumvented by employing instructional techniques more in accord with associative learning processes. Inherent in this claim is the assumption that culturally disadvantaged children are incapable of functioning in a Level II mode and that Level I processes can compensate for Level II deficiencies.

Potentially, Jensen's theory has important educational implications. However, before attempts are made to implement change in current educational practice as a consequence of the model, a major issue requires further research. The assumption of two differentially distributed levels of ability requires corroboration in a population not confounded by race and characterized by a relatively homogeneous environment.

Das (1972) has questioned the appropriateness of the Jensen model in accounting for SES performance differences after comparing MA-matched normal and educable mentally retarded children on tasks of reasoning and memory. When the test scores were factor analyzed separately for each sample, two common factors were obtained. Prima facie, these factors resembled Jensen's memory and reasoning. However, on closer examination this interpretation seemed inappropriate due to observed loading disparities on some tasks. By considering the nature of the task requirements, it was argued that the two factors could be more meaningfully interpreted as reflecting a simultaneous-successive process distinction (Luria, 1966a).

In the same study, Das did not find that performance differences favouring normals were greater in reasoning than in memory tasks. In the hierarchical model, normals would be expected to demonstrate a relative superiority on reasoning tasks.

In the Luria scheme, simultaneous and successive syntheses are seen as parallel styles or strategies rather than hierarchical abilities. Evidence in favour of this position is now available from a number of culturally different samples (Das, 1973a, 1973b). In some samples, such as the children from India, the successive mode appeared to be preferred, whereas in White Canadian children this was not noticed. The findings support the hypothesis that cultural pressures can and do modify individual preference for either mode.

The present study attempts to explore further the structure of cognitive abilities in relation to age and SES. There are clear indications that schooling is an important factor in mental development (cf. Bruner et al., 1966; Schmidt, 1966). Since the children in this study represent different age levels, age is considered as an educational rather than a developmental variable.

Essentially, the investigation is an attempt to determine whether differences in cognitive task performance can be viewed in terms of modes of information integration used by children in problem solving. Further, by focusing attention on age and SES differences, it may be possible to identify the environmental conditions which favour or inhibit the development of specialized abilities.

CHAPTER II

THEORETICAL CONSIDERATIONS AND RELATED LITERATURE

Some Factorial Conceptions of Intelligence

Charles Spearman (1927) was first to propose a factorial conception of intelligence. By intercorrelating large samples of cognitive task performances, he found sufficient communality among tests to support the concept of a single basic mental function. This general factor (g) is supposed to enter into any cognitive task requiring the ability to receive stimuli and mentally manipulate or transform such input. Spearman regarded abilities over and above g as specific or s factors which were unique to certain tasks. In other words, performance on any cognitive task involves a universal or general factor (g) and, to a lesser extent, a specific factor.

Since Spearman's pioneer work, a number of formulations concerning the nature of intelligence have been advanced on the basis of correlational techniques (cf. Burt, 1972; Vernon, 1950; Jensen, 1969; Guilford, 1967; McFarlane-Smith, 1964; Cattell, 1963). Burt (1949) rejected Spearman's monolithic notion of a single basic mental function and elaborated an hierarchical scheme. More recently, Vernon (1969) has provided a definitive model of the hierarchical theory.

Vernon's hierarchical model

Vernon (1969) notes that a characteristic feature of mental structure is hierarchy. An hierarchical or group factor model of intelligence admits the existence of a general factor, g, and successively subdivides into more specialized types of ability. In varying degrees, g enters into any cognitive performance, depending on the complexity of the symbolic processes for solution. The general ability, being symbolic, contrasts with tasks demanding skills of a more enactive or ikonic kind. After the removal of the general factor, g, tests fall into two main categories--the verbal educational (v:ed) and the spatial-perceptual-practical (k:m). Since these factors are not general, but run through a limited number of tests, they are called major group factors. If enough tests are given, the genealogical tree further subdivides into minor groups and then Spearman's s factors (Fig. 1). For Vernon, an ability or factor implies the existence of a

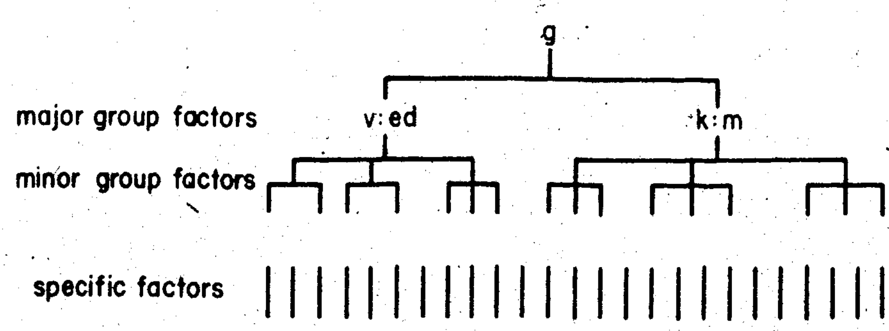

Fig. 1. Vernon's hierarchical model of ability factors. g = general factor, v:ed = verbal-educational aptitude, k:m = spatial-mechanic aptitude.

group or category of performances which correlate highly with one another and are relatively distinct from other performances. Thus, an ability is a construct accounting for the objectively determined correlations between tests.

In reference to the major group factors, Vernon points out that although people who score well on verbal tests usually perform similarly on spatial tests, it is possible for individuals to differ appreciably in their performance in these two areas. Of central importance for the current study is Vernon's claim that abilities over and above g arise partly from heredity but mainly as a function of experience.

The American position, earlier referred to by Vernon (1950) as the 'neo-faculty theory', diverges somewhat from the British view. American factorists are less inclined to acknowledge the presence of a general factor. Following Thurstone (1947) and Guilford (1967), the tendency has been to reduce the mind to a number of independent primary abilities. In reality neither approach serves to negate the other, and both are legitimate models for viewing the structure of mental abilities. The specificity theory does not disprove the existence of a general factor, and likewise, adherence to g involves the acknowledgement of group factors. For large representative samples the hierarchical model appears more parsimonious, whereas with relatively homogeneous groups--university students, MA-matched children--where g is in effect partialled out, the specificity model would possibly have more explanatory merit.

Cattell's theory of fluid and crystallized intelligence

The relative contributions of heredity and experience in the development of abilities is also considered by Cattell (1963). He takes the position that the traditional intelligence test confounds 'general brightness' with 'stamped in abilities'. According to him, the general ability factor now measured by intelligence tests can be reduced to two oblique second order factors which he calls fluid (gf) and crystallized (gc) intelligence. Crystallized ability loads more highly on those cognitive performances in which skilled judgement habits have become crystallized as a result of earlier learning. On the other hand, fluid general ability shows more in 'culture-fair' tests such as Matrices which require adaptation to new situations. Fluid ability 'is a capacity to perceive relations and educe correlates in Spearman's original sense' (p. 5).

The ability, gf, supposedly represents the influence of biological inheritance or constitutional equipment, whereas gc is the result of skills and concepts established through experience. Measures of gf show much greater variance, the standard deviation of IQs being 25+ as contrasted with a sigma of 15 which is typical of verbal tests. Cattell's explanation is that cultural pressures produce greater uniformity in the latter.

Over a person's lifetime gf will be more constant since this general ability is biologically determined. In contrast, gc, which hinges on cultural habits, will be of a more Protean nature. Up until biological maturity, individual differences in gf and gc will reflect mainly differences in cultural opportunity and interest. Subsequent discrepancies will reflect differences in age as the gap between gf and gc will tend to increase with experience and the time decay of gf. With increasing age, gf will show a more rapid decline.

Vernon (1970) concedes that Cattell's theory provides a sound model for conceptualizating mental development and deterioration. He believes that Cattell's second order oblique factors are psychologically more intelligible than g and group factors. However, Vernon notes that if one regards gf as g with a slight admixture of spatial ability and gc as g + v:ed factor, Cattell's scheme could be viewed as an hierarchical theory. Vernon does not regard the genotype or Cattell's gf as being measurable and argues that the major weakness of Cattell's theory is the claim that fluid ability tests are immune to cultural influences. According to Vernon, abstract reasoning skills of the type demanded by Matrices would appear to be built up in the same manner as those involved in verbal reasoning.

Jensen's Level I and Level II abilities

The influence of the Burt-Vernon hierarchical model for the structure of mental abilities is reflected in Jensen's (1970) recent work. Jensen points out that frequently teachers of the disadvantaged report that low SES children with IQs below 100 appear 'brighter' than their high SES counterparts. His findings indicate that lower class children scoring below IQ 100, are generally superior in associative learning ability to a matched group of middle class children (Fig. 2). Above IQ 100, this phenomenon is no longer apparent, which implies a threshold at the midpoint of the IQ distribution. Thus, Jensen suggests that IQ scores above 100 are reasonably accurate assessments of learning ability regardless of social class. In the below threshold range, however, the IQ test grossly underestimates the learning ability of lower class children. While it might be expected that low SES children would be relatively disadvantaged on culturally biased tests, he finds that contrary to expectations, when middle and low SES children are compared on 'culture-fair' intelligence measures such as Matrices, culturally deprived children perform relatively worse on this test. Jensen hypothesizes that these apparent disparities and confusions in

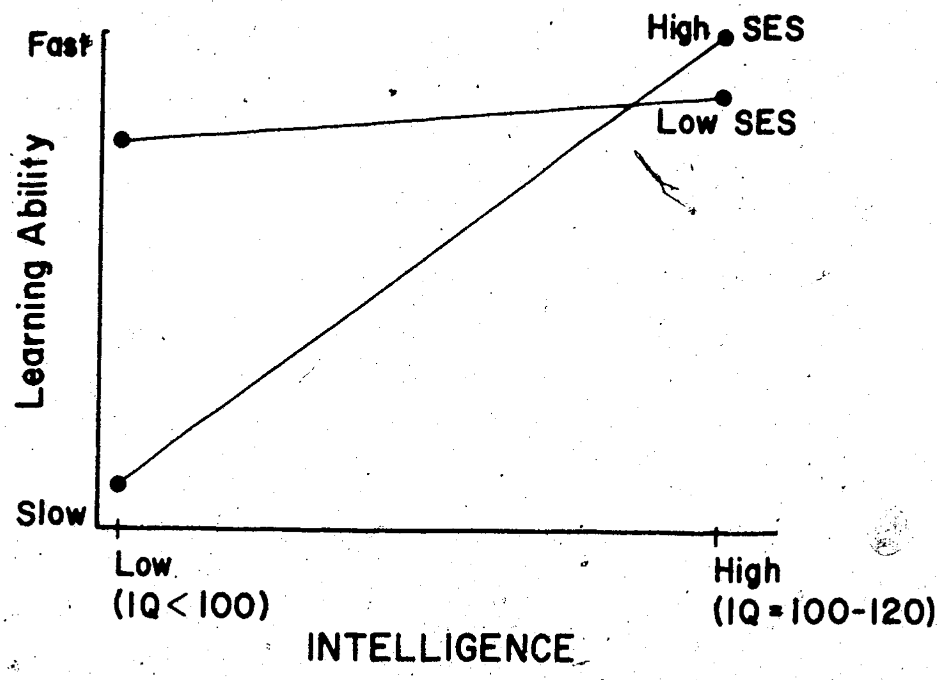

Fig. 2. Learning ability and IQ as a function of SES. The cross-over phenomenon.

cognitive task performance are the consequences of the disparate distribution of two categories of abilities, reasoning and memory, when middle and low SES populations are considered.

Jensen describes human mental abilities in terms of an hierarchical continuum ranging from associative to abstract reasoning abilities. His data, based on factor analysis, show that digit span, serial and paired-associate learning and free recall tend to cluster together, whereas reasoning and symbol manipulation represent a separate and largely orthogonal cluster. The two clusters of abilities can be classified in terms of the amount of information transformation required, or the degree of correspondence between input and output. At lower levels of the hierarchy, the transformation of input or information processing is relatively simple or direct, approaching a 1:1 correspondence. Higher levels of cognitive functioning depend on the elaboration and transformation of information or stimulus input and comparing the input with previously stored information. Hypothetically, cognitive tasks can be placed along a continuum where the extremes are represented by Pavlovian conditioning and abstract problem solving (see Fig. 3).

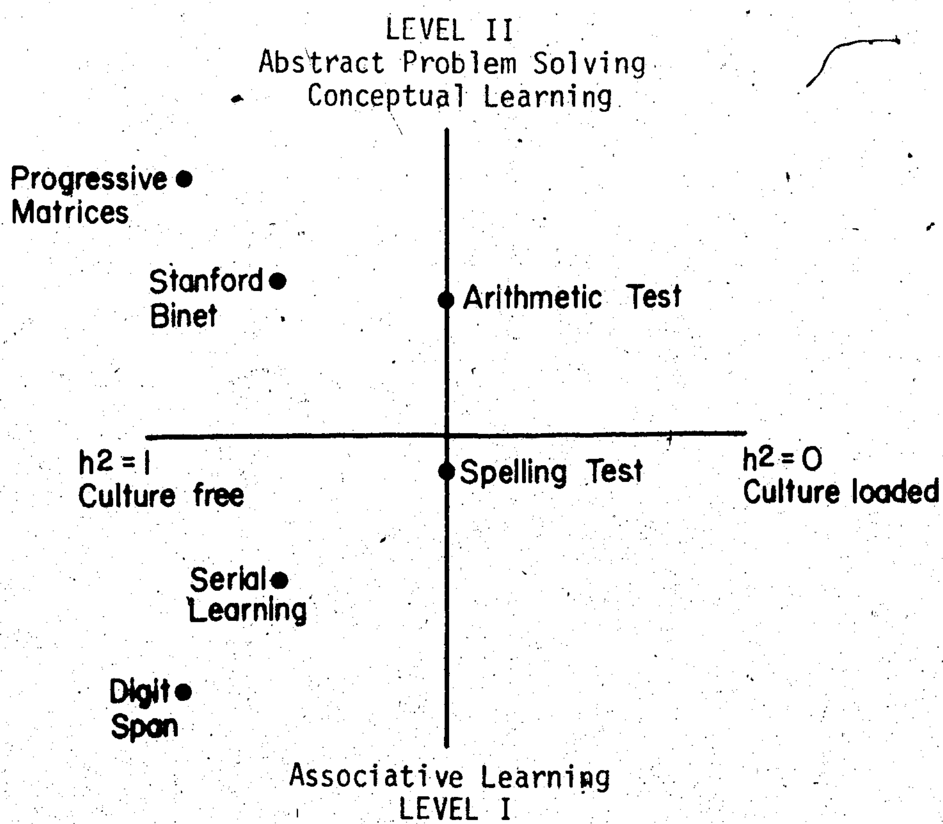

Fig. 3. The two-dimensional space required for comprehending social-class differences in performance on tests of intelligence and learning ability.

According to Jensen, the continuum is the result of two types of mental abilities which he labels Level I and Level II or 'associative' and 'reasoning' ability. Level I represents the ability to receive and store stimuli and later recall or recognize them with a high degree of fidelity. At Level II, the input is transformed or mentally manipulated to arrive at a judgement. The complexity continuum is not the same as difficulty *per se*, nor should it be confused with culturally biased versus culture free content. Matrices and Digit Span, for example, are comparatively 'culture-fair' tests but represent relatively pure measures of Level II and Level I, respectively. These hypothesized levels exist in parallel but are qualitatively different; they are functionally dependent but genotypically independent types of mental processes. Jensen further hypothesizes that Level I is independent of social class, whereas Level II is differentially distributed in the population as a function of SES (Fig. 4).

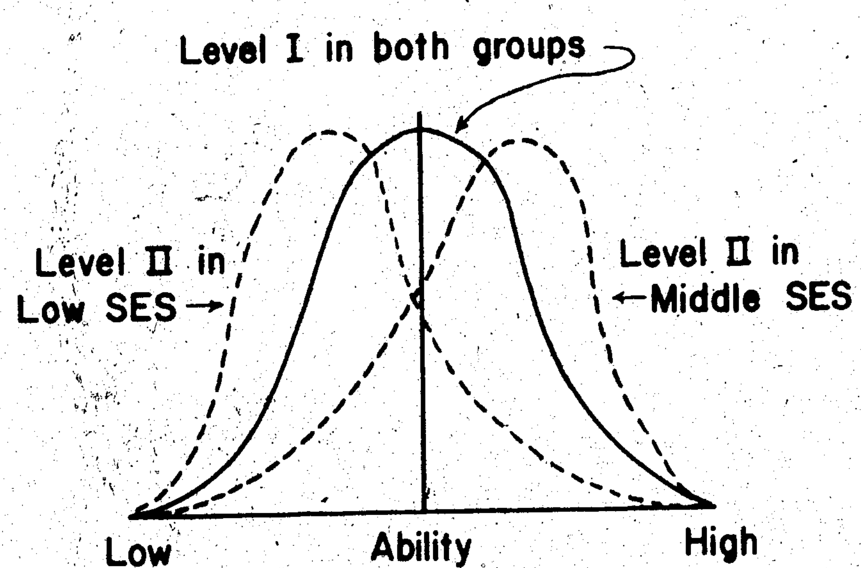

Fig. 4. Hypothetical distributions of Level I and Level II abilities in the middle and lower SES populations.

