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STRUCTURE OF INTELLECTUAL AND DIVERGENT PRODUCTION ABILITIES IN THE LOWER INTELLECTUAL RANGE

BY

© JOHN OLIVER DELANEY

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

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DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Structure of Intellectual and Divergent Production Abilities in the Lower Intellectual Range" submitted by John Oliver Delaney in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT

Studies of the organization of abilities in subnormal individuals have shown that abilities are of essentially the same kind as in normal persons. These studies, with a few exceptions, used traditional measures of intelligence such as the WISC or WAIS thus pointing up the narrow conception of intellectual functioning in subnormal persons. The possible existence of other intellectual qualities not presently measured by the intelligence test warrants examination and may be relevant in refining our understanding of subnormal children.

The present study was an attempt to determine whether children whose IQs ranged from 50 to 80 were characterized by the same abilities as those of IQ 90 to 120. The WISC and a battery of eleven divergent production tests designed by Guilford, which yielded 26 scores, were administered to 48 normal and 46 subnormal children. It was hypothesized that four WISC factors would emerge for both groups but that subnormal children would exhibit less differentiation of divergent production abilities.

Four WISC factors were identified in each group: verbal reasoning, perceptual organization and verbal comprehension for both groups, a memory factor for the normal group and a short-term memory factor for the subnormal group. The six predicted DP factors for the normal group failed to emerge, only two such factors being identified: a broad DP factor, which could possibly be interpreted as divergent production of semantic units, and divergent production of

figural units. A global DP factor and divergent production of figural units were found for the subnormal group. Four other factors were identified for the normal group, visual imagery, numerical, reflection and social awareness. For the subnormal group three other factors were identified as speed, numerical-geometric and reflection while one remained unidentified.

The identification of two divergent production factors indicates an aspect of intellectual functioning which is not measured by traditional intelligence tests and which is independent of the traditional concept of intelligence. It points up that subnormal children cannot be dismissed from consideration in areas of intellectual functioning assumed to be limited to individuals of normal and superior intelligence.

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CHAPTER I

INTRODUCTION

The general level of intellectual functioning has been traditionally emphasized in the assessment of intelligence and expressed in terms of mental age (MA) and intelligence quotients (IQ). This approach to intelligence has two major limitations. First, it suggests that the traditional intelligence test samples a sufficiently broad range of intellectual abilities. However, according to Gallagher and Moss (1963) and Guilford (1967, p. 471) the range of abilities being measured is narrow and, in effect, such tests measure only a limited amount of the total complex of intelligence. The majority of these tasks sample abilities requiring what Guilford terms "cognition." Second, the IQ metric has shown immunity to advances in our understanding of thinking and behaviour. It does not reveal qualitative changes in intellectual development such as increasing ability to solve problems, perform more difficult, abstract, and complex problems (Stott & Ball, p. 44) and possibly crystallization of abilities with increase in age and experience. Such changes are accounted for by a simple quantitative increase in a general ability factor (Stott & Ball, 1965, p. 44). IQ scores do not show how an individual differs from others with a similar score nor do they provide information regarding an individual's differential reactions to a variety of situations (Sarason & Doris, 1969, p. 18). Further, the validity of a new intelligence test is often measured by the degree of its correlation with an old intelligence test thereby perpetuating the original conception of intelligence and guarding it from theoretical and empirical scrutiny. In contrast to this traditional view of intelligence J.P. Guilford's work over the past two decades has been dedicated to demonstrating the multifaceted nature of intelligence. Guilford's factorial investigations into the components of intelligence have resulted in a unified theory of intelligence called the "structure of intellect." His morphological model, as opposed to the hierarchical models of Burt (1949) and Vernon (1961), classifies abilities along three dimensions--operation, content and product--with each ability being represented by the interaction of the three components. The model lists the operations or intellectual activities that the organism does with information as cognition, memory, divergent production, convergent production and evaluation. The content or input domain refers to four broad classes of information: figural, symbolic, semantic and behavioural. The product category describes the forms that information takes in the organism's processing of it, whether in the form of units, classes, relations, systems, transformations or implications (Guilford & Hoepfner, 1966b).

Guilford's analysis of intelligence and development of his model has been largely limited to subjects of normal and superior intelligence. Guilford (1956) noted that such populations allow one to "investigate intellectual qualities and functions in their greatest scope and variety (p. 287)," which suggests that subjects with an intellectual classification of dull normal or retarded would exhibit less crystallization and differentiation of abilities. This assumption, coupled with the belief that many of the intellectual factors obtained with superior groups, as for example in Guilford's model, would not be applicable or simply would not be found among those of lower intellectual functioning (Sarason & Gladwin, 1958, p. 1149) has impeded extensive explorations of abilities in such groups.

The neglect of the study of the intellectual components of mental retardation may be attributed to four factors: (1) the emphasis on the clinical implications of the syndrome; (2) the grouping of the retarded according to the care they need (Kebbon, 1965); (3) the emphasis on the etiology of intellectual defects (Shirley, 1967) and (4) the assumption that abilities in the retarded are not well differentiated and hence hold less promise of a rewarding research (Dingman & Meyers, 1966, pp. 61-62).

General Statement of the Problem

The purpose of this study was to explore the factorial structure of intellectual and divergent production abilities of children in the lower intellectual range and to compare this structure with that of intellectually normal children from the same background. A further purpose was to compare the results for both groups with results which would be expected from Guilford's theory.

Definition of Terms

Lower intellectual range (subnormal children): children who, after physiological examination, have been classified as intellectually subnormal and who have, on an individual administration of the Wechsler Intelligence Scale for Children (WISC), intelligence quotients falling in the 50-80 range.

Normal children: children with intelligence quotients, as measured by individual administration of the Wechsler Intelligence Scale for Children, between 90 and 120 and who are in regular VII-IX grades.

Divergent Production (DP): Generation of information from given information, where emphasis is placed upon variety and quantity of output from the same source; likely to involve transfer (Guilford, 1967, p. 213). Tests of divergent production give the subject an item of information to which he is to respond in a variety of ways, where quantity and quality of responses are variously weighted in deriving a score for the subject's performance.

CHAPTER II

REVIEW OF RELATED RESEARCH

In the investigations of the organization of abilities in persons of subnormal intellectual functioning, the majority of such studies has been centered around mental retardates. Two main approaches have been used: (1) studies of test profiles (Baroff, 1959; Gallagher & Lucito, 1961; Belmont _et al._, 1967) and (2) factor analytic studies (Baumeister & Bartlett, 1962a, 1962b; Taylor, 1964; Kebbon, 1965; Kebbon _et al._, 1967).

A major symptom of mental retardation is subaverage general intelligence (Heber, 1959). However, general defect in intelligence does not mean that the separate abilities are all on the same level as evidenced by Baroff's (1959) investigation of WISC profiles in non-brain-injured defectives. On the average, performance tasks were less difficult than verbal tasks. Similar findings have been reported by Gallagher and Lucito (1961), Alper (1967) and Belmont _et al._ (1967). Meyers _et al._ (1961) compared six-year-old normal children with retardates of comparable mental ages on hand-eye coordination, perceptual speed, linguistic ability and nonverbal reasoning. The normal subjects scored significantly higher on all but one of the thirteen tests. The retarded group's relative strength was in linguistic ability, which involved words as units without complex language structure or verbal reasoning. Nonverbal reasoning was their weakness. In general, retardates show greater strength on performance tasks or tasks requiring only the repetition of previously learned material than on tasks requiring abstraction and verbal reasoning (Meyers _et al._, 1961; Robinson & Robinson, 1965, p. 386).

Factor analytic studies of abilities in the lower intellectual range have, in most cases, used standard instruments as the WISC or WAIS (Baumeister & Bartlett, 1962a, 1962b; Sprague & Quay, 1966; Belmont _et al._, 1967; Osborne & Tillman, 1967). Baumeister and Bartlett (1962a, 1962b) found four factors which underlie the performance of retardates on the WISC: general, verbal, performance and short-term memory. These are similar to the earlier findings made by Gault (1954) with 10½- and 13½-year-old normal children. Belmont _et al._ (1967) found the same three factors--verbal, performance or perceptual organization and memory--for normal and retarded subjects. However, for normal subjects the verbal and performance factors were positively correlated whereas in the retarded subjects a negative relationship was found. They concluded that verbal ability facilitated the performance of perceptual tasks in the normal children while the retarded subjects' less developed verbal skills and the unavailability of these skills in perceptual tasks may account for their limited level of functioning.

The identification of a short-term memory or trace factor in retarded subjects (Baumeister & Bartlett, 1962a, 1962b; Sprague & Quay, 1966) has been interpreted as an important difference in the structure of abilities for normal and retarded individuals. They interpreted this factor as supporting Ellis' (1963, pp. 134-158) trace theory which hypothesizes that retarded persons are characterized by a deficit in short-term memory. However, Dingman and Meyers (1966, pp. 55-76), Meyers and Dingman (1966) and Scott and Scott (1968, pp. 136-139) have cast doubt on the interpretation of a short-term memory factor in the WISC or WAIS as support for Ellis' trace theory.

Kebbon (1965) investigated the organization of abilities in mentally retarded males and normal men of approximately the same age distribution. Analysis of normal and retarded subjects yielded largely similar factors, verbal, spatial-inductive, numerical and psychomotor, but with a more substantial fifth factor, perceptual speed, being obtained for the normal group. Separate analysis of different IQ groups of all subjects, retarded and normal, essentially yielded the same factor structure in each group.

Meyers et al. (1964) explored ability in normal children of two, four and six years and in retarded children of comparable mental ages in four areas: hand-eye coordination, perceptual speed, linguistic ability and figural reasoning. Though the four hypothesized factors did not emerge for each group, the retarded and normal children at each MA level exhibited similarity in structure.

Standardized measures of intelligence, as the WISC and WAIS, were developed on the theory of general intelligence. Wechsler (1958) pointed out that the subtests of the WAIS were to be regarded as different measures of intelligence and not measures of different kinds of intelligence. The assertion here is that tests of intellectual abilities would correlate positively with each other (Guilford, 1964). In the development of an intelligence test under this condition an a priori factorial condition has been created i.e. the probability of obtaining a general factor is increased. Where such a factor is obtained it does not confirm the construct of general intelligence.

Limiting an investigation to a single scale may becloud the issues and slow down the search for wider spectrums of human abilities in childhood (Dingman & Meyers, 1966).

> Though such aids as the ETS battery, the Guilford model and Cattell's (1957) UI series exist, factor analyses of standard intelligence tests continue to be published, unguided by any of these frames of reference and that without such guidance results are difficult to interpret, highly redundant and of little use in guiding future investigations (p. 61).

Continued reliance solely upon conventional intelligence tests and test scores for research into human abilities is considered also by Sarason and Gladwin (1958) and Gallagher and Moss (1963) to be non-productive. Any progress that may be made in this respect will be due to changes about the nature, organization and variety of intellectual processes (Sarason & Gladwin, 1958).

> One's conceptions (i.e. theory) about the variety of intellectual functions should dictate the tests devised and employed rather than one's conceptions being dictated by the tests which happen to be available (p. 1151).

Hutt and Gibby (1965, pp. 33-34) stressed that the degree of mental retardation cannot be represented adequately by IQ alone since children with the same IQ or MA scores vary significantly in many respects of intellectual functioning. Other intellectual qualities not presently measured by the intelligence test may be relevant in refining our understanding of subnormal children. The possible existence of any trait which may contribute to their maximum development warrants examination. Divergent thinking may be such a quality since tests measuring this type of ability seem to be associated with achievement although they are not highly related to traditional tests of intellectual ability (Gallagher & Moss, 1963).

In summary, it appears that in individuals of subnormal intellectual functioning, abilities are of essentially the same kind as in normal persons and that they exhibit intra-individual differences. It should be noted however, that this conclusion is based on the traditional measures.