Level I is independent of SES--at least Jensen has found 'no evidence that would contradict this simple assumption' (1970, p. 58). Level II is disproportinately distributed in the population and is the product of assortative mating. Jensen points out that occupation is positively related to an individual's ability and educational attainments. Moreover, occupation plays a major role in determining SES.

The more 'gifted' an individual in Level II functioning, the greater his chances of moving up the socioeconomic ladder. Since spouses are selected on the basis of educational and social similarity, the genotypic foundation for Level II processes becomes increasingly skewed in the population.

> The greater the social mobility that is permitted by society, the greater will be the segregation of genetic factors associated with social mobility, the chief factors of which are educational and occupational attainments in modern industrial society. In the course of generations, there will be a gradual elimination of genetic factors making for poor Level II ability in the upper classes. (Jensen, 1970, p. 59).

Jensen hypothesizes that individual differences in the two levels of mental functioning are, by the process of selective breeding, genotypically uncorrelated since individuals may perform well on Level I tasks and poorly on tasks demanding Level II abilities. Phenotypically, however, the two abilities by virtue of the hierarchical dependence of Level II on Level I are related. To illustrate, the solving of a complex problem (presumably a Level II function) requires that the subject retain in short-term memory (STM) the individual elements of the problem (Level I) for a sufficient length of time to solve it: 'It is possible to retain the problem in mind without being able to solve it, but the reverse cannot be true' (p. 61).

Since Level I is posited to be a necessary but not sufficient condition for the manifestation of Level II ability, the functional dependence of Level II on Level I implies a 'twisted pear' type of correlation between tests representative of each level. In other words, there will be far fewer people falling into the bottom right quadrant of Figure 5 than in the other three quadrants. Figure 5

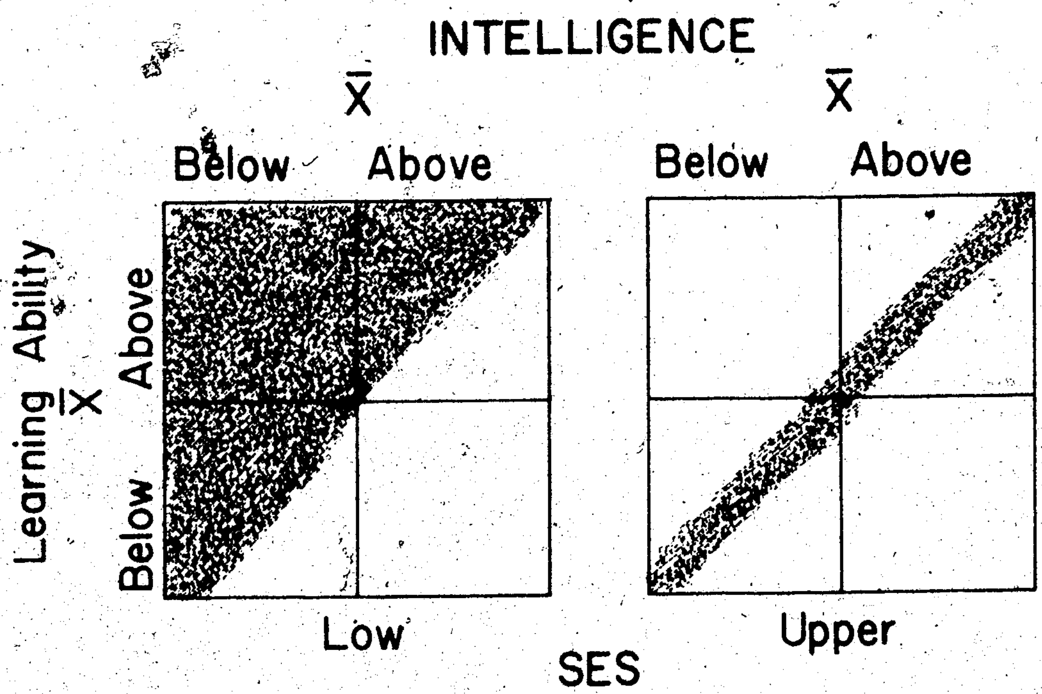

Fig. 5. Schematic illustration of the correlation scatter diagram for the relationship between learning ability and IQ in low and upper SES groups.

accounts for Jensen's findings indicating that his learning tests, principally digit span and serial rote learning, yield significantly different correlations with IQ in low and middle SES groups. In the low SES groups, correlations between the learning tests and IQ are in the range .10 to .20, whereas for middle class children the correlations vary between .60 and .80, which is of similar magnitude to the intercorrelations among various standardized IQ tests. In the light of these findings, Jensen claims that associative learning tests could substitute for IQ tests in the middle and upper SES segments of the population. This could not be said, however, of the lower class segment.

Jensen further hypothesizes that Level I and Level II abilities have markedly different growth curves as illustrated in Figure 6. The graph is intended to depict the hypothesis that Level I ability

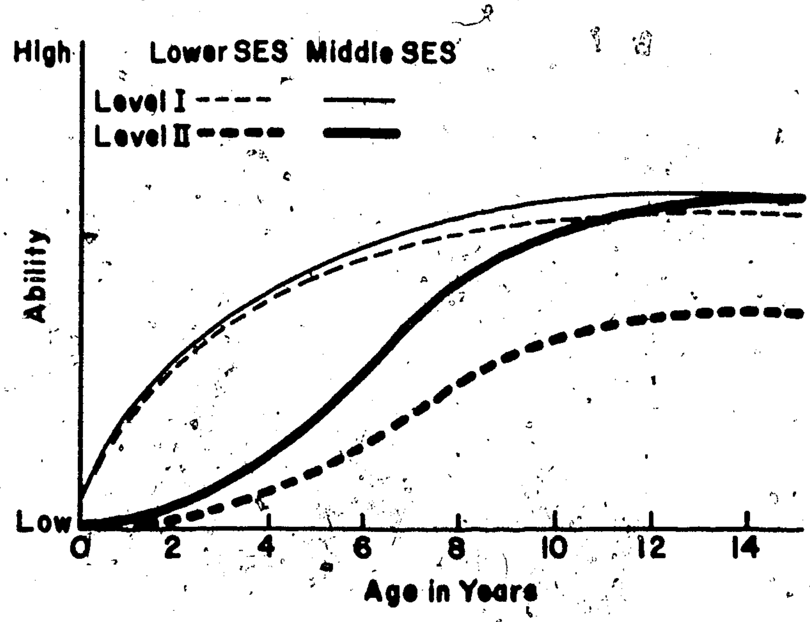

Fig. 6. Hypothetical growth curves for Level I and Level II abilities and middle SES and low SES populations.

increases rapidly with age, levels relatively early and shows only a marginal SES disparity. In contrast, Level II ability does not rise greatly until approximately five years of age. Beyond this period the SES growth curves for Level II ability become increasingly divergent approaching quite different asymtotes. For the present study, these hypothesized growth curves have clear predictive implications for the magnitude of SES performance differences as a function of age and task requirements. Although Jensen hints at information transformation as the critical variable in reasoning and memory, he does not consider how information is transformed or integrated. Perhaps cognitive abilities are intimately related to the manner in which information is transformed. In the next section, Luria's theory which deals directly with this is presented in some detail.

Luria's Simultaneous-Successive Process Distinction

Following Soviet tradition, Luria is not concerned with intellectual performance in terms of IQ measures. His research is biased to the qualitative aspects of cognitive functioning from which he concludes that there are two basic forms of integrative activity of the cerebral cortex. Luria's (1966a, 1966b) model is abstracted from observations with patients suffering from diffuse and localized brain lesions. These observations have led Luria to propose that the brain employs two orthogonal though mutually interdependent modes of coding information which he terms simultaneous and successive syntheses.

The process of simultaneous synthesis possesses the property of surveyability and refers to any system of relationships. Specifically, simultaneous synthesis is concerned with the 'synthesis of individual elements into simultaneous and, above all, spatial groups' (Luria, 1966a, p. 83). On the other hand, successive synthesis deals with seriation and is marked by the absence of the property of surveyability. This process serves to integrate individual elements into successive series distinguishable in time. Unlike Jensen's Levels I and II or White's (1965) cognitive and associative levels, Luria at no time claims that his two abilities are hierarchically arranged. However, for some tasks one strategy may prove to be more efficient than another.

Broadly, Luria has observed that localized lesions of the posterior (parieto-occipital) regions of the brain lead to a disturbance of simultaneous synthesis while the process of successive synthesis remains essentially intact. Conversely, lesions of the anterior (frontal and fronto-temporal) divisions affect the successive process with no corresponding disturbance of simultaneous synthesis. Lashley (1960) and Pribram (1958) subscribe to the parallel-serial process distinction but are reluctant to assign either function to specific brain tissue.

Lashley argues that all information regardless of sense modality arrives serially. The temporal sequence can be retained as such or be readily translated into a spatial concept. Reproductive memory, on the other hand, appears invariably as a temporal sequence, either as a succession of words or acts. According to Lashley, spatial and temporal order appear to be completely interchangeable in cerebral action.

Unlike Luria, Lashley is averse to the localization of brain functions. He is a proponent of equipotentiality rather than localization and claims that the visual cortex is perhaps the only area to show specificity. For Lashley, disturbance of cognitive processes are subject to the law of mass action, whereby efficiency of performance is reduced in proportion to the total amount of brain damage.

As to the question of specific cortical localization of function, Luria's position is somewhat ambiguous. He agrees with Lashley that attempts to directly localize complex functions are at this time inadequate. Nevertheless, Luria is not disinclined to certain bold generalizations. He proposes that posterior lesions (occipital-parietal) in the dominant (left) hemisphere interfere with simultaneous spatial organization, whereas lesions in the fronto-temporal area disturb the sequential organization of visual and auditory input.

Pribram (1958), too, proposes that brain functions can be reduced to two orthogonal processes, namely, sequential-simultaneous ordering. However, he challenges Luria's claim that the fronto-temporal regions are responsible for serial order. He believes that the entire pre-central motor cortex in concert with the posterior divisions deal with the process of simultaneity. According to Pribram, successive synthesis is disturbed only when lesions extend beyond the premotor into the more anterior or prefrontal regions.

For the present purpose, the issue concerning the localization of cortical processes is not a major consideration. The relevance of Luria's theory is that it provides an alternative to an hierarchical model of the intellect which distinguishes between mental functions in terms of stimulus complexity. In the Luria scheme, tasks are classified according to the mode of solution requirements, namely, whether they call for the simultaneous or successive ordering of input. The parallel-sequential process distinction does not imply that task solution strategies are hierarchically arranged; rather, these modes are seen as being parallel and mutually interdependent. Further evidence pointing to this coding strategy distinction is presented in the following discussion.

Factorial Evidence for Coding Strategy Distinctions

Spatial versus verbal ability

According to I. McFarlane-Smith (1964), 'the abilities of the mind are essentially bipolar' (p. 298). Following British tradition, he conceives of human abilities as being arranged hierarchically like a family tree. After the removal of the general factor, tests tend to fall into two major groups, namely, verbal and spatial. Smith cites evidence supporting his contention that spatial and verbal abilities are inversely related. He points out, however, that the correlation between verbal and spatial tests will usually appear positive due to the influence of *g*.

Smith's thesis is that current educational practice overemphasizes verbal ability at the expense of its psychological opposite--spatial ability. He argues that if teaching methods were modified to capitalize on the neglected spatial factor, the pool of ability--and the success rate at school--would be substantially increased.

Smith views spatial ability as an ability to perceive and retain in mind spatial patterns as an organized whole in contrast to the ability 'to switch attention from one item to another when perceived in temporal succession' (p. 52). This distinction bears a remarkable likeness to Luria's simultaneous-successive process dichotomy.

When Smith speaks of 'spatial ability' and Luria, 'simultaneous synthesis', they are in fact referring to the same phenomemon.[1] While there is reason to suspect that a similar relationship exists between verbal ability and the process of successive synthesis, the parallel is not so obvious.

The clinical observations of Gelb and Goldstein (1920)[2] provide the crucial link between 'spatial ability' and 'simultaneous synthesis'. Both Smith and Luria refer to Gelb and Goldstein's observation that, while some brain-injured patients were able to successively differentiate the elementary parts and details of an object (successive synthesis), they were unable to perceive a configuration as a whole. In other words, these patients revealed disturbances in spatial ability or the process of simultaneous synthesis with no corresponding effect in their ability to identify the elementary constituents or parts of the whole.

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[1] Smith is less inclined to venture from the visual mode. However, he does agree that some tests (e.g., arithmetic, Shipley's Abstractions) in addition to conventional spatial tasks do load substantially on the spatial factor.

[2] Cited by Luria (1966a) and Smith (1964).

Gelb used the term 'synopsis' to describe the ability to perceive a series of elements simultaneously as a single whole. Luria (1966a) notes explicitly that the process of 'synopsis' is identical to that which he calls 'simultaneous synthesis'. Lastly, it seems incontestable that the term synopsis is synonymous with Smith's spatial ability or 'the capacity to perceive and hold in mind the structure and proportions of a form or figure grasped as a whole' (1964, p. 6).

Like Luria, Smith claims that many abilities have a measure of cortical localization and that circumscribed lesions result in a predictable impairment of function. In agreement with Luria, Smith cites evidence indicating that lesions of the posterior divisions of the dominant hemisphere (left) result in defects in spatial and mechanical ability. Further, a centre for articulate speech is situated in the anterior divisions of the left cerebral hemisphere for 90 percent of the population.

In addition to the anterior-posterior functional distinctions, the contentious issue of localization of function is further confused by the problem of laterality. While Luria explicitly states that his observations are limited to the dominant hemisphere, other investigators (cf. McFie, 1961; Costa & Vaughn, 1960) claim that right hemispheric lesions disturb spatial abilities, whereas left-sided lesions are associated with language disturbance. Moreover, this is true regardless of handedness. Smith sweepingly concludes his review of cortical localization by claiming that almost any kind of brain damage is liable to result in a disturbance of spatial ability. This position parallels that implied by Cattell (1963) and Wechsler (1958).

Of central importance to the present investigation is Smith's hypothesis that the bipolar verbal/spatial factor can be regarded as a bipolar mode of attention. In this scheme, the positive verbal loadings represent a 'diffusive' or fluctuating mode of attention (successive synthesis), whereas the negative spatial loadings represent a mode of attention which Smith designates 'fixative' or 'concentrative' (simultaneous synthesis).

Earlier, Spearman and Wynn Jones (1950) expressed a similar point of view. Spearman noted that 'spatial' tests can be performed in one of two distinct manners. One he called 'analytic' in the sense that attention fluctuates from one element of the figure to another. The other mode of operation is relatively 'synthetic' in that the figures or their constituents are mentally grasped in much larger units, or 'wholes'.

Smith cites the Memory for Designs test to illustrate the distinction between diffusive and fixative modes of attention. He claims that people who have the ability to form and retain images readily will fulfil the requirements of this test more efficiently by a fixative mode of attention. Having fixated the design in mind, these individuals retain the figure as a complete gestalt and experience no difficulty in reproducing the figure in its correct proportions. Conversely, the people who form visual images with difficulty are best served by a diffusive attentional mode. Their strategy would be to glance at different parts of the figure on exposure and attempt to remember as many details as possible. Das (1972) inferred a similar process distinction in the performance of Memory for Designs test in a factor analytic study.

Luria (1966b), in reference to Kohs Blocks, mentions an identical process distinction. He notes that this task can be solved using either a simultaneous (fixative) strategy or in a less efficient manner whereby the subject defines the task as a series of successive links (diffusive).

In his comprehensive discussion of spatial ability, Smith is less inclined than Luria to venture beyond the visual realm. Luria (1966a, 1966b, 1970), however, finds evidence for simultaneous synthesis in apparently distinct cognitive or behavioural processes as, for example, orientation in space, arithmetical computations and coping with the complexities of grammar. Performance in these domains is intimately related through a dependence on a common cerebral process, namely, simultaneous synthesis. Despite Smith's caution, the following passage from his book, Spatial ability, illustrates the essential agreement between the two researchers:

> If subsequent research should confirm that tests such as (Shipley's) abstractions, number series and arithmetic reasoning do genuinely involve a substantial amount of k, it will be necessary to extend our conception of the spatial factor to embrace abilities to perceive and recognize patterns which cannot be considered to be spatial or geometrical in any sense. (p. 213)

Das' inferred process distinction.