Guilford's attempts to classify intellectual abilities as found through factor analysis have evolved into a theoretical model for the structure of intellect. The specific factors pertaining to divergent thinking occupy an important place in the schema of this larger organization of intellectual abilities. Since the 'structure of intellect' represents the theoretical framework upon which the present study was based a presentation of his theory is given.

Guilford's Structure of Intellect (SI)

Factor analysis was first introduced by Spearman (1904) in his paper on the two-factor theory of intelligence. In the 1930's his general and specific factor theory was found to be not always adequate to describe a battery of psychological tests and was superseded by theories of group factors. Thurstone (1938) proposed that intelligence was composed of several factors which he called primary abilities. Guilford expanded on Thurstone's Multifactor Theory and developed a model which contains the components of the total structure of intellect.

The Aptitudes Project (Guilford, 1959) had as its major objective the elaboration of all aspects of intelligence and the results that gained the most attention were those pertaining to creative-thinking abilities. For Guilford the most significant outcome was the "development of a unified theory of human intellect which organizes the known, unique or primary abilities into a single system called the 'structure of intellect' (Guilford, 1959, p. 469)" (Figure 1). The dimensions of intellectual abilities are classified by three parameters in a three-dimensional model--operation, content and product.

The five operation categories refer to kinds of intellectual activities or processes. Cognition deals with the immediate discovery or rediscovery or recognition of information and is the basis for understanding. Memory is defined as the "retention or storage, with some degree of availability, of information in the form in which it was committed to storage and in connection with the same cues with which it was learned (Guilford, 1967, p. 211)." Divergent production and convergent production both involve the generation of information from given or known information. Convergent production is characterized by responses that are uniquely determined by the given information. Divergent production, on the other hand, describes the ability to think in different directions and is reflected by varied responses. Evaluation is defined as a "process of comparing a product of information with known information according to logical criteria, making a decision concerning criterion satisfaction (Guilford, 1967, p. 185)."

The second way of classifying intellectual abilities is according to the types of content involved. The four classes of content are figural, symbolic, semantic, and behavioural. Figural information is in concrete form and may involve different sense modalities. Symbolic content is composed of signs and material as letters, symbols, digits and other conventional signs which have no significance in and of

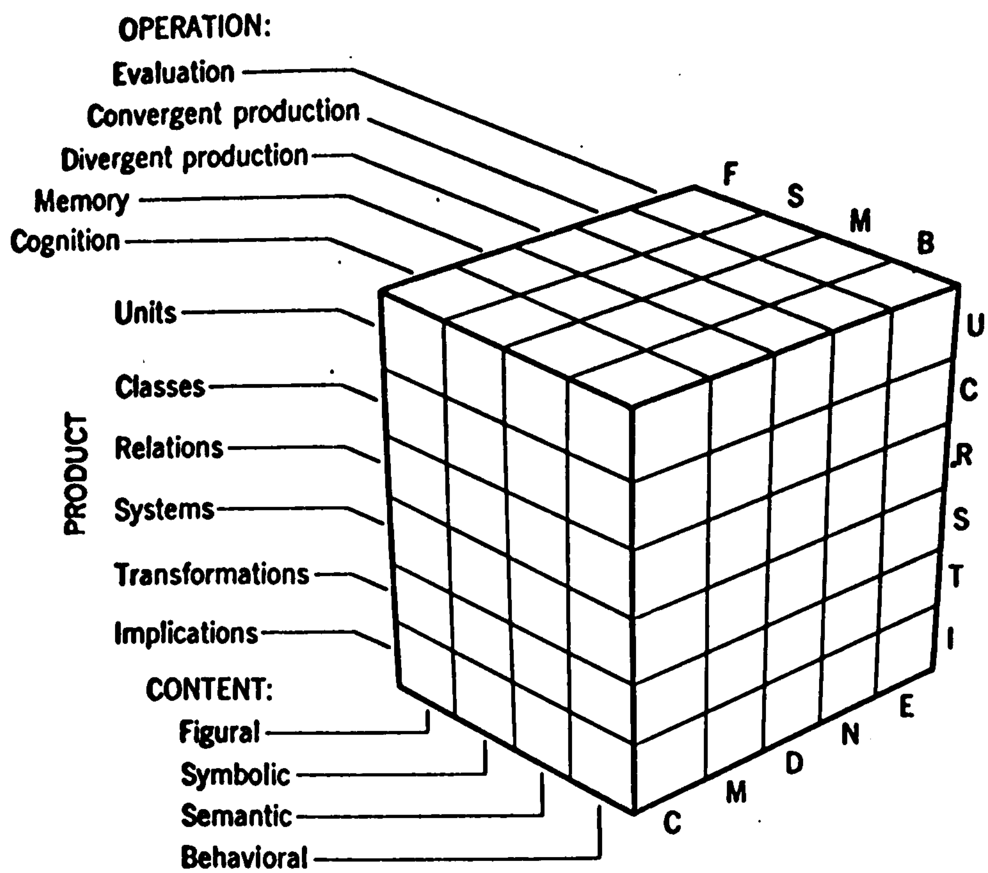

Fig. 1. Structure of Intellect Model (Guilford, 1967)

themselves. Semantic content is in the form of verbal meanings or ideas. Guilford (1967) noted that semantic information need not be verbalized. He added a fourth kind of content to account for the kind of information involved in cognition and operations relating to the behaviour of others. This is similar to Thorndike's (1920) social intelligence. In the divergent production area this behavioural content has yet to be investigated and thus remains in the form of a theoretical construct.

The third classification of the components of intellect deals with Products of the application of Operations to Content. When a certain kind of operation is applied to a certain kind of content as many as six general kinds of products may be involved. Guilford (1959) stated that regardless of which combinations of operation and content are concerned, the same six kinds of products may be obtained--units, classes, relations, systems, transformations and implications. Units represent delineated pieces of information--things, segregated wholes. A class is more than a set of objects with one or more common properties as a class idea is involved. A relation is some connecting link between two things. Systems are characterized by patterns or organizations of interacting parts. Changes, revisions, redefinitions or modifications of products of information define transformation. Implication is defined as expectation, anticipation or prediction from known information. Every intellectual ability represents an intersection of a certain kind of operation applied to a certain kind of content to yield a certain kind of product.

The divergent production portion of the paradigm provided the focus for the present investigation. The matrix which Guilford has formulated for this operation is shown in Table I.

TABLE I

DIVERGENT PRODUCTION ABILITIES

Figural	Symbolic	Semantic	Behavioural	
DFU	DSU	DMU	DBU	Units
DFC	DSC	DMC	DBC	Classes
DFR	DSR	DMR	DBR	Relations
DFS	DSS	DMS	DBS	Systems
DFT	DST	DMT	DBT	Transformations
DFI	DSI	DMI	DBI	Implications

Divergent Production in the Lower Intellectual Range

There is a striking paucity of data accumulated about divergent thinking in the lower intellectual range. The writer found little published material concerning divergent thinking in this group. This may be due to the low expectation of 'creative' contribution from this group with the result that it has not invited much study. The literature is replete with studies exploring the 'creativity' of average and superior individuals because these are the groups which provide society with contributions toward growth and development (Kelson, 1965).

Tisdall (1962) found that educable retarded children placed in a special class programme did not differ significantly on measures of verbal originality, fluency and flexibility from intellectually normal children in a regular class programme. They did score significantly higher than an equated group of educable retarded children receiving regular class instruction. The three groups did not differ significantly on nonverbal measures of originality and elaboration. Kelson (1965) found similar results when retardates from upper, middle and lower socio-economic classes were compared to normal children with similar socio-economic backgrounds. This may suggest that an untapped resource of the mentally retarded may well be in the area of nonverbal divergent production. However, these studies used the Minnesota Test of Creative Thinking and caution should be exercised in interpreting these in terms specific to the Guilford model since the Torrance battery has not yet been directly related to the various factors in the model nor have substantial validity studies been conducted on these instruments. However, Smith (1967), using Guilford-type tests, found similar results on nonverbal measures between retarded and normal children. These results could also be interpreted as weak instrumentation, precluding efficient discrimination between the groups. Smith prefers the interpretation that children are more responsive in areas of maximum development to account for the retarded children's nonverbal performance. However, Smith and Neisworth (1966), comparing intellectually superior with intellectually normal children, found no significant difference on nonverbal measures.

Smith (1967) found, that without statistical control, the normals exceeded significantly the retarded children on twelve of the fourteen verbal measures. Controlling intelligence erased these differences. This he cites as evidence for the "threshold hypothesis."

It is suggested here that what differences there were on the verbal measures were due to differences in verbal ability rather than differences in divergent thinking as the measure of intelligence that Smith used had high verbal content. Differentiation between the two groups on such a measure may reflect differences in verbal facility rather than differences in intelligence.

Cawley and Chase (1967) compared retarded and non-retarded children of equal MA and found no significant differences between the groups. However, matching for mental age means matching on all the variables tapped by the instrument and what is really measured is the effect of chronological age and experience (Gallagher & Lucito, 1961; Kebbon, 1965).

A logical extension of Tisdall (1962) and Smith (1966) is a factor analytic approach to divergent production abilities in subnormal persons and their relation to traditional measures to ascertain patterns of abilities upon which educational planning could be more firmly grounded.

The failure to investigate extensively divergent production abilities in the lower intellectual range represents a narrow conception of intellectual abilities in this group. It may be due to the assumption, previously stated, that such abilities would not be found among subnormal children. There is a difference between advancing an hypothesis which is capable of being studied and advancing an assumption which confuses opinion with evidence. Assumptions cannot be used as evidence for the existence or non-existence of a trait when empirical evidence can be obtained.

Divergent Production Abilities

The Guilford series of studies were initially designed to explore abilities considered to be important in the success of high-level personnel (Green *et al.*, 1952). The outcome of these studies was the 'structure of intellect' model. Subsequently, the model was applied to superior and normal individuals at younger age-levels (Guilford *et al.*, 1961; Merrifield *et al.*, 1963; Guilford & Hoepfner, 1966). All the factors which were found in adults were also found at the ninth grade level (Guilford & Hoepfner, 1966). Some have been found at the sixth grade level (Merrifield *et al.*, 1963) and two have been found at the age of six (McCartin & Meyers, 1966).

The selection of the divergent production abilities which were investigated in this study was based, in part, on studies of normal and superior individuals at the junior high school level (Guilford *et al.*, 1961; Guilford & Hoepfner, 1966a). Of the sixteen divergent production abilities already found six were investigated in this study and are described below. The reasons for the selection of these six are described in Chapter III.

Divergent Production of Units

This product is characterized by production of units which have some class property or properties in common, the property or properties being specified or given to the subject. The specifications should be sufficiently broad to allow variety of response otherwise convergent production may result rather than divergent production.

1. Divergent production of figural units (DFU): the ability to produce many simple figures that conform to given specifications.

The figural properties given are essential to the test problems, with the subject being requested either to add to them or combine them to produce different units, e.g. given a simple basic figure, such as a circle, add just enough to make it a recognizable object.

2. Divergent production of symbolic units (DSU): symbolic information is in the form of signs that can be used to stand for something else. Theoretically, this would involve letters, symbols, digits and other conventional signs. However, only tests involving prefixes, suffixes and specified letters have been used. DSU is theref[illegible] defined as the ability to produce words to satisfy some literal requirement. The meaning of the words, here and in other symbolic abilities is of no consequence, e.g. write as many words with one letter specified (e.g. the letter E) or with two letters specified (e.g. C and A) or with three letters specified (e.g. M, U and B).

3. Divergent production of semantic units (DMU): the ability to produce many elementary ideas appropriate in meaning to given requirements. The best example of a semantic unit is word meaning. However, in DMU tests the 'idea' is the unit, e.g. list consequences of a given event, such as people's no longer needing sleep or list uses for a common object such as a brick.

Divergent Production of Classes

The emphasis here is on the production of varied class responses, i.e. flexibility or shifts in classes or ideas. The essential characteristic of classes is in the form of class ideas and this puts the emphasis upon attributes or properties. In the content area the stimuli are to be classified and reclassified in different ways with each class being formed on the basis of some common property.

4. Divergent production of semantic classes (DMC): the ability to produce a variety of class ideas appropriate to a given idea. This factor is distinguished from DMU in that emphasis is placed on relevant responses only. Instructions to state uses other than common ones essentially demands a change of classes, e.g. state uses, other than the common one, for objects such as a newspaper or a shoe.

Divergent Production Involving Relations

Guilford (1967) reserves the term "relationship" for the complete structure of two correlates and their relation. He defines relation as a "recognized connection between two items of information based upon variables or upon points of contact that apply to them (p. 85)." Divergent production abilities involving relations are measured by tests that require the production of either relations or correlates.

5. Divergent production of symbolic relations (DSR): the ability to relate symbolic items of information in different ways. Only tests involving digits have been constructed as measures of DSR. These call for the applications of numerical operations and to arrive at a specified number in different ways or to combine certain numbers in different ways to achieve a given total, e.g. given the numbers 1, 2, 3, 4 and 5 combine (add) them in several different ways to achieve a total of 7, using each number only once in each answer.

Divergent Production of Systems

A system is an organized aggregate of interrelated items of information. Though the kind of organization is in part determined by environmental stimulation and Gestalt principles, Guilford (1967) states that "the organism has much freedom to produce its own organization and that in this capacity lies an important basis for creative production (p. 91)." This category of systems is similar to Piaget's idea of schema, which is defined as a class of actions. A schema is also a cognitive structure (Flavell, 1963, pp. 41-84) i.e. a product of information.

6. Divergent production of figural systems (DFS): the ability to produce composites of figural information in different ways. Tests of this ability emphasize the organizing of figural elements into wholes e.g. using two or more of several given geometric forms, the subject is to organize them to construct an object that is named such as a face or a lamp.

Derivation of Hypotheses

Guilford's structure of intellect is not a process of information handling but a model by which we may comprehend the nature of human abilities. In this respect Guilford's model is similar to Vernon's (1961) hierarchical model. Guilford's model delineates the nature of intellectual abilities in the young normal adult, but contains no reference as to origin or development of abilities. In this respect an assumption has been made (Guilford, 1956; Meyers & Dingman, 1966) that normal adults would exhibit greater differentiation and complexity of abilities than would normal children and that normal and gifted individuals would, likewise, display greater diversification of abilities than would their counterparts in the lower intellectual range. Dingman and Meyers (1966) put it more succinctly:

> It is assumed that abilities are not performed in the zygote but take identity as systems of competency developed through growth and experience. It is assumed that something like a tissue specialization or motor individuation takes place in mental ability, where the early massive, undifferentiated condition becomes articulated or specialized (p. 23).

As the SI model was developed on adults it can only be inferentially applied to the lower intellectual range.

It was concluded above that the nature and organization of abilities in subnormal individuals is similar to that of normal persons with respect to the various measures used. However, whether differentiation of intellectual abilities occurs with development and experience is not clear due to a lack of evidence. This is due to inherent difficulties which make age-to-age comparisons difficult because of lack of parallelism and continuity in behaviour samplings (Meyers & Dingman, 1966).

Piaget's theory of intelligence (Flavell, 1963) clearly points in favour of differentiation of abilities with maturation and experience. His theory reflects qualitative changes in intellectual activity, mainly in his construct of schemata. Differentiation of motor activity occurs in physical development and there may well be a parallel between motor differentiation and differentiation of intellectual abilities, though not necessarily in comparable stages. On these bases, it appears logical to assume that differentiation in intellectual abilities does take place.

Stott and Ball (1965) have factor analysed infant and pre-school intelligence tests including the Gesell Developmental Schedules, the Merrill-Palmer Scale of Mental Tests and the Stanford-Binet. Analysis of these tests showed that even in the first year some structure of intelligence is present. Analyses of tests over different age levels showed that no more factors were present in the older groups than at the younger age levels. However, a comparison of structure across age levels is difficult, if not impossible, as the content of the same tests vary with succeeding age levels and hence the factor content at different age levels also varies.

> Our analyses of scale content have demonstrated a great lack of consistency among, and within the scales now in wide use in terms of factor content and meaning, thus pointing up the need for more consistent and adequate test scales (p. 138).

Meyers _et al_. (1964) hypothesized that older groups would display greater differentiation of abilities than younger subjects and greater differentiation in normal children than retarded children of comparable mental age. Neither of these hypotheses was supported.

Though the study of ability factors in young children has demonstrated that separate factors exist, it is not clear that differentiation takes place. On the basis of the present evidence the hypothesis of differentiation is not denied (Meyers & Dingman, 1966).

Following the logical assumption that differentiation occurs Meyers and Dingman look at the SI model from a developmental point of view and postulate:

1. that some factors result from the process of formal education. For example, the preliterate child would be devoid of symbolic abilities as factors in this area require some literacy and may

not distinguish well from figural abilities. In relation to the subnormals it can be postulated that a similar pattern will emerge;

2. "that abilities are not performed, but differentiate out of more primitive structure." An implication of this is that an older child has more structure than a younger child;
3. that domains of structure have a developmental order. As memory discriminations precede learning cues and meanings, figural would precede semantic in the child. Symbolic content "is a sort of syntactic superstructure on the semantic world (p. 17)" and would be the last to develop. In early life the figural domain would be more fully structured than the others. Subnormal individuals might be describable in terms of their relative lack in the symbolic domain as compared with the semantic.

They agree with Guilford's ranking of cognition and memory and tentatively look upon divergent thinking as problem solving ability with convergent thinking as the verification step. Cognition and memory would be the most developed with divergent and convergent thinking the least in the subnormals.

The product domain is seen by Meyers and Dingman as increasing in level of difficulty from units to implications. It is possible that subnormal individuals may not reach the higher levels e.g. transformations and implications.

The general purpose of the present exploratory study was to identify intellectual and divergent production abilities in individuals in the lower intellectual range and to compare the factor pattern of these with that of normal persons. In keeping with these objectives the following hypotheses were advanced:

1. The same four WISC factors will emerge for both groups:
   (a) general
   (b) verbal--Information, Comprehension, Similarities, Vocabulary
   (c) performance or perceptual organization--Picture Completion, Object Assembly, Block Design, Picture Arrangement, Coding
   (d) memory--Digit Span, Arithmetic.
2. For normal children, the six factors representing divergent production abilities in the figural, symbolic and content domains will emerge.
3. For the subnormal children there will be less differentiation of divergent production abilities:
   (a) the figural abilities will emerge as in the normal group
   (b) the symbolic ability DSU will emerge, but it may share some variance with semantic factors or with the verbal factor in the WISC. DSR may emerge as a numerical factor with the WISC subtest Arithmetic
   (c) the semantic abilities will be less differentiated with a more global factor emerging, possibly sharing variance with WISC verbal tests.

CHAPTER III

METHOD

Criteria for Test Selection

The battery of divergent production tests was assembled as much as possible according to the following criteria:

1. It should include as many tests as possible on which a large amount of factorial data are available, as for example, tests described by French, Ekstrom and Price in the Kit of Reference Tests (1963).
2. Each test should load highly on one factor only.
3. Each test should permit sufficient differentiation between the scores of subnormal subjects i.e. should not be too high in difficulty level.
4. Each test should have a reasonably high estimated reliability, based on data for normal subjects if none are available for subnormal subjects.
5. The battery should contain at least two non-similar tests per hypothesized factor.
6. Each test should contain homogeneous test items.

The principal aim of this study was to compare subnormal children with normal children in some essential features of intellectual and divergent production abilities and not to investigate the complete structure of such abilities in subnormal children.

So as not to put too great a strain on the subjects, the battery had to be kept as small as possible. The testing time had also to be kept within reasonable limits for practical reasons. This pointed to group testing. An initial battery of eighteen tests relating to nine factors was drawn up, based on previous findings by Guilford and his co-workers. The factors were:

Figural	Symbolic	Semantic
DFU	DSU	DMU
DFS	DSR	DMC
DFT		DMS
DFI		

Factors DSS and DSI were not considered as they had been poorly substantiated (Guilford, 1967, pp. 149-150, 159-160). Factors DFC, DSC, DMT, DMI and DMR were dropped also as many of these tests were considered too difficult for subnormal children (Guilford, personal communication) and because many of the tests measuring these factors shared too much variance with other factors in previous analyses. As the tests in the battery had been used as group tests with normal children a pilot study was carried out to see if it were possible to group-administer the tests to subnormal children.

The Pilot Study

The subnormal group consisted of eight students in the age range 12 years 4 months to 15 years 3 months with an estimated IQ range of 50-80. The estimated level of intellectual functioning was derived from records of previous intellectual assessments and from individual administration of four verbal subtests of the WISC, Information, Comprehension, Arithmetic and Vocabulary. The subnormal children were taken from an opportunity class in a junior high school in Leduc, Alberta. The total enrollment of the class was nineteen, six of whom were sixteen years or older. Due to absenteeism the number given the total test battery was eight. The normal group consisted of five students, randomly selected from a class of 25, in the age range 13 years to 15 years 11 months. The estimated IQ level ranged from 90 to 115, this estimation being taken from cumulative records.

The tests were administered to the subnormal children in two sessions extending over two days, with the total testing time being approximately four hours. Three sessions of sixty minutes each were used for the normal group.

Inspection of responses on all measures for both groups indicated that the tests were not at a level of difficulty that was too high for the subnormal children and that the tests discriminated sufficiently to allow for individual difference.

<u>The Study</u>

Due to demands made on opportunity class children in the area accessible to the investigator (student teaching, various research projects) and due to the fact that extra-curricular activities limited greatly the time they were available for the actual study it was deemed necessary to refine the test battery further. In refining the test battery by eliminating some of the DP factors, adequate coverage of content and product areas to be investigated was sought. Assuming an increasing level of intellectual functioning from Units to Implications (Meyers & Dingman, 1966; Guilford, 1967, p. 63) it was decided to restrict the sample of DP factors to six, two in each content category and at least one in each of Units, Classes, Relations and Systems. The areas selected are shown in Table II.

TABLE II

DP FACTORS USED IN THE STUDY

Figural	Symbolic	Semantic	
DFU	DSU	DMU	Units
		DMC	Classes
	DSR		Relations
DFS			Systems
			Transformations
			Implications

Table III summarizes the eleven tests administered, from which twelve scores were derived, and the task required by each test.

Subjects

The subjects for this study were drawn from three cities in Alberta. The subnormal group were those in opportunity classes between the ages 13 years and 15 years 11 months with intelligence quotients in the range 50-80, whose home language was English and who exhibited no obvious physical or sensory anomalies. Estimates of their intellectual functioning was, in most cases, taken from the cumulative records. The total number who appeared to meet the two criteria of age and IQ was 64. On administration of the WISC, ten were found to have IQs greater than 80 and one with an IQ below 40. Of the remaining 53 two were unable to

TABLE III

DP TESTS

Test	Task required
DFU	
1. Make a Figure	--Construct figures from given elements
2. Make a Mark	--Construct simple lines within a class specification
DSU	
3. Words Beginning & Ending	--Write words beginning and ending with specified letters
4. Words Ending	--Write words with a given suffix
DMU	
5. Plot Titles	--Write titles for a story plot
6. Utility (Fluency)	--Give uses for common objects
DFS	
7. Designs	--Produce patterns from given line elements
8. Making Objects	--Construct named objects from given geometric forms
DSR	
9. Alternate Additions	--Combine digits in different ways to achieve a given total
10. Number Rules	--Reach a specified number from a given number by applying other numbers and operations
DMC	
11. Alternate Uses	--List different uses, other than common ones, for common objects
12. Utility (Flexibility)	--Same as in DMU but scored in terms of shifts in category of uses

respond on the first four DP tests and testing had to be discontinued; two refused to respond to the tests in the testing sessions, one was unable to read or write, one exhibited manipulative difficulties and one was absent during administration of the DP tests. This reduced the subnormal group to 46, of whom 29 were boys.