Following Luria, Das (1972, 1973a, 1973b) has recently proposed a simultaneous-sequential coding distinction as an alternative to Jensen's broad categories of reasoning and memory. Like Smith (1964), Das bases his theory on the results of factor analyses. Moreover, the conclusions drawn independently by both these researchers point to individual differences or preferences in modes of attention which are mutually supportive. While Smith distinguishes between a 'fixative' versus 'diffusive' mode of attention, Das labels these two processes as 'simultaneous' and 'successive' syntheses.

The two modes of information integration were first posited following a comparison of ability patterns in MA-matched normal and retarded children (Das, 1972). The test scores were factor analysed for each group and two common factors emerged. At first glance, the factors extracted resemble Jensen's Level I and Level II or memory and reasoning. For both samples, Auditory Recall (Level I) loads highly on factor II, while Matrices (Level II) loads on factor I. However, if the factor loadings for all tasks are considered, this interpretation seemed inappropriate due to observed loading disparities on some tasks. To illustrate, the Visual Short-Term Memory for digits--which at face value might be expected to involve predominantly factor II or the memory component--reveals a high loading on factor I for normals, whereas retardates appear to employ both components equally. Retaining Jensen's Level I-Level II distinction, it appears that in solving this task normals use reasoning and retardates memory for remembering the digits. Obviously, such an interpretation is contradictory; hence, the two factors cannot be considered as memory and reasoning. It was suggested that the disparities within tasks between the normal and retarded groups represent differences in the actual modes of processing information.

The simultaneous-sequential distinction provides a more appropriate label for the two factors. The two marker tests, Raven's Progressive Matrices and Auditory Serial Recall, provide, respectively, the purest measures of simultaneous and successive syntheses. The Matrices test is presented visually and requires simultaneous synthesis for its solution. On the other hand, Auditory Recall obviously depends on sequential coding. Some tests in the battery may be described as 'mixed' since these have loadings on both factors. It may imply that either or both strategies may be used according to an individual's preference.

For example, Smith (1964) points out that Memory for Designs test (MFD) may be coded successively where the person glances at the parts of the exposed figure and mentally 'stores' for reproduction a successive series of pencil lines. The alternative mode would be to 'fixate' the design in mind and retain the figure as a complete gestalt. The factor loadings in Das' study implied the same distinction. In the case of Visual Short-Term Memory and Cross-Modal Coding (CMC), the normals appear to employ a different and presumably more efficient strategy whereby the elements of the task are represented predominantly as a simultaneous spatial scheme. In the CMC task, the child is presented with a pattern of 'beeps' and is subsequently required to visually identify the auditory set from three simultaneously presented dot patterns. For this task normals code the auditory pattern simultaneously as a spatial representation; whereas the retardates use a mixed strategy where they literally compare the memory of the temporally constructed auditory set with the visual patterns.

In the same study, Das found no evidence to support certain theoretical predictions arising from Jensen's theory. In the hierarchical model, normals would be expected to demonstrate a greater relative superiority on reasoning tasks than the retardates; but for the memory tasks, such as Serial Recall, their superiority will be reduced. Das found that in comparison to normals, retardates were equally handicapped in both reasoning and memory tasks.

In subsequent research, Das (1973a) has extended the generality of the parallel-sequential process distinction in describing differences in problem solving strategies of Canadian and Indian children. The factor analyses for these samples are presented in Tables 1 and 2. For both analyses, the three factors corresponding to simultaneous, successive and speed are labelled to facilitate discussion. For the Edmonton sample an additional factor resembling Vernon's (1969) v:ed factor emerged. This factor has loadings on IQ, Reading and Math Achievement. For the Orissa sample, the IQ and Achievement measures were not available.

With one notable exception, the tasks defining the three common factors load consistently across the cultural groups. Matrices is an exception. For the Orissa sample, this task loads substantially on both the simultaneous and successive factors. This indicates that for these children both processes are used to some extent. Das suggests that this need not be an unacceptable assumption if one takes note of the differences in cultural environment. In contrast to Edmonton children, children from Orissa are reared in a school and social learning environment where sequential modes of thinking are more heavily emphasized. As a consequence, they are more likely to show preference for the successive mode. These findings support the hypothesis that cultural pressures can and do modify individual preference for either mode. The following discussion provides observational evidence for culturally induced strategy differences.

Less Direct Evidence for Simultaneous-Successive Strategies

In a cross-cultural comparison of children's cognitive processes, Dart and Pradhan (1967) provide an example of the simultaneous-successive dichotomy. American children from a Hawaiian city and rural Nepalese children were asked to sketch freehand maps showing how to get from their house to school. A map represents a 1:1 correspondence with reality and

Table 1*

Rotated Factors (Varimax) for Cognitive and Achievement Tests: Edmonton Sample (N = 60)

Variable	I Succ.	II	III Sim.	IV Speed
IQ (from school records)	347	793	204	045
Word Read	-130	-320	045	-879
Matrices	181	384	740	200
Figure Copy	162	157	674	004
Memory for Designs	178	-055	-830	-162
Cross[illegible]g	457	059	433	423
Visua[illegible]	760	034	124	462
Serial[illegible]	896	355	042	013
Free Re[illegible]	898	340	004	019
Reading [illegible]ment	184	851	100	266
Math Achi[illegible]ent	161	844	281	152
Variance	2.684	2.590	2.029	1.328

*Fro[illegible] Das, J. P. Structure of cognitive abilities: evidence for simultaneous and successive processing. <u>Journal of Educational Psychology</u>, 1973 (in press).

Table 2*

Rotated Factors (Varimax) for Cognitive Tests:
Orissa Children (N = 90)

Variable	I Sim.	II Speed	III Succ.
Word Read	-011	830	032
Matrices	624	253	433
Figure Copy	800	-278	-112
Memory for Designs	-809	111	-037
Cross-Modal Coding	206	-640	233
Visual STM	-013	-175	918
Variance	1.726	1.282	1.099

*From: Das, J. P. Structure of cognitive abilities: evidence for simultaneous and successive processing. Journal of Educational Psychology, 1973 (in press).

yet it is an abstraction. The observation pertinent to this discussion is that unlike the spatial representations typical of the American children, the maps of the Nepalese children denote the 'process of going' from one place to the other, not the spatial relationships. In describing a map, whether verbally or graphically, Nepalese children employ a sequential rather than a spatial or simultaneous strategy. The authors suggest that this manner of thinking may extend far beyond mere map making. In fact, by drawing a parallel between the cultural environments of Nepal and India in comparison to Hawaii and Canada, Das' (1973a) previously cited factor analyses support this contention.

Viewed in the context of child rearing practices and experiences in schooling, these findings bear implications for the present study. Like Das, Dart and Pradhan ascribe the observed strategy differences to environmental circumstances. They point out that although all cultures make use of abstraction in speech. writing and religious symbolism, all abstractions are not amenable to observational verification. According to these researchers, the source of knowledge for rural Nepalese children is a closed body; it stems from authority rather than observation, and the schools which they attend perpetuate this attitude by relying heavily on rote memory. Rote learning demands little understanding or conceptualization and as a consequence serves to inhibit the development of abstractive and generalization skills. In short, the writers are implying that learning environments which emphasize abstract causal relations rather than sequentially biased rote learning favour the development of simultaneous modes of spatial representation.

This explanation is consistent with Lovell's (1965) hypothesized strategy distinction in conceptualizing spatial relations. He argues that space may be concretely represented whereby elements are linked to actions or a chain of associations and memories. Such a representation is characterized by a stereotyped sequential route corresponding to the strategy employed by the rural Nepalese children. In contrast, an abstract or internalized spatial representation is a more efficient mode since it is subject to mental operations. This strategy is exemplified by the American group in the Dart and Pradhan study. An internalized spatial scheme lends itself to a simultaneous survey of relationships enabling the subject to determine, for example, the shortest possible route between two designated points.

Summary of Evidence Indicating Process Differences

The evidence presented up to this point suggests that cognitive tasks can be performed in at least two distinct modes which indicate simultaneous and successive integration of information. The supporting evidence for process distinctions comes from both correlational analyses and clinical observation. Taken collectively, it would seem that Jensen's Level II, Luria's simultaneous synthesis, Vernon's g+k, Smith's spatial ability and Cattell's gf, represent analogous abilities. However, their contrasted abilities, namely, Level I, successive synthesis, v:ed, verbal ability and gc, cannot be said to share the same communality except in the rather vague sense that these latter abilities appear to be in varying degrees, memory dependent. The evidence for simultaneous and successive processing distinctions is based on statistical and clinical analyses (cf. Das, 1973b; Luria, 1966a; Smith, 1964). The two modes can be regarded as individual difference variables. An individual may differ appreciably in his performance in either mode and demonstrate preference for one mode in solving a cognitive task. The individual's preferences, however, could be a reflection of cultural and environmental factors.

Environmental Influences on Cognitive Task Performance

Language style differences between social classes represents a contentious issue. According to Sinclair-De Zwartz (1969), the Piagetian approach considers motor action as the source from which mental operations emerge. Language is considered merely part of total cognitive development and is not a condition for the appearance of intellectual operations.

In contrast to this position is the notion that language is of critical importance in shaping cognitive development (cf. Bernstein, 1961, 1965; Vygotsky, 1962; Bruner et al., 1966; Lawton, 1968; Vernon, 1969). Bruner and his colleagues depart clearly from the Piagetian view. They stress the importance of the internalization of language as a 'technique' or tool crucial to the individual's progression to Piaget's 'formal operations' or symbolic thought. Bruner hypothesizes that the functional role of language is intimately influenced by schooling. Following Vygotsky (1962), Bruner argues that schooling forces the child to use language in the absence of immediate referents and nowhere is this process more apparent than in the case of written language. Schooling promotes psychological relativity by breaking down the child's 'realistic' world view where a word is considered as 'real' as the object for which it stands. This process of dissociation of thought from immediate referents enables symbolic activity to occur in the absence of concrete reality and for thought to be in terms of possibility rather than actuality.

Although it has not yet been established whether a particular type of schooling is more favourable than another, there are clear indications that schooling promotes mental development. Bruner (Bruner et al., 1966) cites a series of cross-cultural studies of Mexican, Alaskan Eskimo and Wolof children in Senegal in support of his schooling-language interaction hypothesis. Schooling emerged as the most important single factor influencing performance on Piaget-type developmental tasks. Similarly, Schmidt (1966) found the same relation between schooling and performance on, among other measures, Matrices.

A recurring environmentalist theme is that children with limited exposure to schooling and/or appropriate adult models (cf. John & Goldstein, 1967; Bandura, 1969; Staats, 1970) build up skills largely at the enactive level. The longer a child operates in these limited modes, the more difficult it is for him to move on to symbolic thought. In a highly simplified sense, this position concurs with Bernstein's theory.

Bernstein (1961, 1965) has greatly influenced research on the topic of SES, language code and ability differences. He identifies and contrasts an 'elaborate' language code with a 'public' or 'restricted' code. These codes are respectively the predominant modes of the middle and low SES groups. Low SES children are largely confined to a restricted language code, whereas their middle class peers are able to operate in both. The elaborate code promotes the ability to sustain attention. It is characterized by the precise description of experiences and feelings and lends itself to the analysis of relationships. In contrast, the restricted code is more concrete and disconnected. Much meaning is imparted by redundant emotionally reinforcing phrases and nonverbally through gestures. Like infant speech, its main function is to express feeling and foster social solidarity with the listener; it emphasizes the present rather than the past or future. It is inefficient for tracing causal relations and does not readily provide a medium for Piaget's formal operations.

A further effect of SES language code differences concerns the relationship between the home and school. Invariably, schooling is conducted in the elaborate code by teachers who are either from the middle class ranks or who have adopted middle class speech and values. Thus, for the middle class child schooling is in this sense merely a continuation of the home. In contrast, the home-school relationship for the low SES child is one of discontinuity, and Lawton (1968) regards this linguistic inadequacy as a cumulative deficit increasing in magnitude as school life progresses.

Whereas linguists (cf. Baratz, 1969; Labov, 1970) are inclined to argue that SES linguistic differences represent nothing more than different styles of speaking, Bernstein has demonstrated that the differences between the elaborate and restricted codes transcend mere differences in dialect. He compared middle and working class boys on the Goldman Eisler measure of verbal planning and found that the two codes are associated with qualitative differences in verbal planning orientations. Unlike their middle class SES counterparts, boys operating in the restricted code were characterized by 'short run' searches in their verbal planning operations. Moreover, this relationship was independent of both verbal and nonverbal IQ. These findings are supportive of the supposed working class' intolerance of ambiguity and delay (Klein, 1965).

Bernstein consistently finds that working class boys are relatively much less handicapped on extraverbal in contrast to verbal measures. Additionally, academic attainment is closely related to verbal test scores. The SES discrepancy between verbal and nonverbal IQ is a common finding. Jahoda (1964) selected groups of middle and low SES boys aged ten and fourteen and matched them on Matrices scores. The vocabulary of the middle class group was significantly superior at ten years and the difference increased in magnitude during adolescence. This finding ties in nicely with the 'cumulative deficit' hypothesis (Bernstein, 1961; Deutsch, 1965; Lawton, 1968). Bernstein argued that the working class verbal-extraverbal performance discrepancy represents either a cultural factor or that low SES children are genetically deficient in their ability to function in the verbal medium. He concludes that considering the working class child's relatively deprived linguistic environment, the first alternative is more likely.

Other studies support the low SES linguistic deficit hypothesis. Teasdale and Katz (1968) compared middle and low SES six-year-olds on the Illinois Test of Psycholinguistic Abilities (ITPA). The middle SES group significantly outperformed their low SES peers on all five verbal subtests but on only one of four visual-motor subtests. In a similar study, Karp <u>et al.</u> (1969) administered three verbal and five extra-verbal tests to subjects aged eleven to thirteen years. These investigators found significant SES differences in favour of the upper SES children on all three verbal tests but for only one of the perceptual differentiation tests.

Bernstein is not without his detractors. As previously mentioned, the Piagetian approach does not consider language as a condition for the appearance of intellectual operations. Baratz (1969) notes that

Bernstein's theory 'violates the basic assumption of many linguists that anything can be said in any language' (p. 891). Further, both Labov (1970) and Baratz (1969) have presented evidence indicating that sociolinguistic differences reflect discrepancies in surface form rather than underlying logic.

Lawton responds to this argument by pointing out that, 'Although it is generally accepted that "Anything could be said in any language" it is still unquestionably the case that it is easier to say some things in some languages' (p. 157). Also, Bernstein argues that a given code does not of itself confine the user to a particular level of cognitive development. Rather, it exerts a channeling influence on thought processes. Specifically, the distinguishing difference between the middle and working class child is not merely one of surface form, but a sensitivity to a way of organizing and responding to experience.

In summary, there are indications that the linguistic environment of low SES children is more likely to be associated with the v:ed rather than g and k:m factors (Bernstein, 1965; Teasdale & Katz, 1968; Vernon, 1970). However, unlike the genetically based Levels theory, the environmental position does not provide a consistent model for predicting SES differences in cognitive task performance.

Bruner (Bruner et al., 1966) and Schmidt (1966) point to the influence of schooling on mental development. Schmidt's findings have direct relevance for the present investigation. He found that schooling does influence performance on Matrices, which suggests that the kinds of reasoning skills demanded by this task are not immune to cultural influences as Cattell (1963) claims. Although there is probably no such thing as a culture 'fair' test, there are quite clear indications that some tests are more culturally loaded than others. Peabody Picture Vocabulary has been described as such a measure (cf. Matheny, 1971; De Lacey, 1972). Thus, with increasing schooling, low SES children may be expected to be relatively less handicapped on Matrices in contrast to Picture Vocabulary.

CHAPTER III

METHOD AND PROCEDURE

Subjects

After an initial survey of Edmonton public schools, 120 boys were selected from Grades 1 and 4. Only boys were included in the study. Vernon (1970) mentions that cause-effect relationships appear more straightforward in the male sex with respect to sex differences in test taking behaviours. Each age level was partitioned into two equal groups (N = 30) by means of Blishen (1966) ratings to yield two discrete SES groups.