The normal group, comprising of students in grades 7, 8 and 9, was drawn from two schools. Apart from IQ, age and language criteria socio-economic status of the subnormals was taken into account while selecting the sample so that both groups would have similar socio-economic backgrounds. Father's occupation waa taken as the indicator of socio-economic status for the subnormal group and these occupations were assigned Blishen's socio-economic score (Blishen, 1968). In selecting the normal subjects only those whose father's occupation were in the same socio-economic class as the subnormal group were considered in order to insure similar socio-economic backgrounds for both groups. The normal group consisted of 30 boys and 18 girls. The means and standard deviations for the two groups were:

	Normal	Subnormal
Mean	34.30	34.18
S.D.	8.96	8.46

Testing Schedule

The testing period extended over two months. The WISC was administered to all subjects by six qualified psychometricians. The DP battery was administered by the investigator in single sessions with a rest period of ten minutes being given during the session. Normal and subnormal subjects were taken in groups of five, six or seven. This was done, with the subnormal subjects in mind, in order to insure that the instructions were understood. The similarity of successive tests was kept to a minimum. Table IV gives the order in which the tests were administered. The rest period was given at the end of Set 1.

Procedure

The subjects were assembled into a classroom. In a short introduction to the project, given by the test administrator, the subjects were told that the tests they were about to take were part of a study designed to determine what abilities were involved in solving problems encountered in the tests. They were told that their performance was not related to school progress and would not be revealed to the school. Proctoring of the sessions was performed by the writer. The testing session lasted about two and a quarter hours.

TABLE IV

TEST ORDER

Set 1	Set 2
Make a Figure	Words Ending
Words Beginning & Ending	Number Rules
Alternate Additions	Alternate Uses
Plot Titles	Making Objects
Utility	
Designs	
Make a Mark	

Scoring and Analysis

Each test was hand scored, by one examiner, following the standard instructions with the exception of Number Rules, Alternate

Uses and Designs. As the DP tests were developed and used with normal children and adults, minor modifications were introduced in the three above mentioned test in order to take into account possible lower levels of divergent thinking in the subnormal subjects. The revised scoring procedures were applied to both the subnormal and normal subjects. A description of the modifications introduced is given below.

<u>Number Rules</u>

The task involved the application of numbers and the four arithmetical operations to a given number in order to reach a specified answer. Some operations considered by Guilford to be equivalent were regarded as different for the purposes of scoring this test. The operations regarded as different were:

(1) $3 + 4 = 7$

$3 + 5 - 1 = 7$

(2) $3 + 6 = 9$

$3 + 5 + 1 = 9$

<u>Alternate Uses</u>

The task involved the listing of different uses for common objects other than the common one which was stated. Some uses, considered unacceptable in the scoring directions, were accepted where the author thought that there was an indication of deviation from the common use. These responses tended to be general or vague such as:

Shoe:	for decoration
Button:	to make things with games
Chair:	to play with building things

Credit was given for such responses. However, where any response was obviously overworked credit was given only once.

Designs

The task involved the construction of different patterns from the given number of line elements, using any number at a time in each pattern. In addition to the details provided in the scoring chart by Guilford inlay, overlay and vertical combinations of elements were taken also into account in scoring this test.

After the scoring of all tests was completed 20% of all the tests was randomly selected and scored by an independent scorer. The interscorer reliability indices ranged from .96 to 1.00.

Analysis

From the WISC profiles, fourteen scores were derived, viz. a scaled score for each of the eleven subtests and the three composite intelligence scores, Full Scale, Verbal and Performance. It was decided to include the three intelligence scores in the analysis as an anchoring basis for the WISC factors and to see what relationships existed between divergent thinking and intelligence. One DP test, Utility, was scored for fluency and flexibility, thus resulting in 12 DP scores. The number of variables used in the analysis was then 26.

Principal component analysis was carried out on the two groups separately and rotated orthogonally according to the varimax criterion. Rather than limiting the number of factors to be extracted to the criterion of eigenvalues equal to or greater than unity, it was decided, if necessary, to carry out step-wise factoring in order to determine which set of factors gave the best interpretation. However, as the maximum possible number of DP factors was six and the number of factors hypothesized was ten, it was decided that the maximum number of factors extracted would be ten. The most meaningful set of factors from the normal group was accepted as the target and the factor matrix from the subnormal group was re-rotated by Schonemann's (1966) method for maximum overlap with the target matrix.

TABLE V

MEANS AND STANDARD DEVIATIONS FOR NORMAL AND SUBNORMAL GROUPS

Measure	Normal Group Mean	Normal Group S.D.	Subnormal Group Mean	Subnormal Group S.D.
1	9.29	2.37	4.50	1.43
2	11.17	2.76	5.13	2.08
3	8.63	2.39	4.63	1.82
4	12.19	2.38	6.04	2.47
5	10.04	1.86	4.48	2.01
6	9.21	2.44	5.35	2.43
7	11.02	2.50	7.43	2.11
8	10.25	2.30	6.13	2.54
9	11.04	2.34	5.93	2.43
10	12.04	2.34	7.22	2.57
11	11.29	3.23	6.17	2.56
12	41.67	10.71	16.93	11.20
13	12.69	4.24	4.72	4.36
14	12.50	4.12	7.83	3.18
15	25.79	6.98	17.39	8.22
16	18.50	4.58	7.09	3.95
17	23.27	9.12	4.63	3.82
18	10.77	4.57	4.93	3.62
19	20.06	8.27	11.28	5.95
20	16.02	6.77	3.22	3.01
21	9.25	7.24	1.98	2.89
22	36.94	8.24	25.30	10.69
23	12.67	3.52	7.24	4.29
24	104.50	8.25	69.52	7.99
25	100.58	8.94	68.72	8.46
26	107.88	9.76	76.15	10.21
27	172.44	9.35	173.37	10.76
28	34.30	8.96	34.18	8.46

1 Information
2 Comprehension
3 Arithmetic
4 Similarities
5 Vocabulary
6 Digit Span
7 Picture Completion
8 Picture Arrangement
9 Block Design
10 Object Assembly
11 Coding
12 Make a Figure
13 Make a Mark
14 Words Beginning & Ending
15 Words Ending
16 Alternate Additions
17 Number Rules
18 Plot Titles
19 Utility (fluency)
20 Alternate Uses
21 Utility (flexibility)
22 Making Objects
23 Designs
24 Full Scale IQ
25 Verbal IQ
26 Performance IQ
27 Age
28 Socio-economic status

TABLE VI

INTERCORRELATIONS FOR TWENTY-SIX VARIABLES FOR NORMAL GROUP (N=48)*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	--																									
2	06	--																								
3	43	10	--																							
4	49	19	36	--																						
5	33	25	36	35	--																					
6	14	13	24	11	-05	--																				
7	06	11	03	24	-07	12	--																			
8	15	-06	23	04	-01	-15	-24	--																		
9	12	-10	33	24	16	41	22	-16	--																	
10	16	01	28	13	13	21	11	21	38	--																
11	17	-19	31	02	14	30	-01	05	41	27	--															
12	03	00	05	-09	08	20	-08	24	39	37	36	--														
13	11	-01	-08	-18	12	01	-11	-10	32	21	30	47	--													
14	30	-04	36	19	35	33	-13	08	22	34	45	22	04	--												
15	35	-10	16	28	41	21	-03	07	20	16	45	30	24	62	--											
16	11	-28	39	-01	12	12	-06	21	37	27	37	42	31	25	29	--										
17	42	07	57	34	28	39	-09	23	40	44	51	39	22	41	30	62	--									
18	04	-01	11	-16	05	23	-25	25	-30	-05	29	04	-05	57	40	20	28	--								
19	25	-02	23	04	25	34	-18	03	-10	09	20	15	02	51	56	19	28	60	--							
20	35	01	27	23	35	27	-18	11	28	30	46	24	20	55	54	35	52	46	51	--						
21	23	-03	10	18	23	26	01	03	04	11	25	25	08	37	63	21	20	48	67	54	--					
22	-09	00	16	04	18	-07	00	-03	21	27	55	32	22	33	33	24	25	17	13	37	12	--				
23	-18	-11	13	15	08	23	17	09	28	34	51	26	15	21	31	35	38	27	37	38	41	43	--			
24	57	26	67	57	43	48	29	20	60	57	53	33	13	47	41	32	69	05	19	47	28	27	37	--		
25	68	52	67	69	57	46	13	06	31	26	19	09	-01	40	35	10	57	08	29	41	27	05	08	82	--	
26	25	-01	42	24	14	34	34	29	68	70	67	47	25	38	35	44	57	02	04	39	20	41	54	82	35	--

*Decimals have been omitted.

TABLE VII

INTERCORRELATIONS FOR TWENTY-SIX VARIABLES FOR SUBNORMAL GROUP (N=46)*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	--																									
2	56	--																								
3	29	26	--																							
4	32	40	16	--																						
5	45	48	16	39	--																					
6	26	35	43	07	10	--																				
7	15	14	27	04	14	14	--																			
8	19	33	10	23	33	01	17	--																		
9	19	01	39	15	-04	10	17	41	--																	
10	18	19	04	07	15	-09	17	40	47	--																
11	-21	03	09	-26	-12	07	-08	08	10	07	--															
12	07	37	17	13	13	33	05	16	02	06	34	--														
13	11	25	13	28	21	10	07	21	-01	17	00	55	--													
14	-06	17	23	05	11	28	-05	-11	02	-05	09	36	25	--												
15	23	19	27	05	17	24	-14	-15	-20	-13	08	29	28	50	--											
16	04	28	53	06	06	26	31	29	23	14	28	48	46	28	11	--										
17	19	23	57	09	02	21	32	12	23	13	19	27	28	27	28	48	--									
18	15	33	08	32	31	-07	-05	25	-04	03	22	31	44	24	23	31	20	--								
19	-08	11	19	01	22	14	09	06	-12	02	33	57	44	21	38	32	23	40	--							
20	31	40	06	34	43	12	-20	24	04	21	08	37	30	19	21	15	05	38	29	--						
21	-05	19	-10	17	31	08	-10	-01	-03	23	05	47	40	32	17	19	-09	34	53	54	--					
22	17	19	14	03	-14	05	24	01	03	13	12	49	52	21	14	37	21	16	27	06	18	--				
23	-13	07	-16	34	-01	-06	-15	19	-10	01	16	24	34	-03	03	17	01	34	16	15	07	05	--			
24	52	62	54	44	49	40	42	65	59	55	22	34	27	09	04	47	41	27	18	36	16	17	06	--		
25	69	77	58	63	64	60	21	31	20	11	-09	33	30	20	28	33	33	29	16	42	18	10	06	77	--	
26	16	23	29	09	16	07	43	70	72	72	41	22	15	-03	-18	41	31	15	13	15	07	17	04	81	25	--

*Decimals have been omitted.

TABLE VIII

VARIMAX FACTOR MATRIX FOR NORMAL GROUP (N=48)*

Variable/ Factor	I	II	III	IV	V	VI	VII	VIII	IX	X	h^2
1	879	160	-077	-037	-053	163	-056	-110	150	071	877
2	191	-053	-034	-018	-125	032	034	934	-010	036	932
3	563	023	148	231	547	-236	-175	082	042	075	792
4	728	071	012	051	091	-201	357	094	-048	-183	759
5	469	276	077	178	137	037	-182	278	-257	-514	795
6	163	287	-019	234	152	010	059	151	-240	794	901
7	137	-123	-011	116	-117	-086	821	023	-141	089	770
8	105	031	-024	196	148	-001	-106	-039	890	-090	886
9	265	-115	178	466	336	314	205	-165	-414	213	831
10	089	060	120	853	124	143	072	039	143	019	818
11	166	194	776	113	210	216	-025	-182	003	261	873
12	-036	159	121	361	162	711	002	048	189	082	748
13	-008	023	156	015	097	859	-082	004	-146	-053	804
14	303	549	344	407	-034	-093	-316	-095	-066	110	812
15	344	711	271	100	-069	230	025	-184	-049	-107	813
16	053	171	111	107	775	301	-033	-261	088	-027	826
17	427	183	247	194	636	182	-078	102	143	213	833
18	-102	695	254	-198	096	-134	-229	083	328	232	846
19	052	877	-035	024	138	-049	-127	057	-016	089	823
20	284	595	331	148	196	146	-121	018	-002	022	642
21	109	855	-026	015	056	133	225	-027	008	-002	816
22	-069	125	835	158	080	115	024	091	-055	-229	826
23	-206	413	420	209	436	020	468	043	035	-006	846
24	680	140	289	463	273	099	227	180	041	196	989
25	822	211	021	171	180	-047	026	428	-081	122	990
26	284	043	446	608	266	224	342	-135	159	192	970
Sum of Squares	3.81	3.75	2.32	2.25	2.07	1.86	1.57	1.44	1.39	1.35	21.82

*Decimals have been omitted.

TABLE IX

SCHONEMANN ROTATION OF FACTOR MATRIX FOR SUBNORMAL GROUP FOR MAXIMUM OVERLAP WITH FACTOR MATRIX FOR NORMAL GROUP*

Variable/ Factor	I	II	III	IV	V	VI	VII	VIII	IX	X
1	827	-084	033	-029	-155	257	-062	269	072	-055
2	527	205	249	135	-057	101	019	610	142	097
3	610	030	143	047	507	-056	013	-163	-285	309
4	354	152	-259	091	440	068	007	457	061	-395
5	548	494	-117	118	-148	-233	208	276	200	-148
6	272	135	-051	122	165	064	-040	394	-390	624
7	266	-122	296	106	039	-155	766	-008	-214	031
8	194	-003	127	488	234	-039	268	215	496	-064
9	293	-295	-085	656	371	146	006	-274	067	096
10	228	-067	092	664	-079	283	148	-208	276	-156
11	-192	196	413	069	121	087	-110	-185	451	582
12	-030	527	341	128	180	473	074	226	-094	250
13	055	431	330	046	321	444	140	151	-119	-335
14	-022	455	389	381	048	-198	-389	098	-485	-029
15	313	445	346	-179	001	-037	-480	-039	-220	-003
16	110	239	443	201	505	118	250	022	-129	185
17	417	040	505	-012	461	-044	003	-212	-132	083
18	139	540	317	-047	259	002	-064	101	365	-278
19	037	761	168	-138	157	224	231	-243	031	173
20	300	556	-164	212	-012	317	-200	144	244	-050
21	-018	763	-171	286	-131	363	065	-040	-079	-099
22	024	019	567	003	002	653	165	067	-265	-113
23	-037	163	063	-102	542	158	-058	371	356	-197
24	628	096	162	520	292	111	252	197	227	192
25	756	248	-024	127	246	056	042	503	-061	126
26	256	-085	271	679	227	123	332	-156	384	168

*Decimals have been omitted.

CHAPTER IV

RESULTS

The descriptive statistics for the tests and derived scores used in this study along with age (in months) and socio-economic status are given in Table V. Tables VI and VII contain the intercorrelations for the 26 variables for the normal and subnormal groups, respectively.

Principal component analysis was carried out on both groups extracting eight, nine and ten factors. The eigenvalues are shown in Table X in the Appendix. These were rotated to the varimax criterion. Ten factors were accepted as giving the best interpretation for the two groups. Table VIII gives the varimax rotation of ten factors for the normal group. As similarity and dissimilarity of organization of abilities were emphasized in this study, the varimax rotation for the subnormal group was re-rotated by the Schoneman (1966) least squares orthogonal method for maximum overlap with the factor matrix for the normal group. The resulting new factor matrix for the subnormal group is presented in Table IX. This new factor matrix was another orthogonal rotation of the matrix for the subnormal group and was used for the interpretation of factors for this group and for comparison of structure between the two groups. The varimax rotation for the subnormal group is given in Table XI in the Appendix.

Interpretation of Factors

The rotated factors for both groups are presented in the order in which they emerged. Following the test numbers and titles are the factor loadings which are presented in decreasing order. In the case of the DP measures the designated symbols are given also.

<u>Factor I</u>--Verbal Reasoning

<u>Normal</u>

1	Information	.879
25	Verbal IQ	.822
4	Similarities	.728
24	IQ	.680
3	Arithmetic	.563
5	Vocabulary	.469
17	Number Rules (DSR)	.427
15	Words Ending (DSU)	.344
14	Words Beginning & Ending (DSU)	.303

<u>Subnormal</u>

1	Information	.827
25	Verbal IQ	.756
24	IQ	.628
3	Arithmetic	.610
5	Vocabulary	.548
2	Comprehension	.527
17	Number Rules (DSR)	.427
4	Similarities	.354
23	Designs (DFS)	-.327
15	Words Ending (DSU)	.313
20	Alternate Uses (DMC)	.300

The keys to interpreting this factor are the loadings of information, Full Scale IQ, Verbal IQ, Arithmetic, Vocabulary and Similarities. Involved in this factor are: recall of specific facts, definition of generic terms, verbal categorization and numerical problems involving verbal comprehension and reasoning.

The WISC verbal tests--Information, Vocabulary, Comprehension and Similarities--could be viewed as representing stages in verbal ability from recall of specific facts and knowledge to efficient judgment of situations and events to the identification of communalities among phenomena and are indicative of verbal reasoning (Gault, 1954; Baumeister & Bartlett, 1962a, 1962b; Jones, 1962; Taylor, 1964; Belmont et al., 1967).

In solving tasks in Number Rules, Words Ending, Words Beginning and Ending and Alternate Uses some verbalization and verbal reasoning is involved which facilitates performance on these tasks.

Factor II--Divergent Production

Normal

19	Utility (Fl.)	(DMU)	.877
21	Utility (Fx.)	(DMC)	.855
15	Words Ending	(DSU)	.711
18	Plot Titles	(DMU)	.695
20	Alternate Uses	(DMC)	.595
14	Words Beginning & Ending	(DSU)	.549
23	Designs	(DFS)	.413

Subnormal

21	Utility (Fx)	(DMC)	.763
19	Utility (Fl)	(DMU)	.751
20	Alternate Uses	(DMC)	.556
18	Plot Titles	(DMU)	.540
12	Make a Figure	(DFU)	.527
5	Vocabulary		.498
14	Words Beginning & Ending	(DSU)	.455
15	Words Ending	(DSU)	.445
13	Make a Mark	(DFU)	.431

All tests which loaded on this factor, for both groups, were divergent production tests with the exception of Vocabulary for the subnormal group. For the normal group, all the tests had their highest loadings on this factor with the exception of Designs which had a substantial loading. For the subnormal group, Utility (Fx), Utility (Fl), Alternate Uses, Plot Titles and Make a Figure had their highest loadings here with substantial loadings for Vocabulary, Words Beginning and Ending, Words Ending and Make a Mark. For the present this factor is interpreted as a global divergent production factor for both groups. An alternative interpretation is suggested in Chapter V. The presence of Vocabulary in the subnormal group indicates that a minimum level of Vocabulary may be required for effective performance on the DP tests.

Factor III

Normal--Visual Imagery

22	Making Objects	(DFS)	.835
11	Coding		.776
26	Performance IQ		.446
23	Designs	(DFS)	.420
14	Words Beginning & Ending	(DSU)	.344
20	Alternate Uses	(DMC)	.331

Subnormal--Speed

22	Making Objects	(DFS)	.567
17	Number Rules	(DSR)	.505
16	Alternate Additions	(DSR)	.443
11	Coding		.413
14	Words Beginning & Ending	(DSU)	.389
15	Words Ending	(DSU)	.346
12	Make a Figure	(DFU)	.341
13	Make a Mark	(DFU)	.330
18	Plot Titles	(DMU)	.317

The main determinants of this factor, for the normal group, are Making Objects and Coding. Coding has been variously interpreted as being indicative of visual acuity and motor activity (Rapaport et al., 1968, pp. 156-158), stimulus trace or short-term memory (Baumeister & Bartlett, 1962a, 1962b), eye-hand coordination (Allen & Allen, 1968, p. 15). Wechsler (1958, p. 132) pointed out that because of its multiple determinants, this test is factorially ambiguous. Because of the high loading of Making Objects and the substantial loading of Designs, the predominant ability appears to be visual imagery. To a lesser degree, visual imagery is also involved in Words Beginning and Ending and Alternate Uses and performance on these tests would be facilitated by this ability.

Initial inspection of the loadings for the subnormal group could lead to the conclusion of a global undifferentiated DP factor. As the four symbolic measures loaded on this factor and as the three figural tests involve symbolic elements this factor could be interpreted as symbolic divergent production or symbolic fluency. However, the loading of Coding and the fact that all the tests, with the exception of Number Rules, load higher on other factors indicate that this is probably a task factor. As the DP tests emphasize the generation of responses in timed situations and as Coding is a speed test involving the reproduction of symbols this factor is interpreted as a speed factor. Another interpretation is proposed in Chapter V.

<u>Factor IV</u>--Perceptual Organization

<u>Normal</u>

10	Object Assembly		.853
26	Performance IQ		.608
9	Block Design		.466
24	IQ		.463
14	Words Beginning & Ending	(DSU)	.407
12	Make a Figure	(DFU)	.361

Subnormal

26	Performance IQ		.679
10	Object Assembly		.664
9	Block Design		.656
24	IQ		.520
8	Picture Arrangement		.488
14	Words Beginning & Ending	(DSU)	.381

The high loadings of Object Assembly, Block Design and Performance IQ for both groups are the key elements in naming this factor perceptual organization. In these two nonverbal measures and in Picture Arrangement for the subnormal group, the tasks require the interpretation of visually perceived material and the organization of the discrete parts into a larger, meaningful configuration. The loading of Picture Arrangement for the subnormal group only is possibly due to less familiarity with the situations depicted in the stories in this test and to solve the tasks they have to rely more on perceptual organization.

Words Beginning and Ending and Make a Figure also require the organization of parts into wholes or units, but with less emphasis on the meaningfulness of the pattern. The ability to perceive the matrix of responses and avoid repetitions would facilitate also performance on these two tests.

Factor V

Normal--Numerical Ability

16	Alternate Additions	(DSR)	.775
17	Number Rules	(DSR)	.636
3	Arithmetic		.574
23	Designs	(DFS)	.436
9	Block Design		.336

Subnormal--Numerical-geometric Ability

23	Designs	(DFS)	.542
3	Arithmetic		.507
16	Alternate Additions	(DSR)	.505
17	Number Rules	(DSR)	.461
4	Similarities		.440
9	Block Design		.371
13	Make a Mark	(DFU)	.321

The two intended DSR tests emerged on this factor along with Arithmetic for both groups. The high loading of Arithmetic implies the common application of numerical operations. Though Alternate Additions and Number Rules emerged with their highest loadings on this factor for the normal group, the high loading of Arithmetic indicates numerical ability rather than divergent production of symbolic relations.

For the subnormal group the picture is somewhat confusing especially as all but Designs and Alternate Additions load higher on other factors. The high loading of Alternate Additions and the substantial loadings of Arithmetic and Number Rules indicate a numerical ability factor for this group. However, the high loading of Designs and the loading of Similarities indicate a broader factor than numerical ability. Similarities is probably a measure of cognition of semantic systems (CMS) (Guilford, 1967, p. 472). The subnormal group's responses to this test were more of a concrete or functional nature and probably reflect their reliance on the figural or geometric properties of the paired items i.e. cognition of figural systems (CFS). The loading of Similarities and the loadings of the figural measures, Designs, Block Design and Make a Mark, indicate a figural or geometric as well as a numerical ability.

The loadings of Designs and Block Design for the normal group could also indicate a geometric ability for this group. However, these loadings on a numerical ability factor may be due to the application of numerical operations in attempting to arrive at various solutions.