Grade 4 high and low SES groups were selected on the basis of Lorge-Thorndike Verbal IQ with the qualification that all participants had IQs below 100. The corresponding Grade 1 groups were matched on the Metropolitan Readiness Test with the requirement that an individual's score may not exceed the fiftieth percentile. These restrictions were implemented to test Jensen's hypothesized 'cross over' phenomenon depicted in Figure 2. Jensen (1969) notes that low SES or deprived children are much less handicapped in Level I than Level II abilities. Moreover, he states specifically that high SES children with IQs less than 100 do less well on Level I-type tasks than low SES children of the same IQ range.

In addition to these considerations, restricting the IQ range would have the effect of partialling out the influence of general intelligence. It is generally conceded that high SES children perform better than low SES children on standardized IQ measures. Thus, performance differences between SES samples might be attributed solely to general ability. Notwithstanding Jensen's findings, controlling for IQ should emphasize 'process' rather than 'level' differences between the experimental groups.

The descriptive characteristics of the different samples are presented in Tables 3 and 4 for Grades 1 and 4, respectively. With the

Table 3

Summary Data for Grade 1:
Low and High SES Groups

Variable	Low		High	
	Mean	Std. Dev.	Mean	Std. Dev.
Age (months)	74.47	4.33	74.20	3.40
Blishen Rating	33.06	4.90	61.93	7.69
Metropolitan	47.70	5.21	48.43	5.75

Table 4

Summary Data for Grade 4:
Low and High SES Groups

Variable	Low		High	
	Mean	Std. Dev.	Mean	Std. Dev.
Age (months)	113.87	4.02	113.93	3.12
Blishen Rating	34.13	5.34	64.53	8.68
Lorge-Thorndike VIQ	90.07	6.93	92.93	5.16
Lorge Thorndike PIQ	98.63	8.03	97.63	12.45

exception of Blishen SES ratings, no significant differences between the two SES levels were observed on these measures at either grade level. It is noted that in selecting these samples it was far more difficult to find high SES children meeting the IQ requirements outlined above. In fact, it was necessary to canvass a total of fifteen schools before a suitable sample of 60 high SES children who had comparable IQs with low SES children was obtained. No such problem was encountered for the low SES groups.

Tasks

The test battery was composed of tasks suitable for both age levels in order to evaluate developmental differences in level of performance and problem solving strategies. Testing was conducted at the schools where the participating children attended. Each child was tested over four half-hour sessions and the sequence of administration was the same for all children. With the exception of Matrices and Figure Copying, all tests were given individually.

Tasks were selected to meet two criteria, namely, that they: (1) represent measures of Luria's simultaneous and successive syntheses; (2) correspond to Jensen's Levels I and II and intermediate points along the hierarchical continuum. The tasks in the following description are classified in terms of Luria's distinction.

Measures of Simultaneous Synthesis

Raven's Coloured Progressive Matrices (RPM)

Raven's Progressive Matrices (RPM) is a widely used test devised as a culture-fair measure of reasoning ability. The test consists of thirty-six tasks increasing in difficulty. The tasks are visually presented as a sequence of patterns with one piece omitted. The child is required to complete the pattern by selecting the appropriate match from a series of given alternatives. RPM is a commonly used instrument in cross-cultural comparisons and serves as Jensen's criterion measure of Level II abilities. According to Luria (1966b), the tasks require simultaneous synthesis for their solution. Luria's general finding is that patients suffering from lesions of the occipito-parietal divisions of the cortex manifest noticeable shortcomings in their performance on this test. Such patients concentrate on only one aspect of the stimulus array and are unable to integrate the necessary spatial relationships to effect the correct response.

Figure Copying Test (FCT)

This test was developed by Ilg and Ames (1964) as a measure of developmental readiness. The child is required to copy ten geometrical forms increasing in level of difficulty. The copying requirement removes any dependence on memory from the test. The test appears to be a measure of cognitive development rather than perceptual motor ability (Jensen & Rohwer, 1970). Luria (1966a) believes that asking a person to copy a series of geometrical figures possessing a certain spatial orientation represents one of the simplest forms of simultaneous synthesis.

Memory for Designs (MFD)

This task was developed by Graham and Kendall (1960) primarily as an instrument to detect minimal brain damage. The child is presented visually with a series of fifteen different designs. Each figure is presented individually to the child for a five-second viewing interval.

Subsequently, the chi[illegible]s the design from memory on a blank 8-by-11-inch sheet of [illegible]ponses are scored for errors. It has been used to di[illegible]gui[illegible]s from retardates (Ritchie & Bottler, 1964) and among [illegible]als [illegible] slow from the average reader. In the present study it [illegible] em[illegible]yed solely as a memory task for designs. This task loads hi[illegible] the simultaneous factor in all analyses (cf. Das, 1973a, 19[illegible]).

[illegible]sures of Successive Synthesis

Auditory Serial Recal[illegible]SR)

In this task subje[illegible]s were aurally presented with a series of four word sequences. Immediately following each presentation, the child was required to ve[illegible]lly recall the sequence in the given serial order. Responses are [illegible]d for their serial correctness only. The task can be classified as a Level I measure and, projecting from Das' (1972, 1973a, 1973b) findings, it will serve as an index of successive synthesis (aural presentation minimizes the possibility of arranging elements into a simultaneous spatial array).

Visual Short-Term Memory (VSTM)

The task was adopted from a test originally devised by E. Howarth and J. Browne of the University of Alberta. In this task, a series of five-item grids are visually presented for recall. Each matrix is viewed for five seconds, followed by a two second filler task of colour naming to preclude rehearsal. When the stimuli are numbers, the child is required to reproduce the digits on an empty grid immediately following the filler task. Responses are scored for free and serial position.

The procedure is slightly modified when pictures of objects are used as stimuli. In this case the method of recall consists of selecting matching objects (painted on discs) from an array of nine alternatives. The child manually places his choices on a grid board before him.

Digit Span - forward and backward (DS fwd, bwd)

The tests were abstracted directly from the Wechsler Intelligence Scale for Children (1949). Directions and scoring followed the procedure proposed by the test manual. The digit series were presented by means of a cassette tape recorder. Jensen (1970) singles out DS fwd as a good test of Level I ability and indicates that DS bwd would involve some degree of Level II ability by virtue of its transformation requirements.

Other Measures

Cross-Modal Coding (CMC)

The task was developed by Birch and Belmont (1964) as a measure of auditory-visual integration and has been shown to discriminate between children of high and low reading ability. The test bears a significant general relationship with IQ, suggesting that this kind of intersensory integration may be one of the processes underlying adaptive or intelligent behaviour. The CMC task samples the ability to integrate and compare a temporally structured set of auditory stimuli with spatially distributed visual stimuli. Specifically, the child listens to sound patterns and is subsequently required to visually identify the auditory set from three simultaneously presented dot patterns. In Luria's terms, the task is an index of successive-simultaneous integration. Das (1972, 1973a) finds that this test does not load consistently on either his simultaneous or successive factor. The test is included in this study because of the ambiguous nature of its solution requirements.

Bridge Task

The map task was devised by Farnham-Diggory (1970) as a possible measure of Luria's simultaneous synthesis, but its validity as a measure of simultaneous synthesis has not been empirically established. The correct solution to this task is dependent on the ability to grasp spatial relations from auditory input.

In this task, the child learns to match strings with pictographs representing: a 'road', a 'bridge' and a 'river'. When the child has learnt to reproduce the pictograph patterns from verbal instructions, e.g.,'make a bridge', he is required to construct a pattern corresponding to the command, 'make a bridge, going across a river, with a road on each side'. Simultaneous synthesis can be said to have occurred when the symbolic patterns are co-ordinated with the given relations. This would be demonstrated by the motor act. Where synthesis has not occurred, the final act would be dissociated. An example of a synthesis failure would be in the case where the child arranges the elements of the task sequentially, e.g., bridge, river, road, rather than in the designated relationship. Farnham-Diggory found that children who performed poorly on this task did so not because they failed to understand the terms 'across' and 'on each side', but were unable to grasp the total spatial relationship expressed by the statement.

Word Reading and Colour Naming

These tasks employ the Stroop (1935) charts. The names of four primary colours (red, green, yellow and blue) are capitalized in black letters and occur ten times in random order. The child is instructed to perform the task as quickly as possible and is timed for reading the forty words. In the colour naming variant, coloured strips replace the written word. These tasks serve as marker tests for Das' (1973a, 1973b) speed factor.

Peabody Picture Vocabulary Test (PPVT)

PPVT is a commonly used test designed to measure verbal intelligence (Dunn, 1959, p. 31). The test provides an IQ score and is easily administered and scored. In addition to Matrices, Jensen (1969) has used this test as a criterion measure of Level II ability. Recently, performance on PPVT has been linked with cultural influences, and it is largely for this reason that the test is included in the battery.

Some Hypotheses

The review of literature in the previous chapter does not provide ground for firm hypotheses regarding the performance of high and low SES groups at the two age levels. Only tentative predictions are tendered since, with the exception of Jensen's research, there is little definitive evidence for supposing process differences between contrasted SES groups. The following predictions can be derived from earlier research relating to age and SES differences in Levels I and II ability.

High SES children are expected to be more proficient on Level II-type tasks. Conversely, the SES disparity for Level I measures should be minimal and the direction of differences reversed to favour the low SES groups. Jensen (1969) notes that low SES or culturally deprived children are much less handicapped in Level I than in Level II abilities, hence his plea for tailoring the instruction of such children to capitalize on their Level I ability rather than their conceptual weaknesses. Further, Jensen (1969, 1970) states specifically that high SES children with IQs less than 100 do less well on Level I-type tasks than low SES children from the same IQ range. The SES samples in this study are representative of these categories.

These hypotheses can be examined by analyses of variance techniques where the SES performance disparities for the two levels of ability would be represented statistically by an interaction as depicted in Figure 2. The same hypotheses can be tested in terms of correlations and regression lines. Jensen (1969) claims that good Level I ability is a necessary though not sufficient condition for the development of Level II. This implies that far fewer children will fall in the bottom right quadrant of Figure 5 than in the other three quadrants. This means that the magnitude of the correlation coefficient between tasks corresponding to Level I and Level II ability should be greater for the high SES groups. For the low SES groups the corresponding correlation will be significantly lower or nonexistent. In fact, Jensen (1968) has obtained correlations of .70 and over and .20 and under in high and low groups, respectively.

Developmentally, performance differences between the two SES groups will be less marked in the younger age (Grade 1) than in the older age group (Grade 4). Learning up to the Grade 1 level is posited to be largely dependent on the development of Level I ability (see Fig. 6) which is independent of SES. Jensen's (1970) hypothesized growth curves would predict that by Grade 4, performance differences will be well established on Level II-type tasks since SES differences in Level II ability become increasingly divergent as a function of age.

Standardized intelligence measures will intercorrelate highly for all samples since they supposedly tap reasoning or Level II ability. Similarly, the same relationships will hold for tests of short-term memory. Jensen's (1969, 1970) data based on factor analysis indicate that short-term memory tasks tend to cluster together, whereas reasoning and symbol manipulation represent a separate and largely orthogonal cluster.

The factor analyses of test scores will serve as the major test of the relative merits of the 'ability' versus 'process' model. If the simultaneous-successive process distinction represents a viable individual difference variable, the factors corresponding to these modes of thinking will be largely independent of standardized intelligence measures. Further, the simultaneous and successive tasks discussed in the preceding section will serve as marker tests identifying the two modes of information integration.

Jensen's hypothesized growth curves for Levels I and II (Fig. 6) provide an alternative explanation for the environmentalists' 'cumulative deficit' afflicting low SES children. At higher levels of schooling, greater SES performance differences would be predicted from theories based on non-genetic assumptions (cf. Deutsch, 1965;

Bernstein, 1965; Lawton, 1968). Unlike Jensen's theory, however, the nature of these differences is less clearly defined. Nevertheless, it is suggested that, in view of the environmentalists' emphasis on linguistic deficit, proponents of this view would predict that low SES children will be increasingly disadvantaged on verbally loaded tasks (Bernstein, 1961; Jahoda, 1964; Golden et al., 1971).

Thus, the environmental cumulative deficit position would predict cognitive task performance differences which stand in direct contradiction to Jensen's predictions, namely, with increasing age low SES children will be less handicapped in nonverbal tasks.

An underlying theme of current conceptions of mental development is that the child's cognitive growth proceeds from enactive or motor beginnings to the complex symbolic level (cf. White, 1965; Bruner, 1966; Vernon, 1970). In other words, intellectual development is seen as progressing from the concrete to the abstract. This view is reflected in Jensen's hypothesized growth curves of Levels I and II.

Retaining Jensen's Levels distinction, the factor corresponding to Level I should account for more test variance in Grade 1 than in Grade 4, since Level II ability in the younger age group is only beginning to develop. With increasing age, abilities or processing skills supposedly undergo greater differentiation (Jensen, 1970; Witkin, 1962). Hence, strategy differences should be more marked in Grade 4 children.

Beyond the face validity of the task requirements, Luria's analysis of simultaneous and successive syntheses provides no grounds for hypothesizing strategy differences as a function of age and SES. Although Das (1972, 1973b) consistently finds similar factor structures emerging from quite different samples, his age groups in all cases parallel the older age group in this study. One of the major interests in the present investigation is to determine whether the Luria model can be meaningfully extended to embrace an even wider age span and if so, whether processing differences in the two age groups can be identified.

CHAPTER IV

RESULTS AND DISCUSSION

The results of the study are presented and discussed in this chapter under appropriate subheadings. Broad implications and an integration of the findings are dealt with in the following chapter. The mean and standard deviation values for the experimental tasks are given in Tables 5 and 6 for the contrasted SES samples in Grade 1 and Grade 4, respectively.

Performance Comparisons of SES and Age Groups

All common variables for the two age and SES levels were analyzed separately by two-way (Age x SES) analyses of variance. The results of these analyses are presented in Table 7. On all performance measures Grade 4 children performed at a superior level when compared with their Grade 1 counterparts. Within grades, however, certain SES performance discrepancies are apparent. A descriptive analysis for each significant finding (over and above age differences) is given in the next section in order of tabular occurrence.

Raven's Coloured Progressive Matrices

The analysis indicates that the average performance of high SES boys is superior to that of low SES boys at both age levels. When the results are analyzed separately for each grade (*t*-tests), the mean SES difference is more marked at Grade 1. The SES difference between Grade 4 groups was not significant ($p > .10$). In the present analysis, the *F*-ratio (SES) acquires significance from the more pronounced disparity at the Grade 1 level. At Grade 4, low SES boys in comparison

Table 5

Mean and Standard Deviation Values for Grade 1 Experimental Tasks: Low and High SES Respectively

Variable	Low		High	
	Mean	Std. Dev.	Mean	Std. Dev.
Matrices	13.77	2.01	15.37	3.21
Figure Copy	5.47	1.45	5.80	1.21
Memory for Designs	16.50	6.09	12.67	5.82
Cross-Modal Coding	7.70	2.61	6.63	3.31
Visual STM - dig	18.43	5.85	21.57	9.56
Word Read	94.23	50.41	70.90	25.10
Serial Recall	58.57	25.51	60.47	27.31
Free Recall	76.17	13.86	76.93	4.10
PPVT IQ	105.43	12.81	110.10	11.05
Visual STM - obj	14.43	5.40	15.47	5.70
Colour Read	60.60	22.75	59.27	21.17
Bridge Task	2.40	1.22	2.43	1.25
Digit Span - fwd	4.10	.71	4.17	.75
Digit Span - bwd	2.63	.76	2.50	.82

Table 6

Mean and Standard Deviation Values for Grade 4
Experimental Tasks: Low and High SES Respectively

Variable	Low		High	
	Mean	Std. Dev.	Mean	Std. Dev.
Matrices	25.57	4.24	26.93	4.87
Figure Copy	9.13	1.50	8.93	1.28
Memory for Designs	3.00	3.39	3.37	3.13
Cross-Modal Coding	16.47	3.12	16.80	3.42
Visual STM - dig	47.83	11.98	51.87	11.27
Word Read	24.37	3.13	23.53	3.95
Serial Recall	84.73	9.84	86.30	10.87
Free Recall	90.40	6.38	90.43	6.87
PPVT IQ	106.20	9.35	113.30	8.10
Visual STM - obj	23.47	5.33	25.50	6.06
Colour Read	36.40	7.03	36.37	6.39
Bridge Task	3.50	.86	3.57	1.19
Digit Span - fwd	5.23	.86	5.57	.82
Digit Span - bwd	3.37	.61	3.40	.62

Table 7

Summary of Two-Way Analyses of Variance for Grades 1 and 4 (Age) and High and Low SES

Variable	F-ratio		
	Age	SES	Age x SES
Matrices	292.22**	4.71*	< 1
Figure Copy	184.87**	< 1	1.13
Memory for Designs	168.93**	3.90*	5.73*
Cross-Modal Coding	274.64**	< 1	1.50
Visual STM - dig	269.10**	3.89*	< 1
Word Read	129.06**	5.48*	4.75*
Serial Recall	50.33**	< 1	< 1
Free Recall	45.70**	< 1	< 1
PPVT - raw	275.58**	8.41**	1.90
IQ	1.10	9.40**	< 1
MA	268.02**	7.15**	2.14
Visual STM - obj	86.42**	2.24	< 1
Colour Read	63.00**	< 1	< 1
Blishen Rating	2.16	563.70**	< 1
Bridge Task	28.66**	< 1	< 1
Digit Span - fwd	77.98**	1.94	< 1
Digit Span - bwd	39.58**	< 1	< 1

*p = < .05

**p = < .01

to their high SES peers perform equivalently on this task. These observations concur with Schmidt's (1966) findings indicating that performance on Matrices is influenced more by schooling than by socioeconomic factors. More recently, Vernon (1973) compared large samples of Grade 4 high and low SES children (N = 198) on a battery of tasks including Matrices and found no class difference on this measure.