Factor VI--DFU

Normal

13	Make a Mark	(DFU)	.859
12	Make a Figure	(DFU)	.711
9	Block Design		.314
16	Alternate Additions	(DSR)	.301

Subnormal

22	Making Objects	(DFS)	.653
12	Make a Figure	(DFU)	.473
13	Make a Mark	(DFU)	.444
21	Utility (Fx)	(DMC)	.363
20	Alternate Uses	(DMC)	.317

For the normal group, the two intended DFU tests mark the highest loadings on this factor and are the keys to naming it DFU. Both these tests involve the generation of figures having some specified class properties. The loading of Block Design can be interpreted as representing some element of figural units. This test is a specific example of figure construction which is so restricted in the requirements of the tasks that only one solution is acceptable for each task. In Make a Mark and Make a Figure, succeeding responses become more and more restricted because of the previous responses and the requirements of the task. As a result, these responses tend to be more specific with the consequence that some of the generated products of the DFU tests and the products of Block Design are similar in their specificity. The presence of Alternate Additions is due to the common searching for different combinations in this and the DFU tests.

For the subnormal group, the two DFU tests also loaded on this factor. However, Making Objects marks the highest loading for this group. This test emphasizes the organizing of visual-figural elements into named objects. Guilford and Hoepfner (1966a) found DFS variance entering into the DFU factor. He attributed this to the possibility that "in the visual-figured area a unit can be treated as a system and a system can be readily conceived as a unit (Guilford, 1967, p. 140)." This factor then, for the subnormal group, could be interpreted either as DFU or DFS. Guilford (1967, p. 148) stated that naming the objects to be constructed in Making Objects should decrease the DFU variance that would come if subjects had to think of the objects that they were to make. It is possible that naming the objects does not eliminate the DFU variance for the subnormal group. The view taken here is that Making Objects is not a measure of figural systems for this group but rather DFU in that it was responded to or the information was processed in terms of units.

The loadings of Utility (Fx) and Alternate Uses are not readily interpretable. They may be artifacts of the factor match.

Factor VII--Reflection

Normal

7	Picture Completion		.821
23	Designs	(DFS)	.468
4	Similarities		.357
26	Performance IQ		.342
14	Words Beginning & Ending	(DSU)	-.316

Subnormal

7	Picture Completion		.766
15	Words Ending	(DSU)	-.480
14	Words Beginning & Ending	(DSU)	-.389
26	Performance IQ		.332

The key to interpreting this factor is the high loading of Picture Completion for both groups. This test involves recognition of visually perceived material, scanning it and selecting essential from non-essential detail. Similarities involves the appraisal of relationships between items in some essential aspect. Skill in selecting essential from non-essential detail is an important component in establishing these relationships. This factor is interpreted as the ability to reflect and carefully analyse the perceived material in order to reach a successful solution. To produce many patterns in the Designs test, keen observation to detail is needed such that small changes can result in a new pattern.

Such careful analysis of the stimuli, however, would lead to a decrease in performance on tests where emphasis is on quantitative rather than qualitative responses as is evidenced by the negative loadings of Words Beginning and Ending and Words Ending.

Factor VIII--Verbal Comprehension

Normal			
2	Comprehension		.934
25	Verbal IQ		.428
Subnormal			
2	Comprehension		.610
25	Verbal IQ		.503
4	Similarities		.457
6	Digit Span		.394
23	Designs	(DFS)	.371

The high loading of Comprehension for both groups and the loading of Similarities for the subnormal group are the determinants in naming this factor verbal comprehension. For the normal group this factor could be interpreted also as social intelligence. However, in the absence of any other substantial loading, apart from Verbal IQ, it is interpreted as a specific verbal factor.

The presence of Digit Span for the subnormal group is probably due to concentration i.e. attempting to introduce meaning into the digital series as the pattern becomes complicated (Rapaport _et al._, 1968, p. 115). As Comprehension and Similarities are less dependent on formally learned material than are Information and Vocabulary (Cohen, 1959) concentration on the stimuli becomes necessary and particularly for the subnormal group.

Factor IX

Normal--Social Awareness

8	Picture Arrangement		.890
9	Block Design		-.414
18	Plot Titles	(DMU)	.328

Subnormal--Unidentified

8	Picture Arrangement		.496
14	Words Beginning & Ending	(DSU)	-.485
11	Coding		.451
6	Digit Span		-.390
26	Performance IQ		.384
18	Plot Titles	(DMU)	.365
23	Making Objects	(DFS)	.356

For the normal group the high loading of Picture Arrangement indicates that the underlying dimension is probably recognition of human interactions. This test and, to a lesser extent Plot Titles, involve judgment and understanding sequence of cause and effect of behaviour. The negative loading of Block Design is not readily interpretable. It is suggested that this factor represents a continuum from analysis and synthesis of concrete social events to analysis and synthesis of abstract designs with no environmental referent.

For the subnormal group the picture is rather confusing. Though Picture Arrangement has its highest loading on this factor it is nevertheless only moderate. All other loadings, with the exception of Words Beginning & Ending, are secondary. Though Picture Arrangement and Plot Titles indicate a possible factor of social awareness, the presence of Coding makes this factor difficult to interpret.

<u>Factor X</u>

<u>Normal</u>--Memory

6	Digit Span		.794
5	Vocabulary		-.514

<u>Subnormal</u>--Short-term Memory

6	Digit Span		.624
11	Coding		.582
4	Similarities		-.395
13	Make a Mark	(DFU)	-.335
3	Arithmetic		.309

Both Digit Span and Vocabulary have their highest loadings on this factor for the normal group. Digit Span is interpreted as being indicative of short-term memory. However, the negative loading of Vocabulary indicates that this is a memory factor with short-term memory and long-term memory at opposite ends of a continuum.

This factor, for the subnormal group, with loadings of Digit Span, Coding and the minimal loading of Arithmetic is interpreted as short-term memory. The negative loadings of Similarities and Make a Mark could be interpreted as being indicative of long-term memory. However, other possible interpretations could be made. These will be discussed in Chapter V.

CHAPTER V

DISCUSSION

Hypothesis 1

The first of the present findings to be discussed concerns Hypothesis 1 which predicted four WISC factors for both groups. Three of the four hypothesized factors were substantiated: Verbal (Factor I), Performance or Perceptual Organization (Factor IV) and Memory (Factor X). The failure of a general ability factor to emerge is in harmony with previous findings (Cohen, 1959; Belmont et al., 1967).

Verbal Reasoning. As in Cohen's analysis, two verbal factors emerged--Verbal Reasoning (Factor I) and Verbal Comprehension (Factor VIII). Why two verbal factors emerged is not clear and the distinction between the two may be arbitrary. Comprehension loaded most highly on Factor VIII for both groups. In Cohen's study Comprehension loaded on a similar factor consistently across three age levels. Verbal Reasoning may represent formally learned verbal or scholastic ability (Taylor, 1964) while Verbal Comprehension may reflect the application of verbal skills to new situations (Cohen, 1959). In keeping with this, Rapaport et al. (1968, pp. 80-105) stated that Information and Vocabulary reflected the early educational environment and Similarities verbal concept formation, whereas Comprehension was a measure of judgment, appropriate understanding and reaction to reality situations.

Perceptual Organization. This factor was identified by the loadings of Block Design and Object Assembly for both groups and the loading of Picture Arrangement for the subnormal group. A similar factor has been identified by Gault (1954), Cohen (1959), Maxwell (1959), Baumeister and Bartlett (1962a, 1962b), and Belmont _et al._ (1967).

Memory. Factor X, for the normal group, had a high positive loading on Digit Span and a moderate negative loading on Vocabulary. Digit Span has been interpreted as being indicative of memory (Gault, 1954), short-term memory (Baumeister & Bartlett, 1962a, 1962b; Allen & Allen, 1968, p. 14) and attention or freedom from distractibility (Cohen, 1959; Belmont _et al._, 1967). Rapaport _et al._, (1968, pp. 105-117) argued that Digit Span was not a measure of memory span but rather a measure of attention. Vocabulary is dependent upon recall of learned material and past experiences whereas Digit Span is the immediate retention and reproduction of verbally produced stimuli.

For the subnormal group, the positive loadings of Digit Span, Coding and Arithmetic appear consistent with previous findings for mental retardates on this factor (Baumeister & Bartlett, 1962b; Belmont _et al._, 1967) and have been interpreted as a stimulus trace factor analagous to Ellis' (1963, pp. 134-158) trace or short-term memory. The identification of a short-term memory factor in these studies has been suggested as an important difference in the organization of abilities between mental retardates and normals. Baumeister (1967, p. 183) suggested that the short-term memory factor may, in part, account for the retardates poorer performance on Digit Span, Coding and Arithmetic. In keeping with previous findings this factor has been identified as short-term memory.

Hypothesis 2

For the normal group the six predicted divergent production factors failed to emerge. Only two DP factors were identified, Factor II and Factor IV.

Factor II (Divergent Production). All the tests measuring DMU, DMC and DSU loaded highly on this factor. This could be interpreted as a broad divergent production ability subsuming ideational fluency (DMU), word fluency (DSU) and flexibility (DMC). The failure of DMU and DMC to emerge as distinct factors may be due to two possible reasons: (1) the fact that Utility was used both as a measure of fluency and flexibility, with the result that the DMC score on this test was determined, in part, by the fluency of responses. This is reflected in the high inter-correlations for the normal and subnormal groups, .670 and .526 respectively; (2) though the nature of Alternate Uses forces shifts in response classes, its main determinant is probably divergent verbal fluency.

Words Beginning and Ending and Words Ending were developed as symbolic measures which emphasize the generation of words with no emphasis on their meaning. However, cognition (CMU) may be playing a role in terms of vocabulary i.e. recognition and recall of familiar words and, rather than being measures of DSU or word fluency, they are measures of divergent verbal (ideational) fluency. This broad factor could be interpreted as a more specific "structure of intellect" factor viz. ideational fluency or DMU. However, Wilson et al. (1954), Frick et al. (1959), Kettner et al. (1959) and Guilford and Hoepfner (1966a) have identified separate factors, among others, for ideational fluency, word fluency and flexibility. The loading of Designs on this factor is probably due to the common search for varied responses (fluency).

Factor VI (DFU). DFU was the only specific divergent production factor to emerge for either group.

Hypothesis 3

Partial support was found for this hypothesis on Factors II, V and VI.

(1) Figural Abilities--DFU and DFS

DFU emerged as was predicted (Factor VI). However, DFS failed to emerge. Its two measures, Making Objects and Designs, had their loadings on DFU and Numerical Ability (Factor V) respectively.

(2) Symbolic Abilities--DSU and DSR

The symbolic abilities loaded as was predicted, DSU going with the divergent semantic abilities and DSR with Arithmetic.

(3) Semantic Abilities--DMU and DMC

The tests for DMU and DMC loaded on a broad divergent production factor (Factor II). However, this factor was more global than predicted in that the DFU tests, Make a Figure and Make a Mark, loaded also. On this factor, except for the loadings of the DFU tests and Vocabulary, all loadings were similar to that for the normal group. The four abilities subsumed under this broad divergent production factor are: ideational fluency (DMU), word fluency (DSU), flexibility (DMC) and DFU. The DFU tests, however, shared their variance with Factor VI which has been interpreted as DFU. The common denominator among these tests on Factor II appears to be divergent fluency of responses. The presence of Vocabulary indicates that a certain amount of verbal facility is required by the subnormals to perform on these DP tests, an ability which is not required by the normal group.

Non-hypothesized Factors

Discussed here are factors which emerged but were not hypothesized. After each factor heading the name of the factor is given. Where the corresponding factors were interpreted differently the names for both normal and subnormal groups are given in that order.

Factor III (Visual Imagery: Speed). This factor was identified by the high loadings of Making Objects and Coding as visual imagery for the normal group. In Coding, visual images of some of the digit-symbol patterns facilitates performance while ocular shifts for each digit would retard performance. Similarly, in Making Objects mental images of the specific objects named enhance performance in the construction of these objects.

A perceptual organization factor (Factor IV) was identified which appears distinct from the visual imagery factor. Perceptual organization emphasizes the recognition of visually perceived material and the juxtaposition of the parts until they form a meaningful whole. This requires analysis and synthesis while visual imagery is dependent upon images of immediate stimuli or past experience.

Factor III for the subnormal group was identified as a task factor. Eight DP tests, spanning figural units and systems, symbolic units and relations and semantic units, loaded on this factor along with Coding. As all the loadings, with the exception of Number Rules, were secondary and as all these measures have the common denominator of time, this factor was identified as speed factor. It could be argued that Factor III for the normal group is also a speed factor. But, in view of the high loadings of Making Objects and Coding and the fact that motor speed without visual imagery would not enhance performance on either Making Objects or Coding such an interpretation is not plausible.

Factor V (Numerical: Numerical-geometric). It is doubtful that this factor could be interpreted as DSR even though Alternate Additions and Number Rules loaded highly. The substantial loading of Arithmetic for both groups indicates numerical ability. The high loading of Designs and the loadings of Block Design and Make a Mark for the subnormal group indicate that this is a numerical-geometric factor for this group. In solving the Similarities tasks the subnormal group resorted to the geometric properties of the items and, hence, their responses tended to be more concrete or functional.

Factor VII (Reflection). Picture Completion loaded in Gault's (1954) analysis on a spatial-perceptual factor, on verbal comprehension in Cohen's (1959) study with minimal loadings and on a performance factor in the Baumeister and Bartlett (1962a, 1962b) studies. It failed to emerge in Maxwell's (1960) analysis and loaded on the performance factor for the retarded group only in Belmont et al. (1967). Robinson and Robinson (1965, pp. 420-421) pointed out that little research evidence existed to indicate what the WISC subtests measured. The high loading of Picture Completion in the present study on this factor for both groups may indicate a specific WISC factor. However, in view of the loading of Similarities for the normal group and the negative loadings of Words Beginning and Ending for both groups and Words Ending for the subnormal group, an interpretation other than a specific WISC factor is desirable.

Picture Completion involves the recognition of perceived material, scanning it and skill in selecting essential from non-essential detail (Allen & Allen, 1968, p. 14). Similarities involves the categorization of paired items on some important common property. Both involve the discovery of consistency and inconsistency and the appraisal of relationships. Effective performance here requires careful analysis of the perceptual field. In this analysis caution and delay of immediate reaction must be exercised. However, caution, delay and careful analysis of the perceptual field lead to fewer responses where emphasis is on quantitative rather than qualitative responses in a given time. This conclusion is in keeping with the negative loadings of this factor. Reflection would appear to be the underlying psychological dimension of this factor.

Factor IX (Social awareness: Unidentified). For the normal group the high loading of Picture Arrangement appears to indicate another specific WISC factor. There is lack of consistency in previous factor analytic studies (Gault, 1954; Cohen, 1959; Maxwell, 1960; Baumeister & Bartlett, 1962a; Jones, 1962; Belmont et al., 1967) regarding the loadings of Picture Arrangement and Block Design on common factors. Both have loaded on the same factor in some of the above studies and on different factors in others. Unlike the present analysis, Picture Arrangement and Block Design have not loaded substantially in the opposite direction on the same factor in the previous studies.

Picture Arrangement and, to a lesser degree, Plot Titles involve recognition of human interactions. Both require judgment and understanding of cause and effect of behaviour. Picture Arrangement in particular, is a reflection of the ability to comprehend and size up a total situation (Wechsler, 1958, p. 75). The negative loading of Block Design is not easy to explain. A possible explanation is that Picture Arrangement and Plot Titles, in this context, measure a domain of social awareness while Block Design could be representative of abstract nonverbal reasoning, analysis and synthesis of designs which have no inherent meaning.

For the subnormal group, all loadings on this factor are comparatively low. While Picture Arrangement and Plot Titles loaded on this factor, the loading of Coding and the negative loadings of Words Beginning and Ending and Digit Span make this factor difficult to interpret. Hence, no psychological interpretation is attempted.

Comparison of Normal and Subnormal Groups

Six of the ten factors have been considered similar for the two groups. The same variables loaded highly on the corresponding factors in each group. However, some differences occurred in terms of minor loadings of other variables. The remaining four factors, Factors III, V, IX and X, were conceived as different. The following discussion does not include Factors I and IV because they have been viewed as displaying very little difference. Factor IX has been omitted also because of its uninterpretability for the subnormal group.

Factor II (Divergent Production). This factor, for both groups, appears to represent a broad divergent production ability. For the normal group, this factor could appear to be a more specific divergent semantic factor of ideational fluency. Such an interpretation is only possible when the underlying dimension of DMC and DSU is interpreted as divergent verbal fluency. For the subnormal group, the same tests loaded along with the two DFU measures and Vocabulary. The presence of Make a Figure and Make a Mark preclude any more specific description of this factor, as may be possible for the normal group, other than a broad undifferentiated divergent production ability. This encompassing ability spans figural, symbolic and semantic units and semantic classes, with the main determinant being fluency of responses. The loading of Vocabulary, for the subnormal group only, indicates that verbal ability or facility contributes to some of the variance of this group on divergent production. The normal group possesses sufficient verbal facility and so variation on the DP tests is accounted for by divergent production ability itself.

The emergence of a broad divergent production factor for the subnormal group which is independent of WISC subtests and IQ is important. It highlights a domain of intellectual functioning which is not incorporated in conventional intelligence tests.

Factor III (Visual Imagery: Speed). This factor points up one of the major differences between the two groups. Visual imagery accounts for most of the variance in Coding and Making Objects and for some of the variance in Designs, Words Beginning and Ending and Alternate Uses for the normal group. No such ability was identified for the subnormal group. Except for Coding, all other variables loading on this factor belong to the DP battery, most of the loadings being secondary. Part of the variance of each of these tests is accounted for by a factor which has been identified as a speed factor. For the normal group the time allowed for all tests used in the study was adequate. For the subnormal group, because of slowness of reaction and writing, the time was not adequate for all and hence influenced the variation of scores. Increasing the time for the DP tests for this group would perhaps make this factor more similar. In eliminating the time element the possibility exists that more specific divergent production abilities could be identified in subnormal children.

There is another possible interpretation of this speed factor. Luria (1963) stated that one of the main characteristics of the mentally retarded child was a "disturbance in the lability of the nervous processes" and as a result he displays a pathological inertness and is "sluggish" (p. 195). Shif (1969), summarizing Soviet research on mental retardates, stated that oligophrenics were unable to modify existing knowledge in order to adapt it to the conditions of a new problem.

> Characteristic of the younger classes is a tendency immediately to attack a problem when presented with it. This 'easy' approach to problems is due to an inadequate comprehension of the task. When difficulties arise, these pupils do not change their methods, due to their inertness (p. 348).

The variety of abilities that are subsumed under this factor may reflect mental inertness or sluggishness in some of the subnormal group.

It is possible that mental speed is the important determinant in this factor and not the time element.

Interestingly, only one WISC subtest loaded on this factor for the subnormal group. This indicates that in power performance tests as Block Design and Picture Arrangement, the time allowed to solve each task is adequate.

Factor V (Numerical Ability: Numerical-geometric Ability). The high loading of Designs and the loadings of Similarities and Make a Mark for the subnormal are the essential differences between the groups on this factor. The loading of Similarities indicates that part of the variance on this test must be accounted for by a factor other than verbal reasoning, verbal comprehension, or short-term memory. In this case it is numerical-geometric ability which reflects their inability to abstract the essential common components from the paired items and have to rely on superficial or figural but less essential properties.

Factor VI (DFU). This specific divergent production factor emerged clearly for the normal group. For the subnormal group, it was not as readily identifiable. The essential difference lies in the magnitude of the loadings of the two DFU tests and Making Objects for the subnormal group. The fact that Make a Figure shared its variance with the divergent production and speed factors and Make a Mark shared its variance with divergent production, speed, numerical ability and short-term memory, makes this factor an unlikely candidate for DFU. However, the only other high loading is for Making Objects. Its variance is also shared with the speed factor. This factor could be interpreted, for the subnormal group, either as DFU or DFS. As the varimax solution for this group was rotated for maximum overlap with the varimax solution for the normal group, this factor is identified as DFU, albeit a weak one.

Factor VII (Reflection). The difference between the two groups on this factor lies in the loadings of Similarities and Designs for the normal group. The ability to delay and analyse the perceptual field for important detail is reflected in the loadings of Picture Completion, Designs and Similarities. The fact that neither Similarities nor Designs loaded for the subnormal group does not necessarily mean that they lack this ability. But, taking into account the fact that Similarities shared its variance among verbal reasoning, numerical ability, verbal comprehension and short-term memory, it could be concluded that the subnormal children were unable to reflect and analyse the perceptual field and resorted to other strategies to solve the tasks involved.

Factor VIII (Verbal Comprehension). This factor emerged clearly and unambiguously for the normal group. For the subnormal group, Similarities and Digit Span also loaded on this factor. Similarities requires more than comprehension since the tasks involve the identification of communalities among phenomena. The loading of Similarities for the subnormal group indicates that comprehension of instructions and requirements of the task accounted, in part, for their variation on this test. The normal group possesses the basic requirement of comprehension and, hence, Similarities becomes a measure of verbal reasoning. For the subnormal group, Similarities is more a measure of verbal comprehension than verbal reasoning. This is reflected by the loadings of .728 and .354 for Similarities for the normal and subnormal groups, respectively, on verbal reasoning.

The loading of Digit Span for the subnormal group indicates a possible weakness in their short-term memory. In order to remember and reproduce the digits, meaning or subvocal verbalization, i.e. concentration, is introduced into the digit patterns. Concentration is probably also a factor in Comprehension and Similarities since these tests require the application of verbal skills to new situations. The loading of Designs is probably due to the use of verbalization in making different design patterns.

Factor X (Memory: Short-term Memory). This factor for the normal group has been interpreted as memory which includes both long- and short-term memory. For the subnormal group, the loadings of Digit Span, Coding and Arithmetic have been identified as being indicative of short-term memory.

Baumeister and Bartlett (1962a) found a fourth factor in retarded children which was not found in normal children which they interpreted as stimulus trace or short-term memory. The subtests which loaded on this factor were Coding, Arithmetic and Picture Arrangement. However, Digit Span was omitted from this analysis. Baumeister and Bartlett (1962b) found a similar factor with loadings from Arithmetic, Digit Span and Coding for retarded subjects. A similar factor was identified for retarded adults by Sprague and Quay (1966) in their analysis of the WAIS. They interpreted this stimulus trace factor as supporting Ellis' (1963, pp. 134-158) trace theory. However, Osborne and Tillman (1967) identified a factor for retarded children on which loaded Comprehension, Digit Span, Object Assembly and Coding. They interpreted this as "freedom from distractibility." A similar interpretation has been made by Belmont _et al_. (1967). Meyers and Dingman (1966) stated that:

> there is in the WISC only one subtest that clearly and unambiguously has face validity for short-term memory, the digit test. Presumption of this quality in other subtests is risky (p. 22).

Wechsler (1958, p. 132) noted that the subtest Coding had many determinants and was factorially ambiguous.