Memory for Designs

For this task both the SES main effect and the Age x SES interaction are significant. At Grade 1, the high SES group made fewer errors in performing the task requirements and is clearly superior to the low SES group. The significant interaction reflects a 'smoothing effect' in performance between Grades 1 and 4. At Grade 4, the SES difference is no longer apparent. In fact, the difference slightly favours the low SES group.

Memory for Designs and Matrices test scores are significantly correlated for both age levels, indicating that these tasks sample analagous abilities. The present data indicate that SES performance difference on Matrices and Memory for Designs decreases with age. One way of accounting for this increasing congruence is in terms of the 'levelling effect' of uniform classroom instruction. The theoretical rationale for this hypothesis rests on the premise that the home environments of the two SES levels may be more variable than the classroom milieu of a common school system. In comparison to Grade 4, SES differences in performance are more marked in Grade 1 children, who are minimally exposed to formal schooling. Schmidt (1966) provides supportive evidence for the contention that schooling has a levelling effect on cognitive task performance. He compared children varying in school entrance age on Matrices and found that performance on this task was more influenced by the length of schooling than either socioeconomic circumstances or chronological age per se. The present results imply that schooling rather than SES is the prime environmental factor.

Visual Short-Term Memory

High SES boys recalled more numbers in their correct serial position than low SES boys. The nonsignificant Age x SES interaction indicates that the relative performance of the two SES groups does not alter as a function of age or schooling. In a slightly modified form of this task where the visual stimuli were pictures of common objects rather than Arabic numbers, similar trends were apparent but were not significant; perhaps the object recognition task was simpler than digit recall.

Stroop Word Reading

This task is at face validity a measure of response speed, since the children were instructed to complete this task as quickly as possible. In the analysis, both age and SES main effects are significant. More importantly, the analysis reveals a significant Age x SES interaction. While both high SES groups are characterized by a shorter response latency, the SES effect acquires significance from the interaction. At the Grade 1 level, low SES children are markedly slower in comparison to the high SES group. By Grade 4, the SES difference is negligible. It is obvious that at Grade 1 this task is measuring reading ability in addition to response latency. It is not the case for colour naming--the analysis of speed of colour naming does not yield significant SES differences. The word reading test at the Grade 1 level appears to be sensitive to superior preschool preparation such as reading readiness.

Peabody Picture Vocabulary Test (PPVT)

Since the mean ages of high and low SES children at each grade level are practically identical, the analyses of the Peabody raw and MA scores are discussed collectively. At both Grade 1 and Grade 4, the mean performance of high SES children is superior to that of low SES groups. The Age x SES interaction was not significant.

For the IQ analysis, the nonsignificant age main effect indicates that the IQ discrepancy between SES groups remains constant between grade levels. However, separate analyses for each grade (t-tests) reveal a larger IQ difference between high and low SES children in Grade 4.

Performance in PPVT was particularly linked with SES. This relationship between PPVT and SES is clearly illustrated in the Grade 4 factor analysis (see Appendix A2) where factor II is defined almost exclusively by these parameters. A consideration of Bernstein's (1965) interpretation of language codes suggests that the high SES group in comparison to the low SES should do better on measures of verbal ability. In fact, Bernstein and other investigators such as Teasdale and Katz (1968) and Karp et al. (1969) present evidence to support the hypothe[redacted] low SES children are afflicted by a linguistic [redacted] regards PPVT as culturally biased--in the sense th[redacted]rmance is largely dependent on the richness of [redacted]nt--the present results lend support to the cultural deprivation position.

An observation which is less congruent with the deprivation hypothesis inheres in the fact that although the Grade 4 groups were not significantly different on Lorge-Thorndike Verbal IQ, there were no significant SES differences in Lorge-Thorndike Performance (nonverbal) IQ measures. Investigations cited in the preceding chapter suggest that the cultural environment of low SES children serves to depress the performance of this group on verbally dependent IQ measures. Extending from these findings and considering that the groups were, in effect, verbally matched, it would be expected that SES differences on Performance IQ would favour the low SES group. Although a significant interaction was not attained, this trend is apparent in Figure 7.

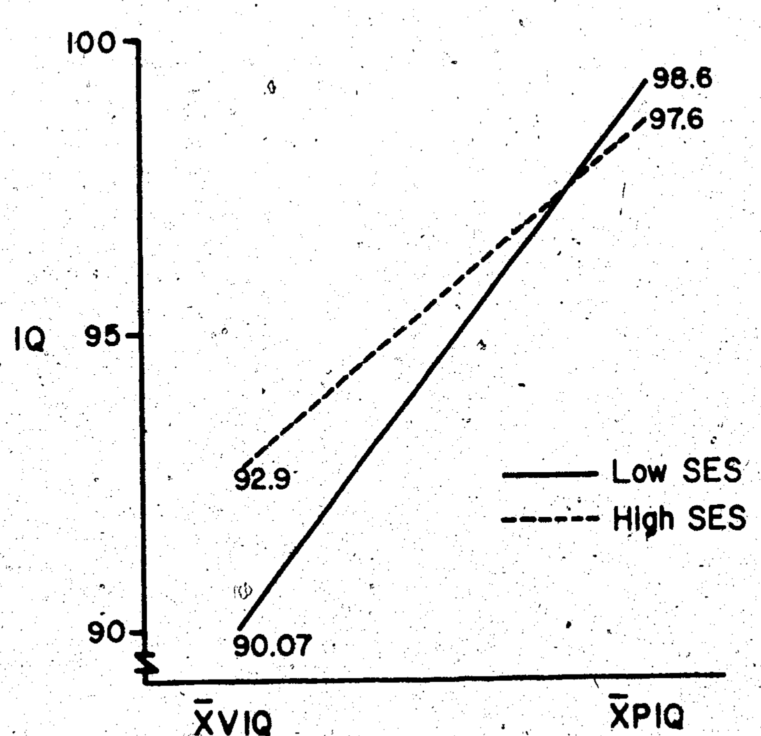

Fig. 7. Graphic representation of mean high and low SES performance comparisons on Lorge-Thorndike Verbal and Performance IQs.

The Levels Theory in Relation to SES

Considering both age levels collectively, the high SES performed better on the reasoning tasks than the low SES groups. With one exception, the data are ostensibly consistent with Jensen's (1970) hypotheses. His model would predict that SES differences will be greater on Level II-type tasks, whereas Level I performance differences will be nonexistent or insignificant. Thus, the results do not appear to be incongruent with this position. Differences favouring the high SES groups are apparent on tasks presumably measuring Level II ability, namely, Matrices, Memory for Designs and PPVT.

However, from Jensen's research, SES groups would not be expected to differ in Level I measures. Visual STM (digits) represents a Level I task on which the high SES groups performed significantly better than their low SES counterparts. This anomaly is difficult to resolve. Yet, on more traditional Level I measures (Digit Span, Serial and Free Recall) the two SES groups did not differ.

Cross-Modal Coding may be construed as a task bearing some degree of Level II saturation by virtue of its transformation requirements. In the testing situation, many Grade 1 children found the task too difficult, whereas at Grade 4 this situation was somewhat reversed. These floor and ceiling effects would work against the possibility of finding SES differences.

Two observations stand in contradiction to the Levels theory. Firstly, when Grades 1 and 4 are considered separately, only the Grade 1 results accord with the hypothesis that high SES children will be more proficient on Level II-type tasks. This was not the case for Grade 4 since, with the exception of the culturally loaded PPVT, SES differences on Level II measures are not apparent. These findings were taken to imply that within a relatively homogeneous environment, schooling does exert a modifying influence on cognitive task performance. Secondly, the hypothesis that high SES children with IQ less than 100 do less well on Level I tasks than low SES children in the same IQ range is disconfirmed by the current data. In fact, the tendency was in the opposite direction (cf. Visual STM (digits)).

Developmental Differences in Test Performance

Jensen (1969) hypothesizes different growth curves for Level I and Level II abilities. The child's behavioural development up to four years of age is attributed almost entirely to the development of Level I abilities. By Grade 4 there is a marked SES divergence in Level II abilities as a function of age. Based on the differential growth rates of Levels I and II, Jensen's model would predict greater SES differences at the higher age level. This prediction is not supported by the present data. Except for PPVT, differences favouring high SES children are more pronounced at Grade 1. Jensen (1969, 1970) describes Matrices as one of the purest Level II measures. Further, he argues that SES differences on Matrices will be larger than PPVT differences for the same groups. While this situation can be observed for the Grade 1 data, this relationship is not evident at Grade 4. Parallel evidence has recently been presented by Vernon (1973). He compared contrasted SES groups from Grade 5 on a battery of tasks designed to replicate Jensen's findings in a more uniform cultural environment. As in the present study where age (cf. Grade 4) and environmental conditions are similar, Vernon found no SES differences on Matrices.

Correlations Between Levels I and II Abilities in Low and High SES Groups

Discussed in this section are the correlations which are relevant to Jensen's theory. A major prediction derived from the Jensen model (1969) is that the magnitude of the correlation between performance on Level I and Level II tasks should be greater for the high SES groups.

Correlation coefficients between Level I and Level II tasks were calculated separately for each of the four samples and are presented in Tables 8 and 9. An inspection of these values clearly disconfirms the prediction that Level I and Level II abilities are more closely related in the high SES groups. Similar findings have been reported by Rowher _et al._ (1971) and Vernon (1973).

Age Comparisons of Level II Measures

Jensen's criterion for classifying mental abilities hierarchically resides in the transformation requirements of the task or the degree of correspondence between 'input' and 'output'. At lower levels of the hierarchy, the transformation of input is relatively simple or direct, approaching a 1:1 correspondence. Higher levels of cognitive functioning depend on the elaboration and transformation of stimulus input and comparing the input with previously stored information. Hypothetically, cognitive tasks can be placed along a continuum where the extremes are represented by simple associative learning and complex problem solving. The complexity requirements of standardized ability measures such as Matrices, PPVT and Lorge-Thorndike sets these tasks apart from rote memory. While the Metropolitan Readiness Test is not

Table 8

Grade 1 Correlations Between Tasks Representing Levels I and II
Low and High SES Samples Respectively*

	LEVEL II					
	Matrices		PPVT IQ		Metropolitan	
	Low	High	Low	High	Low	High
LEVEL I						
Visual STM - dig	-292	075	090	133	327	219
Visual STM - obj	279	284	039	-093	074	-012
Serial Recall	053	-169	257	166	182	361
Free Recall	089	-098	325	138	072	330
Digit Span - fwd	179	-109	262	109	260	263
Digit Span - bwd	099	082	329	125	214	449

*Decimal points omitted

Table 9

Grade 4 Correlations Between Tasks Representing Levels I and II
Low and High SES Samples Respectively*

	LEVEL II							
	Matrices		PPVT IQ		Lorge-Thorndike VIQ		Lorge-Thorndike PIQ	
	Low	High	Low	High	Low	High	Low	High
LEVEL I								
Visual STM - dig	-080	-044	197	-265	-044	048	-175	-197
Visual STM - obj	-102	-216	-061	-109	132	021	-038	-048
Serial Recall	-005	-146	244	-205	-126	-037	127	-295
Free Recall	059	-065	202	-199	-105	014	087	-239
Digit Span - fwd	-072	244	106	035	-047	207	-152	-186
Digit Span - bwd	406	174	109	201	166	175	540	148

*Decimal points omitted

explicitly an ability measure in the sense of Spearman's g, this task would be expected to tap reasoning rather than associative learning ability.

Thus, the Matrices, Metropolitan Readiness, PPVT and Lorge-Thorndike tests represent Level II abilities. The test intercorrelations for both grades are given in Table 10. With the possible exception of the correlation between Matrices and Lorge-Thorndike Performance IQ in Grade 4 children, the data indicate that these reasoning tests are not measuring abilities which are highly related. These tasks obviously do not represent a unidimensional ability such as Level II.

Table 10a

Intercorrelations of Level II Task for Grade 1 Children (N = 60)

	Matrices	PPVT IQ	Metropolitan
Matrices		.270	.130
PPVT IQ			.355
Metropolitan			

Table 10b

Intercorrelations of Level II Task for Grade 4 Children (N = 60)

	Matrices	PPVT IQ	Lorge-Thorndike VIQ	Lorge-Thorndike PIQ
Matrices		.325	.164	.446
PPVT IQ			.193	.241
Lorge-Thorndike VIQ				.061
Lorge-Thorndike PIQ				

Evidence for a Simultaneous-Successive Process Distinction: Results of Factor Analyses

In subsequent analyses the test scores were intercorrelated and the resultant matrix subjected to a principal component factor analysis. In this procedure no communalities are estimated by the computer programme. Following the Kaiser-Guttman rule, analysis is continued as long as eigen values are greater than 1 and a varimax rotation is performed on the principal axis loadings.

Stability over two age groups

All measures for Grade1 and 4 children were factor analyzed separately for each age level. In both analyses, three factors identified as simultaneous, successive and speed are clearly evident. The factor analyses summarized in Tables 11 and 12 were undertaken in an attempt to replicate Das' (cf. 1973b) earlier findings and facilitate age comparisons. The factor structures are essentially similar for both age levels and the three factors which emerge are identified collectively as successive, simultaneous and speed. For Grade 1 (Table 11), factors I and III are designated as successive and simultaneous, respectively. The highest loadings for factor I were for Serial and Free Recall. Matrices, Figure Copying and Memory for Designs define factor III. Word Reading and Colour Naming are the marker tests for speed, and load on factor II.

Grade 4 factor loadings are given in Table 12. The first factor is successive as it was for Grade 1. Serial and Free Recall and, to a slightly lesser degree, Visual STM load on this factor. Factor II is the simultaneous integration factor. In order of magnitude, Matrices, Figure Copying and Memory for Designs load on this factor. The third or speed factor is defined by the Word Reading and Colour Naming tasks.

Table 11

Rotated Factors (Varimax) for Grade 1
SES Combined (N = 60)*

Variable	I	II	III
Matrices	-146	088	784
Figure Copy	290	-108	762
Memory for Designs	-119	394	-713
Visual STM - dig	-060	-557	163
Word Read	-287	766	046
Serial Recall	951	-166	101
Free Recall	955	-108	051
Colour Read	-161	801	-067
Variance	2.048	1.753	1.751

*Decimal points omitted

Table 12

Rotated Factors (Varimax) for Grade 4
SES Combined (N = 60)*

Variable	I	II	III
Matrices	-008	876	007
Figure Copy	005	797	067
Memory for Designs	091	-750	-016
Visual STM - dig	689	-043	-188
Word Read	-129	002	842
Serial Recall	950	-054	013
Free Recall	941	-008	012
Colour Read	-005	070	833
Variance	2.288	1.974	1.444

*Decimal points omitted

In the next set of tables (13 and 14), factor loadings of some additional tests are presented along with the previously noted tests. In these tables the simultaneous, successive and speed factors clearly emerge. The fourth factor for both age levels is tentatively designated as an imagery factor. Factors I and II in both tables are representative of the successive and simultaneous modes of integration. For both age levels the highest loadings on factor I are for Auditory Recall and Digit Span fwd; Matrices, Figure Copying and Memory for Designs load highly on factor II. Factor III represents speed, as Word Reading and Colour Naming load highly on this factor.

The last factor, IV, may best be described as an imagery factor, as the tasks which load highly on this factor appear to share a common element, namely, imagery. This factor accounts for the least variance in test scores and from the results of other analyses is shown to be the least stable. In view of the rather protean nature of this factor, the following section dealing with developmental trends is addressed largely to the first three factors emerging from the analyses.

Although the factor loadings for some tasks differ between age levels, the foregoing analyses indicate that children, within the age range sampled, consistently resort to similar processing strategies on most tasks. However, disparate factor loadings on some tasks, for example, Digit Span bwd are noticed: for Grade 1 it has a high loading on speed, but for Grade 4 the highest loading is on the imagery factor with a substantial loading on simultaneous synthesis. Such developmental differences are discussed in the following section.

Table 13

Rotated Factors (Varimax) for Grade 1
Expanded Battery - SES Combined (N = 60)*

Variable	I	II	III	IV
Matrices	-143	690	206	321
Figure Copy	206	739	-082	217
Memory for Designs	-085	-747	403	025
Visual STM - dig	-001	047	-333	612
Word Read	-248	-007	786	-134
Serial Recall	915	080	-194	096
Free Recall	917	039	-115	137
Visual STM - obj	124	151	-063	863
Colour Read	-049	-105	791	-043
Bridge Task	386	609	-144	-299
Digit Span - fwd	811	183	-171	063
Digit Span - bwd	250	129	-532	259
Variance	2.696	2.045	1.953	1.478

*Decimal points omitted

Table 14

Rotated Factors (Varimax) for Grade 4
Expanded Battery - SES Combined (N = 60)*

Variable	I	II	III	IV
Matrices	017	905	061	061
Figure Copy	-005	750	008	-034
Memory for Designs	076	-689	-020	053
Visual STM - dig	645	-050	-316	032
Word Read	-090	003	789	020
Serial Recall	934	-070	-008	-114
Free Recall	910	-026	-003	-152
Visual STM - obj	404	-061	-408	534
Colour Read	047	056	800	097
Bridge Task	-116	427	192	641
Digit Span - fwd	801	051	095	126
Digit Span - bwd	148	420	-131	-660
Variance	2.974	2.233	1.596	1.203

*Decimal points omitted

Developmental Trends in Problem Solving Strategies

Disparities in factor loadings on some tasks suggest some developmental differences in coding. Figure Copying for Grade 4 loads entirely on the simultaneous factor (Table 12). At Grade 1 (Table 11) it has a high loading on the same factor but, in addition, the task loads to a lesser extent on the successive factor. Speculatively, unlike their Grade 4 counterparts, younger children are more likely to demonstrate some degree of strategy ambivalence. Perhaps for Grade 1 children the figures to be copied are less clearly integrated in a total spatial scheme. As a consequence, children at this age are more prone to reproduce a given figure as a fragmented series of pencil lines. This inference is consistent with observations made in the test situation.

For Grade 1 children (Table 11) Visual STM (dig) loads substantially on the speed factor, whereas at Grade 4 the successive factor shows the predominant loading. A consideration of the task's requirements makes this observation more intelligible. In this task the stimulus or number matrix is displayed visually for five seconds. Presumably, for the older age group the five second exposure period is sufficient for the child to capitalize on this time interval and code the digits serially for reproduction. On the other hand, younger children appear less inclined to attend consistently to the visually presented digits and successful performance for this age group is largely dependent on the time spent apprehending the stimulus matrix.

A similar inference applies to the Memory for Designs task (Tables 11 and 12). Although both age levels predominantly employ a simultaneous strategy, the speed factor exerts some influence on Grade 1 performance. Specifically, Grade 1 performance is partly dependent on whether or not the child makes effective use of the five second exposure time; the longer he effectively attends to the design, the more adequate his performance.

The Bridge Task (Table 13) in the Grade 1 analysis loads on the simultaneous and, to a lesser extent, the successive factor. At Grade 4 (Table 14) this task is independent of the successive mode and loads on the visualization and simultaneous factors. For Grade 1, the loading on the successive factor suggests that these children are less likely to transform the verbal instructions to conform with designated spatial relationships. This interpretation is consistent with observations made in the testing situation. For example, the correct response to the request, 'Make a bridge, going across a river, with a road on each side', requires that the child construct the river first. The younger children more often constructed their patterns in accord with the verbal sequence (successive synthesis)--bridge, river, road--rather than indicating an understanding of the spatial relationships (simultaneous synthesis).

In the same tables, Digit Span fwd and bwd load on different factors at both age levels. For each grade, Digit Span fwd represents a good measure of successive synthesis and clearly loads on one factor. On the other hand, Digit Span bwd is virtually independent of the successive mode since the task requires some degree of input transformation. This task loads substantially on the speed factor for Grade 1, suggesting once more that for this age group speed with which the series of digits is apprehended is an important ingredient for effective responding. For Grade 4 children, however, speed is no longer an important consideration; rather, these children are dependent on the ability to form an imaginal sequence and simultaneously reorder the array.

These observations are compatible with Luria's (1966a) claim that the process of simultaneous synthesis is neither modality specific nor synonymous with the processing of nonverbal visually presented material. In fact, Luria (1970) states specifically that some behavioural processes which appear to be quite unrelated do in actuality share common properties by virtue of their dependence on the same cognitive process. For example, certain brain lesions which affect orientation in space also affect the ability to handle the complexities of grammar. To deal effectively with many grammatical structures requires the ability to grasp spatial relations. Thus, in order to differentiate between such statements as 'father's brother' and 'brother's father', the listener must analyze and compare the spatial relations between the elements in each expression. Huttonlocker's (1968) work in visual imagery complements Luria's clinical observations. According to her, individuals solve relational statements by creating 'in their heads' an imaginal array. She provides evidence indicating that the solution to a three-term syllogism, for example, is effected by the individual consulting the imaginal array or, in Luria's terms, by the process of simultaneous synthesis.

Other tests which suggest processing differences in the two age groups are Visual STM for digits and objects. For Grade 1 (Table 13) both tasks load highest on the imagery factor. In contrast, at Grade 4 (Table 14), Visual STM for digits has its highest loading on the successive factor, while for Visual STM for objects the loadings are split between the imagery and successive factors in this order of magnitude. Speculatively, children from the older age group code the visually presented digits as a verbal sequence for subsequent reproduction, whereas, to borrow Bruner's terminology, the younger age group employs an ikonic mode for both tasks. When the visual stimuli are objects rather than familiar Arabic numbers, the loadings shift to the imagery factor for the Grade 4 group. Under these conditions, the objects are less likely to be coded verbally and the child resorts more to an ikonic representation.

The Stability of Simultaneous and Successive Synthesis Across SES Levels

Eight test scores for Grade 4 children in the present study were pooled with corresponding Grade 4 scores from an earlier investigation. This procedure yielded two disparate groups of sixty low and sixty high SES children and made it possible to separately factor analyze and compare each group. The results of these analyses are given in Tables 15 and 16.

An inspection of these tables indicates that the three factors, simultaneous, successive and speed, are stable across SES groups. Although the factor structures are highly compatible in terms of their marker test loadings and order of emergence, loading disparities for Cross-Modal Coding are apparent. This observation is in line with previous findings reported by Das (1972, 1973a, 1973b).

As suggested in the task analysis (see Ch. III), Cross-Modal Coding represents a mixed task as both simultaneous and successive synthesis may be used to some extent. The task loads on more than one factor in both analyses. For high SES children, speed and the process

Table 15

Rotated Factors (Varimax) for Grade 4 High SES Children.
(N = 60)*

Variable	I	II	III
Matrices	121	845	-058
Figure Copy	125	755	110
Memory for Designs	189	-788	-052
Cross-Modal Coding	063	492	677
Word Read	-106	119	805
Visual STM - dig	555	087	629
Serial Recall	962	022	135
Free Recall	959	024	121
Variance	2.234	2.171	1.553

*Decimal points omitted

Table 16

Rotated Factors (Varimax) for Grade 4 Low SES Children
(N = 60)*

Variable	I	II	III
Matrices	150	847	201
Figure Copy	-010	682	013
Memory for Designs	110	-769	219
Cross-Modal Coding	541	430	334
Word Read	-131	-030	914
Visual STM - dig	714	-069	-360
Serial Recall	921	011	-015
Free Recall	935	014	-004
Variance	2.548	1.965	1.166

*Decimal points omitted

of simultaneous synthesis are important influences in their performance. On the other hand, low SES children resort to a mixed coding strategy where they probably compare the memory of the temporally constructed auditory sequence with the simultaneously presented dot patterns. Potentially, this task has important implications for further research as its ambiguous solution requirements could provide an index of individual preference for either mode.

SES Differences in Strategy Preferences

Factor scores were derived for all children in the present study and analyzed for SES differences (Table 17). Thus, each Grade 1 child was assigned three factor scores on the basis of the factor analysis in Table 11. The three factor scores for Grade 4 children were derived from the analysis summarized in Table 12. The only SES

Table 17

t-tests on Factor Scores for Grades 1 and 4:
Low and High SES respectively

Variable	Grade 1 Low Mean	Grade 1 High Mean	Grade 4 Low Mean	Grade 4 High Mean	*p* Grade 1	*p* Grade 4
Successive	50.33	49.67	49.10	50.90	NS	NS
Speed	52.14	47.86	51.20	48.80	NS	NS
Simultaneous	47.20	52.80	49.66	50.34	.03	NS

disparity was found at Grade 1 for the simultaneous mode where the mean difference favoured the high SES group ($p < .05$). This could be interpreted as indicating that Grade 1 high SES children are either more gifted in the simultaneous mode or demonstrate a culturally induced preference in using this strategy. If the non-significant SES differences at Grade 4 are interpreted as a schooling effect, the latter alternative would seem more plausible.

Summary

The cultural environment of children who participated in this study probably differs less widely in SES or cultural advantage-disadvantage than the milieu from which Jensen's initial data were gathered. Nevertheless, the results of the current investigation failed to support the major hypotheses derived from the Levels theory. Although SES performance differences occurred on tasks presumed to measure Level II or reasoning ability, these differences favouring high SES children were found principally at the younger age level. With the exception of the culturally loaded PPVT, no SES performance difference was consistent for Grade 4 children in Level II abilities. On the other hand, SES differences were less marked on Level I than on Level II measures and in this sense Jensen's more general points regarding class differences on different types of abilities tend to be confirmed.

The prediction that the magnitude of the correlation between performance on Level I and Level II tasks should be greater for the high SES groups was disconfirmed by the present data. Also disconfirmed was the prediction that high SES children with IQ less than 100 do less well on Level I tasks than low SES children in the same IQ range. Further, the hypothesis that SES differences in Level II-type tasks will be more marked with increasing age was not supported. That these results go against the Jensen model can be interpreted with optimism. Matrices has been described as a relatively pure measure of Level II ability; Memory for Designs requires similar solution strategies. The two SES groups in Grade 4 perform equally well in these tasks. Thus, developmental shifts on these measures indicate that Level II-type ability, or in Cattell's terms 'fluid intelligence', is susceptible to environmental influences. The narrowing SES performance discrepancies at Grade 4 accord with Schmidt's (1966) findings indicating that schooling does exert a levelling effect on cognitive task performance.

The picture vocabulary test did not correlate highly with other intelligence measures used in this study. Hence, the abilities tapped by this test remain somewhat obscure (cf. Matheny, 1971). Nevertheless, performance on PPVT was clearly linked with SES, and it was contended that the cultural factors which determine picture vocabulary performance favour high SES children.

The results of the factor analyses replicate Das' (cf. Das, 1973b) earlier findings and extend the generality of the simultaneous-successive process distinction to embrace an even wider age range. The stability of the simultaneous and successive factors over age and across SES levels indicate that children within the age and SES ranges samples possess in their repertoire similar coding strategies. Additionally, process differences related to age and SES were apparent by considering the disparities among factor loadings on some of the experimental tasks.

CHAPTER V

CONCLUSIONS

A major purpose of the study was to compare the relative merits of two conceptually divergent models of cognitive functioning, namely, Jensen's hierarchical model of reasoning and memory in contrast to the Luria scheme positing two parallel modes of information integration. The results are clearly supportive of the simultaneous-successive coding distinction and provide no confirmation for the hierarchical model, postulating the existence of two levels of cognitive ability differentially distributed in high and low SES groups.

The results of this investigation support the hypothesis that the processes of simultaneous versus successive synthesis provide a more appropriate description of individual differences in cognitive problem solving strategies than reasoning versus memory. The results augment earlier findings (cf. Das, 1973a) pointing to the internal consistency of the Luria two-process distinction. Further, the distinction can be generalized beyond the original age samples (nine to eleven years) to describe processing strategies of Grade 1 children. The stability of these factors over age, and across SES levels, may offer an alternative to current models of hierarchical cognitive development (cf. Zigler, 1970; White, 1965; Bruner, 1966; Jensen, 1970). Despite loading disparities on some tasks, the simultaneous and successive process modes inferred from the target tests in the factor analyses indicate that children within the age range sampled (Grades 1 to 4) possess in their repertoire similar coding strategies. On some tasks, however, individuals may demonstrate preference for the successive mode over the simultaneous mode or vice-versa.

White (1965) advocates a hierarchical model of mental development. He reviews several lines of evidence indicating that children's behaviour after age six shows a 'transition from animal-like to human-like learning'. This transition from associative to symbolic or abstract thought depends critically on the inhibition of the associative function. Jensen (1969) acknowledges White's developmental distinction between 'associative' and 'cognitive' abilities and this thinking is reflected in the hypothesized growth curves of Levels I and II (Fig. 6).

White (1965), in turn, refers to Hofstaetter (1954) who possibly provided the initial impetus for these developmental curves. Hofstaetter factor analyzed Bayley's longitudinal matrix of MA correlations extending from two months to eighteen years. The matrix resolved into three statistically independent factors designated respectively as sensory motor, persistence and symbol manipulation. At approximately age six, the symbol manipulation factor assumes prime importance and from ten years on, accounts for almost all the variance of intelligence test scores.

These developmental trends in the factor loadings are reminiscent of Jensen's growth curves for Levels I and II and could be interpreted as indicating different modes of functioning at various ages. Hofstaetter's favoured interpretation is relevant to the results of this study. He claims that the disparate factor loadings at various age levels tell us more about the diagnostic tools used than the underlying cognitive strategies employed by children at different ages. In other words, the different tasks administered at particular developmental levels simply reflect what 'intelligent' children are supposed to do at a given age. The implication of Hofstaetter's argument is that children do in fact possess qualitatively similar cognitive strategies over a wider developmental range than is usually supposed. In the present study, the battery of tasks was identical for the ages sampled and the recurring stability and similarity of the factor structures at both age levels concur with this position.

As expected, the results of this investigation demonstrate that on all measures quantitative increases in the level of performance are associated with increasing age. More importantly, however, the data support Kogan's (1971) contention that by utilizing appropriate techniques, it becomes possible to identify qualitative similarities and differences in cognitive development. It has been recognized for some time (cf. Bloom, 1964) that intelligence measures below age eight are unreliable predictors of later intelligence. But this may be due to the fact that psychologists have tended to neglect relevant cognitive processes in younger children. The results of the factor analyses in the present study suggest that in spite of age differences in level of performance, similar cognitive strategies are available to the younger children, although these strategies may be employed differently in comparison with older children on some tasks.

Besides the developmental similarities in factor structures at both age levels, there is a further observation relevant to the present discussion. The factor designated as representing 'successive synthesis' in this study most closely parallels that which Jensen (1969) and White (1965) would label the 'Level I' or 'associative' factor. From this point of view, the successive or Level I factor should account for more variance in test scores at Grade 1 than it would at Grade 4 because, according to theory, Level II abilities are supposedly only beginning to emerge at the younger age. The present analyses provide no evidence to support this position. Further discussion of Levels I and II is provided in the next section.

Levels I and II: A Critique

Jensen (1969) hypothesizes that Level I and II abilities are hierarchically related. That is, good Level I ability is posited to be a necessary though not sufficient condition for the growth of Level II. This implies a distorted pear shaped correlation scatter diagram where far fewer children fall in the bottom right quadrant of Figure 5 than in the other three quadrants. The theory rests on the premise that the magnitude of the correlation between learning ability and IQ is significantly greater in high SES groups than in corresponding low SES groups. Although Jensen (1968) has obtained correlations of .60 and over and .20 and under in high and low SES groups respectively, other investigators (Durning, 1968; Guinagh, 1969; Rohwer et al., 1971) have attempted to replicate this 'twisted pear' formulation but have been unsuccessful. The present results also fail to demonstrate SES differences in the correlations between Level I and Level II abilities.

Vernon (1970) has expressed concern as to the Levels theory. He finds it difficult to envisage a teaching approach based on associative abilities and is aware of the problem of deciding who should be selected for what would be regarded as an inferior type of schooling. Further, Vernon reviews evidence from previous factorial studies which suggest that STM tasks do not embody a strong common factor. Stemming from this concern, Vernon (1973) has recently attempted to confirm

Jensen's findings using less strongly contrasted SES groups and a wider range of tasks. As in the present study where the environmental conditions are highly similar, Vernon finds no evidence to support the 'twisted pear' formulation which is essential for positing a functional dependence of Level II on Level I.