For the subnormal group in the present study, Digit Span and Coding had their highest loadings on Factor X with minimal loading from Arithmetic. Similarities and Make a Mark had negative loadings. A number of interpretations are possible: (1) concentration or freedom from distractibility. Viewing Similarities as the application of verbal skills to new situations would require concentration (cf. Factor VIII). The negative loading of Similarities seems to indicate that this is probably not a concentration factor; (2) Digit Span, Coding and Arithmetic have in common the use of numbers. In view of the factorial ambiguity of Coding (Wechsler, 1958) it could be interpreted as numerical facility. However, Coding seems to be more indicative of hand-eye coordination or psychomotor ability than facility with numbers; (3) short-term memory. In view of the object of factor match and as Factor

X for the normal group was identified as a memory factor this seems to be the most likely interpretation. The identification of this factor for the subnormal group and not for the normal group does not mean that normal children do not possess short-term memory. It means that in the subnormal group the tests elicit more variance in this function greater than in the normal group which gives rise to a factor (Meyers & Dingman, 1966). Such a factor does not necessarily reveal a generally lower level of performance by retardates on these tasks.

While using the same labels for both groups to identify six similar factors it appears that the organization of abilities is similar for both groups apart from the four exceptions noted. Inspection of the factor matrices for the two groups shows that, for the subnormal group, the abilities tend to be more diffuse or less differentiated than those for the normal group. For the normal group, only three of the 23 tests used in the study, Block Design, Words Beginning and Ending and Designs, shared their variance with three or more factors. For the subnormal group, however, 11 of the tests shared their variance with three or more factors. This diffuseness shows that for most tests more than one ability was needed to solve the various tasks i.e. many of the subnormal group were below a threshold or deficient in the various specific abilities with the result that they had to resort to other abilities in order to effectively solve the tasks. However, this interpretation is advanced with caution as the apparent diffuseness may, in part, be due to the technique of factor match. As the comparison was made between two similar age groups it leaves the problem of differentiation unanswered.

Intelligence and Divergent Production

Implicit in Hypothesis II and III is the contention that divergent production is independent of intelligence for the normal group but interrelated for the subnormal group i.e. above a certain threshold of intelligence divergent production abilities are independent of intelligence. This area of investigation has become clouded as measures of divergent production have become associated with 'creativity' on the basis of a loosely formulated analogy that convergent production is to intelligence as divergent production is to creativity (Miezitis, 1967). The distinction between the two is not entertained here as it is outside the realm of the present study.

Wallach and Kogan (1965) reviewed studies supposedly supporting the hypothesis that a general cognitive dimension of 'creativity' exists like the concept of intelligence but independent of the latter. They pointed out that the average correlations between tests representing the conventional intelligence domain and measures of 'creativity' were equal to or greater than the average intercorrelations between 'creativity' indices and concluded that these measures were not indicators of a single psychological dimension parallel to and distinct from the dimension of general intelligence.

Thorndike (1962) re-analysed data on creativity indices and suggested that there was some reality to a broad domain, distinct from the domain of the conventional intelligence test, to which the designation "divergent thinking" or "creative thinking" might be legitimately applied. He suggested, however, that this was a rather more nebulous and loosely formed domain than that of the conventional intellect.

The findings in the present study support this position. The intelligence variables, IQ, Verbal IQ and Performance IQ, did not load on any factor in either group that could be construed as divergent production. For the normal group, IQ and Verbal IQ loaded on verbal reasoning, IQ and Performance IQ on perceptual organization, Verbal IQ on comprehension and Performance IQ on visual imagery and reflection. A similar pattern was found for the subnormal group, the only difference being that Performance IQ did not load on Factor III (speed) and loaded on Factor IX.

CHAPTER VI

SUMMARY AND IMPLICATIONS

The present study was an attempt to determine whether children whose IQs ranged from 50-80 were characterized by the same abilities as those of IQ 90 to 120. The WISC and a battery of eleven divergent production tests designed by Guilford, which yielded 26 scores, were administered to 48 normal and 46 subnormal children. It was hypothesized that four WISC factors would emerge for both groups but that subnormal children would exhibit less differentiation of divergent production abilities.

The intercorrelations of 26 variables for both groups were factor analysed extracting eight, nine and ten factors and rotated to the varimax criterion. Ten factors were accepted as giving the best interpretation for the two groups. The factor matrix for the subnormal group was re-rotated by the Schonemann (1966) least squares orthogonal method for maximum overlap with the factor matrix for the normal group.

Four WISC factors were identified in each group: verbal reasoning, perceptual organization and verbal comprehension for both groups, a memory factor for the normal group and a short-term memory factor for the subnormal group. The six predicted DP factors for the normal group failed to emerge, only two such factors being identified: a broad DP factor, which could possibly be interpreted as divergent production of semantic units, and divergent production of figural units. A global DP factor and divergent production of figural units were found for the subnormal group. Four other factors were identified for the normal group, visual imagery, numerical, reflection and social awareness. For the subnormal group three other factors were identified as speed, numerical-geometric and reflection while one remained unidentified.

Implications for SI Model

The structure of intellect model represents the organization of abilities to be found in the young adult. The WISC, on the other hand, was developed on the basis of a general ability concept with the subtests being measures of intelligence and not measures of different kinds of intelligence (Wechsler, 1958, p. 64). The failure of a general intelligence factor to emerge for either group indicates that a general ability concept is insufficient to describe intellectual functioning.

The emergence of two divergent production factors and the failure of the six hypothesized divergent production factors to emerge for the normal group appears to cast some doubt on the validity of Guilford's model. Three possible reasons why this occurred are ventured. Firstly, the WISC subtests appear to be measures of broader abilities (Glasser & Zimmerman, 1967) while the DP tests are measures of more substantial specific abilities. Factor analysing a matrix of intercorrelations which included broad and specific ability measures may result in more group factors with some measures of specific abilities being subsumed, in part, under some broader ability factor. This may be due to common content i.e. figural, symbolic, or semantic, or to some common ability e.g. memory, imagery. The resulting analysis may then fail to show more specific abilities such as semantic fluency or semantic flexibility.

Secondly, the failure of the six hypothesized DP factors to emerge may be related to the number of factors extracted. The difference between the results obtained in this study and in Guilford's analyses (e.g. Guilford & Hoepfner, 1966a) may lie in the coverage of factors. Although only two DP factors emerged in this study, this does not mean that additional DP factors could not be obtained. However, further extraction of factors might be questionable in view of the number of hypothesized factors, the number of variables and the high communalities.

Thirdly, the systematic coverage of the divergent production area chosen in the present study included cells that were related to each other in terms of either content or product. Thus, it may be that shared content or product variance contributed to the failure of the six factors to emerge.

Sarason and Gladwin (1958) and Sarason and Doris (1969, pp. 36-62) stressed the inadequacy of intelligence tests alone for the evaluation of human abilities. Cohen (1959) pointed out that different aspects of intellectual functioning are measured by the same items at different ages. Stott and Ball (1965), in their analyses of infant and preschool tests, showed the lack of "consistency among and within the scales in terms of factor content and meaning, thus pointing up the need for more consistent and adequate tests (p. 138)." The identification of two divergent production factors in the present study indicates an spect of intellectual functioning which is not measured by conventional intelligence tests and which is independent of the traditional concept of intelligence. Adequate measures of intellectual functioning must incorporate this and other possible neglected dimensions. However, the SI model is incomplete for this purpose. Although there is an implicit hierarchy of abilities in the model, it represents all abilities as co-equivalent in their status and relationship to one another (Haynes, 1970). From a pragmatic point of view future research should be directed toward identifying abilities which are important for intellectual functioning and achievement. This would necessitate the systematic search for broader abilities in the SI model. The DP factors which emerged in the study could be indicative of a broader dimension of divergent production than is depicted in the SI model. A comprehensive conception of the intellectual functioning of subnormal children should incorporate extensive assessment based on a broad range of variables.

Implications for Education

The identification of divergent production abilities in the subnormal children points out that these children cannot be dismissed from consideration in areas of intellectual functioning assumed to be limited to individuals of normal and superior intelligence. It suggests an untapped area of mental functioning in subnormal children. Rouse (1965) found that the level of divergent production in mental retardates increased significantly after a treatment series of lessons which were designed to foster divergent thinking.

Dunn (1963, pp. 53-127) enumerates three characteristics of special education: (1) special facilities and equipment; (2) specially trained personnel and (3) special methods and curriculum. This last characteristic may be the most neglected. Guskin and Spicker (1967, p. 242) stated that in the education of the mentally retarded the tendency has been to use a content similar to that employed in regular grades but presented in "more simplified language at a slower pace with endless repetition to enhance over-learning" and conclude that such children benefited little by special education programmes.

As the needs of subnormal children are of primary concern emphasis should be placed on individual thinking and generation of ideas. This could be achieved by encouragement of open discussion of classroom topics and the formulation and presentation of thoughts and ideas, by dramatization of ideas which could help reinforce the thinking of new ideas and promote more effective association of ideas, by specific development of aspects of curricula which aim at development of independent and divergent thinking e.g. reading programmes where the subnormal children can create as well as reproduce stories. Unless research into intellectual functioning of these children, based on a broad conception of intelligence, does not result in new information and action, it will be an interesting but wasteful process.

Before applying the results of this study further investigations of divergent production in subnormal children are needed because of the relatively small sample. Care must be taken not to extend the results to retarded children, since the study used subnormal children most of whom were in the 60-80 IQ range and the tests do not apply to children who do not have at least some verbal facility.

This study investigated only some of the divergent production abilities that have been identified and does not describe the nature of intellectual functioning in subnormal children. Rather, it is hoped that it indicates the need for extensive systematic explorations of abilities in the comparative assessment of normal-subnormal differentials.

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APPENDIX

TABLE X

EIGENVALUES FOR NORMAL AND SUBNORMAL GROUPS

Normal	Subnormal
7.840	6.774
2.998	3.279
2.781	2.637
1.659	2.308
1.431	1.410
1.252	1.298
1.170	1.054
1.087	1.013
0.876	0.910
0.722	0.712
0.635	0.670
0.611	0.584
0.513	0.552
0.478	0.457
0.430	0.417
0.340	0.390
0.283	0.338
0.241	0.318
0.205	0.252
0.147	0.210
0.120	0.188
0.096	0.122
0.081	0.104
0.001	0.001
0.001	0.001
0.000	0.000

TABLE XI

VARIMAX FACTOR MATRIX FOR SUBNORMAL GROUP (N=46)*

Variable/ Factor	I	II	III	IV	V	VI	VII	VIII	IX	X	h^2
1	815	119	-064	193	-194	188	-172	-015	-157	-144	868
2	824	105	033	-000	155	167	107	179	148	089	816
3	193	163	021	830	-078	-020	-038	299	048	079	859
4	432	129	106	113	541	-055	-507	072	-023	-071	790
5	693	070	390	-021	047	-304	-129	-120	099	238	830
6	302	-049	057	218	-074	026	076	813	144	033	840
7	107	198	-048	218	-149	157	-085	036	-092	824	844
8	311	637	-007	-050	370	-089	117	-064	-026	221	718
9	-073	826	-088	310	-059	-043	-123	168	-042	-127	859
10	114	800	135	-084	-128	160	-020	-191	003	-017	757
11	-102	178	122	127	111	024	873	065	014	091	861
12	148	047	486	083	240	493	290	328	187	033	796
13	118	056	419	177	411	564	-139	-074	160	079	768
14	010	-023	176	159	-002	107	-007	147	922	-036	941
15	277	-321	205	403	-077	116	120	-106	480	-264	729
16	007	246	192	457	283	295	184	224	180	314	689
17	111	137	-046	764	061	187	127	-052	167	141	722
18	299	012	355	179	501	048	178	-365	198	-011	704
19	-006	-109	782	285	100	141	300	-019	-003	143	845
20	440	185	560	-055	143	002	002	018	076	-351	695
21	073	111	856	-190	-001	136	-098	061	193	-094	865
22	047	055	097	099	-002	908	037	-001	054	100	864
23	-039	-023	046	-061	855	106	083	-010	-062	-115	774
24	567	670	125	305	129	031	079	218	001	195	988
25	801	131	145	334	159	-005	-175	365	064	058	988
26	120	897	051	160	056	063	269	004	-044	234	983
Sum of Squares	3.68	3.40	2.58	2.37	1.93	1.81	1.54	1.39	1.39	1.32	21.39

*Decimals have been omitted.