There are several explanations which could account for the limited support obtained for the Jensen model. In the following statement Jensen (1970) himself identifies a potential weak link:

> Extremely simple forms of learning, which require no discriminations and involve no competition among multiple response alternatives--for example, classical conditioning --do not distinguish even between retardates and persons of average or superior IQ. It is only when discriminative features enter the conditioning procedures that some correlation with intelligence is manifested (p. 79).

Possibly Jensen's hypothesis that the distribution of associative learning ability is independent of SES represents merely an artifact of his short-term memory tasks. The measures of 'basic learning ability' may be dependent on such primitive functions that they fail to differentiate between individuals of varying intellectual ability.

In support of this position, Wechsler (1958) points out that Digit Span, which serves as a basic test of Level I, is a poor measure of intelligence and argues that 'rote memory[1] is an ability of which a certain absolute minimum is required, but excesses of which seemingly contribute relatively little to the capacities of the individual as a whole' (p. 71). Similarly, Miller (1956) notes that the 'span of immediate memory' or in Jensen's terms, Level I, 'is valuable principally because an unusually short span is a reliable indicator

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[1] This term is misleading as it implies repetition or rehearsal strategies.

of mental deficiency; a long span does not necessarily mean high intelligence' (p. 4).

Prima facie, the Levels theory appears sound. Jensen points to the well documented relationship between SES and IQ performance and claims that IQ or Level II is functionally related to SES. Level I is supposed to be independent of SES and is posited to be a 'necessary but not sufficient condition' for the manifestation of Level II ability. With certain qualifications, the hierarchical dependence of Level II on Level I is a logical necessity; for example, a person must be able to hold a problem in mind long enough to solve it. Simply retaining the problem does not guarantee its solution. The qualification is, however, that the so-called 'twisted pear' relationship can only hold within rather narrow limits. Since if good Level I ability is necessary for good Level II ability, extremely high Level II would in turn imply extremely high Level I ability. Vernon (1973) notes that some children are found with good Level II and poor Level I and it is perhaps not surprising that subsequent investigations attempting to replicate the twisted pear formulation have been unsuccessful.

It also seems logical (Miller, 1956; Wechsler, 1958) that Level I ability (Digit Span) would be independent of SES or, at least, differences on these tasks would be minimal as the ability to recall digits immediately following presentation represents a rather narrow ability. However, from the point of view of educational practice, it is unlikely, as Vernon (1970) implies, that the ability to recall a series of random digits will have much bearing on the kinds of learning that teachers are interested in.

A major criticism of the Levels theory is the inductive leap from a 'structural' capacity (Digit Span) to a supposed broad category of ability (Level I) embracing wide areas of the learning domain. In the Jensen model, STM becomes variously 'associative learning', 'rote learning', 'basic learning ability' and is involved in effective responding to questions such as, 'Who wrote Faust?' (Jensen, 1970, p. 55). In the Luria scheme, the ability to recall or order events sequentially is dependent on the process of successive synthesis rather than on STM capacity. Luria (1966a) points out that although some brain injured patients with fronto-temporal lesions are able to hold in mind or recall six or seven digits correctly, they cannot order them in their correct serial position. Although the marker tests for successive synthesis in this study represent good measures of Level I ability, the conceptual distinctions between these contrasted models--capacity versus process--have completely different implications for cognitive functioning.

Almost without exception, the studies from which the hypothesized SES ability differences were derived by Jensen confound SES and race. Jensen (1970) acknowledges that in reality his middle and low SES data represent white and negro comparisons, respectively. If Jensen's theory is reduced to negro-white rather than SES comparisons, his results accord with commonly reported findings which indicate that negroes are less handicapped on verbal tasks, especially those dependent on rote learning.

For example, Higgins and Sivers (1958) compared white and negro children aged seven to nine years on the Terman Merrill and Matrices tests. In this comparison, both racial groups score equivalently on Terman Merrill, yet on the nonverbal reasoning test there was a ten point IQ discrepancy favouring the white group. Similarly, Tyler's (1956) survey of race differences indicates that the greater deficit of negroes on nonverbal material is a frequent finding, while Semler and Iscoe (1963) report that negroes generally do well on rote learning tests.

These findings are not limited to the United States. Vernon's (1965, 1969) research in Jamaica indicates that negroes are most handicapped in symbolic thinking with nonverbal materials such as Matrices and Block Design. Yet they have sufficient verbal facility to do relatively better at verbal intelligence tests. Whether these observed differences are genetically or culturally conditioned is irrelevant to the present discussion. The review is intended merely to suggest that the phenomena observed by Jensen in racially confounded studies may have been spuriously generalized to SES differences.

The present study failed to demonstrate ability differences in the two SES groups which should have been found if the Levels theory were universally valid. Perhaps the success of the theory can be attributed to the extreme samples used by Jensen. Undoubtedly, the cultural milieu of children who participated in this study is more homogeneous than the environment from which Jensen's children were sampled. Although the current SES groups appear to be as disparate as the Californian samples in terms of SES ratings, they did not differ in other ways such as ethnic and cultural characteristics.

Implications and Suggestions for Educational Research

The relative independence of process differences from conventional indices of ability (IQ) inferred from this study has educational significance since it suggests that the standardized test information contained in a child's cumulative record at school does not begin to tap process variations in the child's repertoire.

Cronbach (1971) notes that aptitudes or the factors which promote a child's survival in a learning environment are influenced as much by individual differences in styles of thought as by the abilities sampled in conventional tests. More importantly, aptitude information is only educationally useful if the aptitude and treatment interact. This means that g or general ability represents a poor basis for differentiating instruction because the general measure will correlate with success under practically any condition of instruction.

A growing criticism of current educational practice is that too much emphasis is placed on designing instruments which attempt to predict school success. In line with Cronbach's position, a more fruitful approach would be to select an aptitude variable such as simultaneous or successive synthesis and design treatments which would interact with these variables. To illustrate, simultaneous synthesis appears to share links with spatial ability. Effective use of simultaneous integration may assist the child to master tasks calling for spatial transformations of data. At present, performance on simultaneous tasks such as Matrices, Figure Copying and Memory for Designs has little power to predict learning, but this may be because instruction is largely in the verbal medium (cf. Smith, 1964; Cronbach, 1971). It seems feasible that if teaching methods were modified to capitalize on the simultaneous factor, children showing a preference for this mode of thought would learn more effectively and, as a consequence, the success rate at school could be substantially increased.

Conversely, children favouring a successive mode might profit more from a sequential or verbally oriented approach. This matching of differential aptitudes with instruction is by no means a novel suggestion; it has served as an effective basis for military classification for more than thirty years (Cronbach, 1971).

Obviously an important question requiring further investigation is whether or not the inferred process distinctions--simultaneous and successive synthesis--play differential roles in determining a child's effectiveness in cognitive task performance. Does one mode have an advantage over the other? Moreover, if the present research, along with previous work, has confirmed that the Luria model represents two viable individual difference variables, a further consideration would be to determine whether individual preference for either mode is amenable to modification. Ingenious instructional methods have to be devised to bring about such modifications. How to teach a child to switch his coding process would then become a problem for innovative educators.

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APPENDIX

Appendix I-1

Rotated Factors (Varimax) for Grade 1:
All Variables (N = 60)*

Variable	I	II	III	IV	V	VI	VII
Matrices	-130	227	-167	635	039	-335	416
Figure Copy	229	-059	081	801	157	075	037
Memory for Designs	-114	-113	-347	-717	082	126	095
Cross-Modal Coding	146	162	178	-023	-029	205	810
Visual STM - dig[1]	012	038	313	131	765	-106	-174
Visual STM - dig[2]	125	211	-029	-143	756	107	073
Word Read	-270	-140	-713	054	-059	354	-031
Serial Semantic	944	105	103	089	055	040	037
Serial Control	897	054	221	136	113	126	024
Total Serial Recall	946	083	163	114	085	083	032
Free Semantic	921	130	025	048	090	-079	086
Free Control	937	028	136	004	018	-073	062
Total Free Recall	962	087	078	029	059	-079	078
PPVT - raw	134	960	080	075	089	055	051
IQ	133	940	089	069	040	-136	071
MA	131	961	077	066	084	069	050
Age	078	225	-035	240	314	608	079
Visual STM - obj	149	-200	136	256	449	-409	313
Colour Read	-140	118	-765	-090	-017	-033	-265
Blishen Rating	029	176	-008	242	185	-692	-162
Bridge Task	287	268	192	493	-267	095	-200
Digit Span - fwd	711	125	205	193	-134	005	-148
Digit Span - bwd	186	127	616	151	136	062	021
Metropolitan	142	313	518	248	100	123	-220
Variance	6.180	3.274	2.257	2.212	1.697	1.437	1.219

*Decimal points omitted

[1] Serial Position

[2] Free Recall

Appendix I-2

Rotated Factors (Varimax) for Grade 4:
All Variables (N = 60)*

Variable	I	II	III	IV	V	VI	VII
Matrices	-002	265	855	-063	039	083	057
Figure Copy	-070	017	757	085	045	-166	-062
Memory for Designs	-001	044	-680	197	055	-083	-052
Cross-Modal Coding	090	-051	576	324	130	004	-205
Visual STM - dig[1]	339	054	004	869	-125	023	-004
Visual STM - dig[2]	181	110	-051	816	034	-063	023
Word Read	-068	048	005	-127	802	092	-086
Serial Semantic	878	112	-147	171	058	-178	002
Serial Control	860	-052	080	193	-147	149	-052
Total Serial Recall	956	044	-052	199	-035	-039	-024
Free Semantic	916	029	-017	104	097	-161	-009
Free Control	880	-108	036	151	-152	165	-118
Total Free Recall	966	-041	010	137	-026	-002	-067
PPVT - raw	057	973	100	061	-002	-069	-017
IQ	025	924	116	019	139	092	-033
MA	063	971	106	052	003	-060	-029
Age	047	290	063	116	-414	-674	035
Visual STM - obj	241	-022	-030	346	-308	245	559
Colour Read	-004	023	079	020	763	-104	160
Blishen Rating	021	530	036	105	-116	320	263
Bridge Task	-101	220	324	-178	229	-102	605
Digit Span - fwd	716	226	-016	104	002	-003	176
Digit Span - bwd	154	139	374	009	-111	223	-586
Lorge-Thorndike VIQ	-053	236	030	018	-160	764	-080
Frames	326	052	-164	852	-122	002	003
Lorge-Thorndike PIQ	-095	247	590	-255	002	-002	080
Variance	5.870	3.469	2.801	2.734	1.730	1.452	1.245

*Decimal points omitted

[1]Serial Position

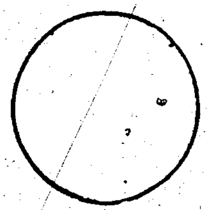
[2]Free Recall

APPENDIX B

Figure Copying

Ten examples of the designs used are given below.

1



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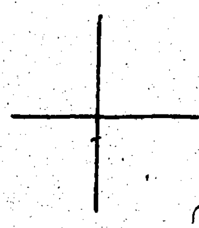

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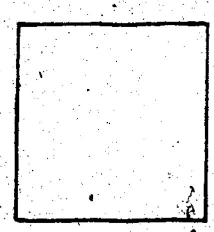

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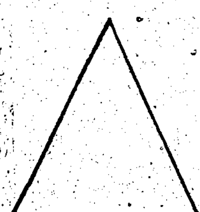

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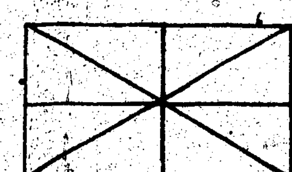

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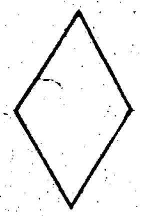

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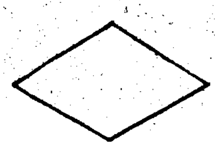

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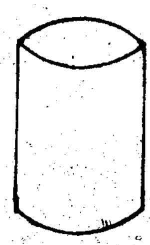

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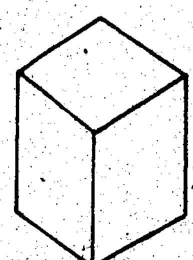
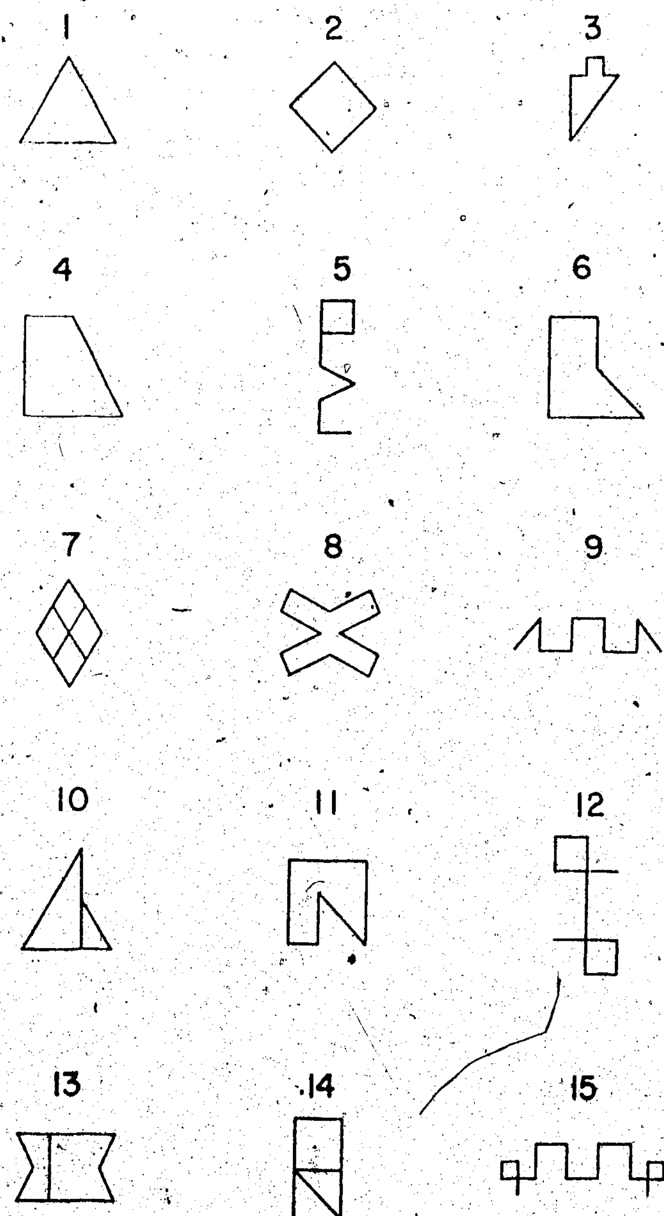


10

Memory for Designs

Given below are the Memory for Designs test drawings. Numbers did not appear on the faces of the actual plates, but are given here for purposes of identification.



Memory for Designs

Administration

The subject was provided with a pencil, an eraser and a sheet of white paper. The following instructions were given: 'I am going to show you some cards with drawings on them. I will let you look at a card for five seconds; then I will take it away and let you draw from memory what you have seen. Be sure to look at the drawing carefully so that you can make yours just like it. Don't start to draw until I take the card away. Ready, here's the first one.' The examiner then showed the card for five seconds, holding it at right angles to the child's line of vision. As it was withdrawn, he was told, 'Now draw it just like the picture'. It was sometimes necessary to remind the subject several times not to draw until the card was taken away. No attempt was made to urge guessing or the completion of a partly remembered design.

Scoring

Each design was scored on a four-point scale with values from 0 to 3. The total score was the sume of the scores on the 15 individual designs; the higher the score, the poorer the performance. The general principles for scoring are elucidated below.

0 points:

a. This rating is given to a satisfactory reproduction or (with certain exceptions) to one that contains no more than two easily identifiable errors. (Symmetrical errors, which occur frequently on Designs 12 and 15, are counted as only one error.)

b. Omitted or incomplete drawings, if no error has been made up to the time subject indicates loss of the memory, are also given 0 ratings.

1 point:

a. More than two easily identifiable errors have been made, but the general configuration or gestalt is retained.

b. Reversal of a part only is rated 1.

2 points:

a. The general configuration has been lost. (These ratings are the most difficult to make, but the criteria have been objectified by the use of examples.)

b. The strict counting of errors has not been adhered to; certain errors, as omissions and additions of parts, are penalized more heavily than others because they may change the total configuration radically. Although, in general, the omission of a minor detail or a small addition is considered only one error, when the omission or addition changes the shape of the design (e.g., from a quadrangle to a pentagon), a rating of 2 is given.

3 points: a. The design has been rotated (i.e., the axis turned 180°, 90° or, in the case of Designs 2 and 7, 45°) or reversed (mirrored either laterally or in such a way that the reproduction is upside down).

b. In general, orientation errors of 90° may be recognized and scored even when the figure is incomplete. However, those of 180° may not be scored as orientiation errors unless the figure otherwise meets the requirements of a rating of 0 to 1.

c. Exceptions:

i. Reversals of parts only are not scored in this category, but are given a rating of 1.

ii. Errors in the orientation of Design 4, since they do not clearly differentiate control from brain-damaged subjects, and since an incorrect slant of only one side occurs frequently and easily gives the impression of a rotation or reversal, are given a score of 1. this represents a change from the original scoring instructions.

Auditory Serial Recall

The semantic and control word lists in random order are given below.

key hot cow pen	wide long big great
wide large big high	great high tall long
day cow wall bar	few pen hot wall
long big fat great	day cow bar wall
pen wall book key	tall fat large high
book bar wall hot	long big great fat
key few hot book	few day cow book
high fat huge wide	tall long big huge
huge great fat large	key book day hot
key day cow bar	wide huge long large
wide tall large huge	high tall fat big
bar pen few day	pen few wall cow

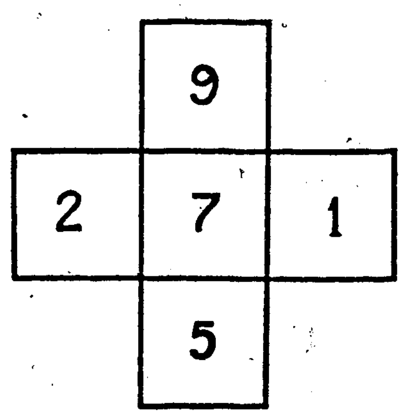
Instructions

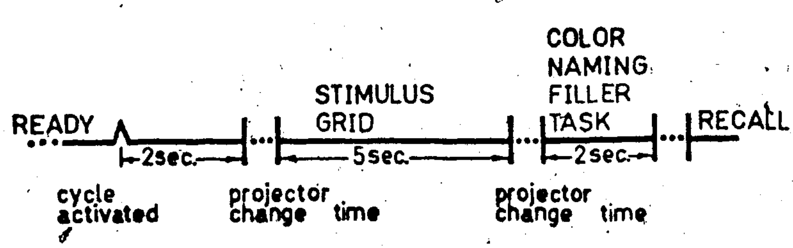
I am going to say some words. When I am finished I want you to say the words just the way I said them. There will be four words in each group. I'll repeat the instructions. I am going to say some groups of words. When I am finished I want you to say the words just the way I said them. Let's try a group of words. Ready? Big long great tall. (Pause) You should have said, big long great tall. Each time I say a group of four words, I want you to say the words in exactly the same order that I do. Let's try another group of words. Ready? Cow day key few. (Pause) You should have said, cow day key few. Let's try one more list of words. Ready? Man mad map pan. (Pause) You should have said, man mad map pan. You see, when I say a group of words, I want you to say the same words just as I do. Now let's try some other groups of words. Ready (begin test).

Stimuli numbers for visual short-term memory

*1.	9 8 4 5 1	12.	5 3 6 1 9
*2.	9 2 7 1 5	13.	6 3 2 9 5
3.	2 4 9 7 1	14.	2 3 5 9 6
4.	7 2 3 9 6	15.	8 1 6 5 3
5.	7 5 2 9 4	16.	1 3 5 8 9
6.	4 8 9 3 1	17.	2 4 5 8 1
7.	5 4 8 1 6	18.	8 3 6 5 1
8.	9 7 5 3 1	19.	1 5 6 3 8
9.	3 5 6 1 8	20.	5 9 2 3 6
10.	7 3 9 8 4	21.	4 5 9 2 7
11.	3 8 6 9 4	22.	6 9 2 4 5

*Series 1 and 2 were for practice purposes only and were not scored.

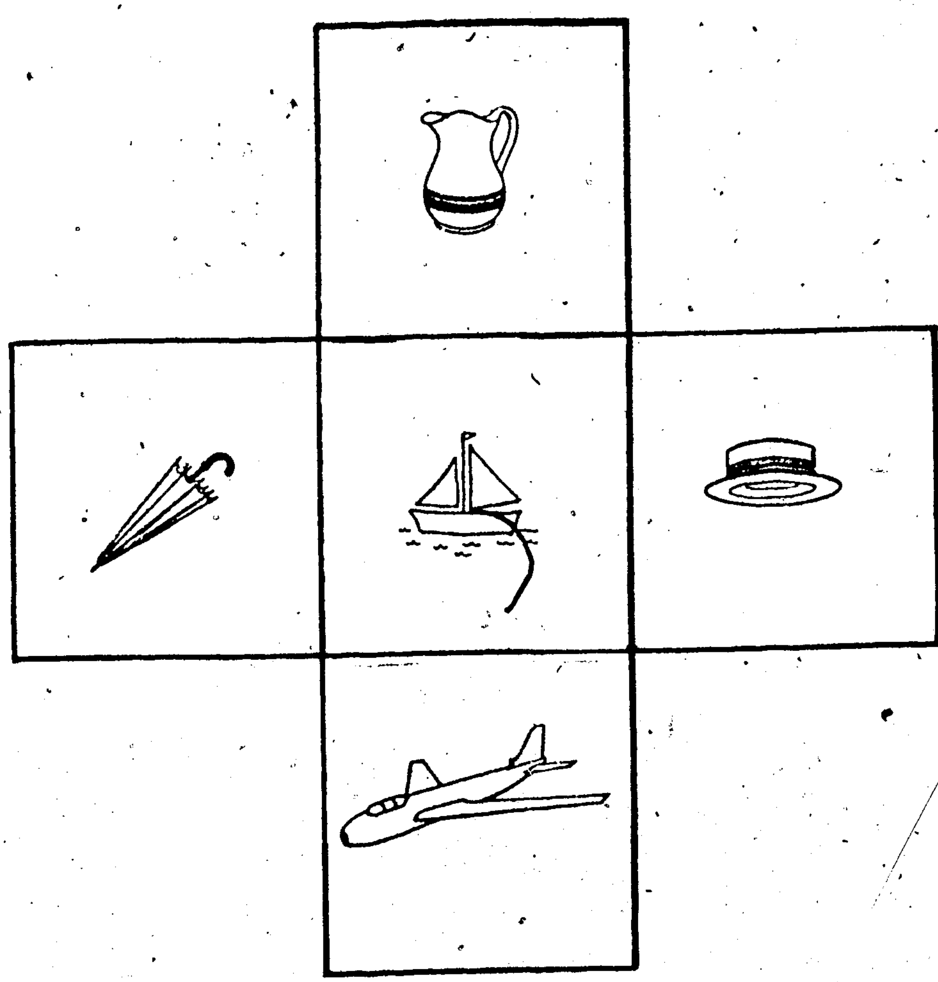




Depicted above is a sample stimulus grid for visual short-term memory. (The 22 different grids were formed with digits from 1 to 9.) The lower portion represents the time sequence in visual short-term memory presentation.

Example of Stimulus Matrix for Visual Short-Term Memory - objects

Nine line drawings were abstracted from the Stanford-Binet picture vocabulary test. The objects were numbered from 1 to 9 and were presented in the same random order as the numbers in Visual Short-Term Memory - digits. A pictorial example is given below.



Instructions for Visual Short-Term Memory

I am going to show you some numbers[1] and some colours. I want you to watch the screen and do as I tell you (project slide 1). Look at these numbers, try to remember each number (pause then project slide 2). Now name these colours starting at the top (pause then project blank slide 3). Now write the numbers you saw at first on this paper. Good. [If incorrect, repeat example 1.]

Now let's try another one (project slide 4). Look at these numbers and try to remember them (pause briefly then project slide 5). Name these colours starting at the top (project slide 6). Now write the numbers you have just seen.

[Repeat until subject understands the instructions and can successfully reproduce the digits.]

set timers

Now we are going to try again, but we will go a bit faster. Ready? (engage timers) [As the first sequence progresses say] look at the numbers . . . name the colours . . . Write . . . .

Let's try another set. Ready? (engage timers) Good. Remember to look at the numbers, name as many colours as you can, then write the numbers.

[Start test with each trial preceded by a ready signal.]

[1]When pictures of objects are used as stimuli, the method of recall consists of selecting matching objects (printed on discs) from an array of nine alternatives. The child manually places his choices on a grid board before him.

Digit Span

Digits forward

Directions: 'I am going to say some numbers. Listen carefully, and when I am through say them right after me.' The digits were presented at the rate of one per second. All subjects were started with the three-digit series. If the subject repeated trial 1 of a series correctly, it was scored plus and the next higher series was given. If the subject failed on trial 1, he was given trial 2 of the same series. The task was discontinued when failure on both trials of a given series occurred.

Scoring: The score was the highest number of digits repeated without error on either trial. Thus, if the highest number of digits correctly repeated by a subject was five digits forward, his score was 5. Maximum score: 9 points.

Series	Trial 1	Trial 2
(3)	3-8-6	6-1-2
(4)	3-4-1-7	6-1-5-8
(5)	8-4-2-3-9	5-2-1-8-6
(6)	3-8-9-1-7-4	7-9-6-4-8-3
(7)	5-1-7-4-2-3-8	9-8-5-2-1-6-3
(8)	1-6-4-5-9-7-6-3	2-9-7-6-3-1-5-4
(9)	5-3-8-7-1-2-4-6-9	4-2-6-9-1-7-8-3-5

Digits backward

Directions: 'Now I am going to say some more numbers, but this time when I stop I want you to say them backwards. For example, if I say 9-2-7, what would you say?' If the child responded correctly, the test proceeded, beginning with trial 1 of the three-digit series. But if he failed, the example, the correct answer was given, followed by another example (5-6-3-). If the child succeeded, the test proceeded, using trial 1 of the three-digit series. However, if he failed this second example, the test proceeded, but began with trial 1 of the two-digit series. Some children who passed the unrecorded examples failed both trials of the three-digit series; in this case, the trials of the two-digit series were given and the test was terminated. The second trial of a series was given only if the first trial was failed.

Scoring: The score was the highest number of digits repeated backwards without error. Maximum score: 8 points.

Series	Trial 1	Trial 2
(2)	2-5	6-3
(3)	5-7-4	2-5-9
(4)	7-2-9-6	8-4-9-3
(5)	4-1-3-5-7	9-7-5-8-2
(6)	1-6-5-2-9-8	3-6-7-1-9-4
(7)	8-5-9-2-3-4-2	4-5-7-9-2-8-1
(8)	6-9-1-6-3-2-5-8	3-1-7-9-5-4-8-2

Cross-Modal Coding

Auditory and visual test stimuli for cross-modal coding are shown below. Large and small spaces represent approximate time intervals of 1.35 seconds and .35 seconds, respectively. The underlines were omitted from test cards when presented to the subjects.

	AUDITORY STIMULI	VISUAL STIMULI		
	EXAMPLES			
	• •	••	<u>• •</u>	•••
	• ••	•••	<u>• ••</u>	•• •
	•• •	•••	• ••	<u>•• •</u>
	TEST ITEMS			
1	•• ••	• •••	• •• •	<u>•• ••</u>
2	• •••	••••	<u>• •••</u>	••• •
3	••• ••	•••••	•• •••	<u>••• ••</u>
4	• •• •	<u>• •• •</u>	•••••	•• ••
5	••• •• •	<u>••• •• •</u>	•• ••• •	• ••• ••
6	•• •••	••• ••	<u>•• •••</u>	•••• •
7	•• •• ••	<u>•• •• ••</u>	•••• ••	••• • ••
8	••• ••• •	•• ••• ••	••• •• ••	<u>••• ••• •</u>
9	•• • •••	•• •• ••	<u>•• • •••</u>	•• ••• •
10	• ••• ••	• •• •••	<u>• ••• ••</u>	•• • •••

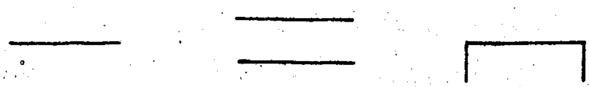
Instructions for Cross-Modal Coding

I am going to let you listen to some patterns of sounds. Listen carefully. (Examples 1, 2 and 3 without the visual stimulus cards were presented.) Each of the patterns you heard are just like the dots you see on this card. (Card shown) Let's take a look at each one. Here is what the first one sounded like. (Example 1 presented.) This is what the second one sounded like. (Card 2 shown and example 2 presented.) You see. It is just like the dots that are on this card. Let's take a look at the other one that we listened to. (Card 3 shown and example 3 presented.) Each pattern you hear is going to be like one of the dot patterns you see here. Let me show you. Listen! (Card 4 shown, example 1 presented. N.B. Card 4 and all subsequent cards contain three possible sound patterns of which one is correct. Cards 1 to 3 contain only the correct pattern.0 Which one did you hear? It was this one. (Examiner points to the correct pattern.) Listen again, then you show me which one you heard. Ready? (Card 5 shown and example 2 presented.) Which one is it? (Subject points.) Let's listen to a different one. Ready? (Card 6 shown, example 3 presented.) Which one is it this time? Let's try another one. You show me which one you heard. Ready? (Example 1 presented, followed immediately by card 7.) Listen again and then show me which one you have heard. (Example 2 presented, then card 8 shown.) Ready? (Example 3, then card 9.) Ready? (Example 1, then card 10.) Ready? (Example 2, then card 11.) Ready? (Example 3, then card 12.) If the subject did not correctly identify any of the last three stimuli, the instructions were repeated until he could.) Listen carefully and pick out the dots that look like the tones you hear. Ready? (Test item 1 presented, followed by the rest of the test.)

Administration of Bridge Task

Each pattern below was drawn in black on a 3" x 5" white card: A = 'road', B = 'river', C = 'bridge'.

A B C



The child was provided with six wire strips which were placed in a cluster to his left. Four strips were six inches long and two were two inches long. For the preliminary training, the following instructions were given:

'I am going to show you some cards with drawings on them. When I show you a picture, I want you to make one just like it with your bits of wire. Pretend this is a road (showing pattern A above). Make me a road just like this.' (Occasionally a child would begin to use all six strips, in which case the tester would say, 'that's the right idea, but your road is much longer than this one.') When the child responded correctly, the wire strip was placed back in the pile. Subsequently, the tester would say, 'Pretend this is a river (showing pattern B). Make me a river just like this'. The same procedure was followed for pattern C. Occasionally the child would construct his 'bridge' from three six-inch strips rather than from two two-inch and one one-inch strip as depicted on the card. Such an oversight was brought to the child's attention.

Following this sequence, the child was asked to reproduce each pattern separately without the visual aid. Only six children required further assistance from the card patterns. The criterion for beginning the test was two faultless runs through the series.

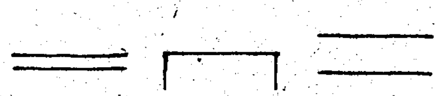
Instructions for the bridge task: 'Now, using all your pieces of wire, and working right here (indicating the table), make a bridge, going across a river, with a road on each side.' The instructions, 'Make a bridge, going across a river, with a road on each side' were repeated once.

Scoring Procedure for Bridge Task

The child's construction was sketched by the tester and scored in accord with the examples below. If he simply reconstructed the patterns or, if the response was too chaotic to be recognized, a score of 1 was assigned.

A score of 2 was given if the child at least began to fulfil the task requirements. A score of 3 was given if two requirements were met: the bridge was oriented toward the river, if not crossing it, and at least one of the roads was correct. A score of 4 was given only if the bridge was placed across the river, and only if the roads were on each side of the bridge. But a score of 5 was given only if the bridge was placed across the river and only if the roads were leading away from the bridge.

Score Example

1


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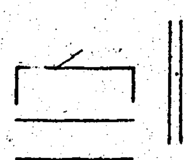

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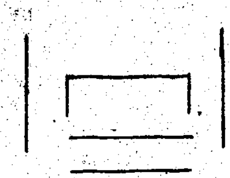

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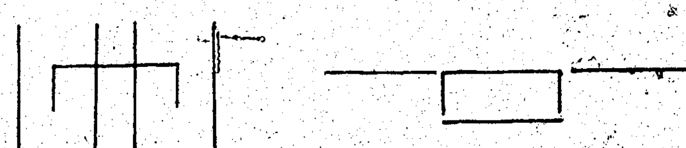

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