Visual Perceptual, Perceptual Motor and Temporal Sequence Tasks: The Performance of Average and Below Average Readers

by

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ABSTRACT

Although visual perceptual and perceptual motor tasks emerge from diverse theoretical rationales and are used in a variety of contexts, systematic comparisons of the significance of task parameters in differentiating between subject groups are lacking. The present study compares the performance by average and below average readers on a group of visual perceptual, perceptual motor and temporal sequence tasks, systematically varied across presentation and response parameters, in order to explore the relative significance of task parameters, and also to examine cognitive processes used by the groups in task performance.

Subjects were initially identified as average or below average readers on the basis of reading test scores, and the final sample of 40 average and 40 below average readers was selected by matching for IQ across reading groups. A battery of 10 tasks was administered to all subjects in the final sample. T-tests between groups indicated that some categories of tasks, including visual synthesis and
temporal sequence tasks, differentiated between groups more powerfully than others, although no single parameter emerged as uniquely significant. Task intercorrelations and factor analysis results suggested that patterns of cognitive processes differed between groups. Average readers tended to use a single process in performance of several task variations, while the performance of below average readers tended to be dominated by task-specific demands.
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CHAPTER 1

INTRODUCTION

Tests of perceptual motor integration, usually consisting of the recognition and copying of two-dimensional geometric forms, have become well-known and widely utilized for a variety of clinical, research and educational purposes. Recognition of their significance has led to a proliferation of tasks emerging from differing theoretical rationales and characterized by varying task parameters.

Clinical acceptance of this type of test can be traced to Bender's (1938) early exploration of the copying of visual gestalten to explore child development, organic brain disease and psychological disorders. Her observations indicated that the capacity to copy geometric forms varied according to the maturational level, growth pattern and pathology of the individual. The sensitivity of the Visual Motor Gestalt test to maturational level and psychological and neurological disorders has lead to a steady increase in its use by clinicians and researchers (Koppitz, 1963). Another example of clinical adaptation
of form copying tasks is found in the work of Graham and Kendall (1964), who devised a task requiring the reproduction of visually perceived stimuli from memory. Their observations supported the hypothesis that the memory component of the task effectively discriminated subjects with organic brain disorders from those with non-organic disorders.

Form copying tasks are also much in evidence in the literature on child development. Ilg and Ames (1964) for example, have discussed the relationship of form copying ability and maturational level. Expanding on the earlier work of Gesell (1940, 1946, 1947), they provide a detailed, qualitative analysis of the form copying characteristics associated with each stage of development of the child. They view the ability to copy geometric forms as a tangible and measurable expression of the dynamic and complex inner processes of the evolving child.

Within a neuropsychological context, visual perceptual and perceptual motor tasks have been used in the investigation of the effects of brain damage on cognitive functioning. Recent efforts include Luria's (1973) work. Through observation of the performance on perceptual tasks by brain damaged subjects, he has localized areas of the
brain that appear to affect skills associated with adequate perceptual motor integration. A direct outgrowth of Luria's neuropsychological investigations has been the use of visual perceptual and perceptual motor tasks in research on central processing. The work of Das and colleagues (Das, Kirby & Jarman, 1975; Jarman, 1978a, 1978b, 1978c; Jarman & Das, 1977; Kirby & Das, 1977) for example, has illuminated the relationship between perceptual motor ability and other complex cognitive processes, such as reading, by interpreting them within the framework of central processing.

The literature on human abilities also suggests a relationship between perceptual motor ability and overall cognitive functioning. For example, Jensen's (1970) inclusion of figure copying as a measure of Level II (reasoning) ability, in his hierarchical model of cognitive abilities suggests that tests of perceptual motor integration may be significant in the measurement of overall cognitive functioning. Further support for this view is found in the use of form recognition (matching) and form copying tasks in cognitive ability measures such as the Stanford-Binet Intelligence Scale (Terman & Merrill, 1973), and in the noted correlations of tests such as the Visual Motor Gestalt with measures of intelligence (Koppitz, 1963).
The school readiness and kindergarten screening literature suggests yet another application of perceptual motor integration tasks. Recent interest in the evaluation of school readiness, early diagnosis of developmental delay and prevention of potential learning problems has led to formulation of appropriate groups of measurements usually referred to as readiness or kindergarten screening tests (DeHirsch, Jansky & Langford, 1966; Ilg & Ames, 1964; Satz, Taylor, Friel & Fletcher, in press; Stevenson, Parker, Wilkinson, Hegion & Fish, 1976). Perceptual motor tasks have been used frequently in this context due to their observed maturation sensitivity and repeated findings of their predictive relationship to subsequent reading achievement (DeHirsch, et al., 1966; Satz, et al., in press). The "maturational lag" hypothesis of Satz and associates (Satz, et al., in press; Satz & Sparrow, 1970; Satz & Van Nostrand, 1973) leads them to postulate that the diagnostic indicators of developmental reading disability vary with the chronological age of the child, and, as the early developing skills of perceptual motor integration are in primary ascendency in grade K, delays in those skills are most likely to forecast later problems in reading; hence the predictive validity of perceptual motor tasks when administered in grade K.

Several of the theoretical orientations that have
been mentioned have had an impact on the reading disability literature. The predictive orientation of readiness and kindergarten screening studies has been mentioned. The literature also includes studies of reading disability in which attempts have been made to understand the complex variables associated with reading by identifying concomitant deficiencies in other areas of cognitive functioning, such as spatial and perceptual abilities (Doehring, 1968) and central processing (Leong, 1976; Cummins & Das, 1977). Results of these studies have suggested that reading disability is not a unitary phenomenon, but a condition with multiple etiologies, and with a relationship to other cognitive functions, including spatial and perceptual abilities and central processing.

In spite of the widespread use of perceptual motor tasks and recognition of their diagnostic and predictive significance, there is a lack of comprehensive investigation into the processes involved in perceptual motor functioning (Birch & Lefford, 1967). Noting this, Birch and Lefford varied task demands in order to explore the processes underlying the development of the child's ability to perceive and accurately copy a visually presented stimulus. They related changes in the familiar task of copying two-dimensional forms to concurrent alterations in capacities
for perceptual differentiation (analysis) and integration (synthesis) by using segmented geometric forms as stimuli and response choices. Their data suggested that different abilities may be involved in the performance of perceptual tasks with varying task parameters.

A reexamination of perceptual analysis and synthesis by Greenburg (1972) failed to support the theory of differential perceptual abilities across varying task parameters, conflicting with the observations of Birch and Lefford. McDaniel (1972) also varied task demands in a study of complex perceptual processes, adding yet another task parameter by presenting segments of a geometric form in a temporally ordered sequence. His data did not support the hypothesis that different perceptual abilities are required in the performance of complex perceptual tasks with varying task parameters, with the possible exception of serial integration.

With perceptual motor tasks used in such diverse contexts, the observation that they are less than consistent across presentation and response variables (Chalfant & Scheffelin, 1969) is not surprising. Clinicians and researchers have used different task parameters, thereby suggesting, explicitly or implicitly, that specific task
parameters may be differentially important in the measurement of perceptual motor integration. Using task parameters as a basis for classification, several categories of perceptual motor tasks are seen to emerge.

Examination of response variables reveals two main response modes: recognition (matching) and reproduction (copying). Examples of perceptual motor tasks requiring the reproduction response include the familiar Visual Motor Gestalt test (Bender, 1938), the copy forms task employed by Ilg and Ames (1964), and the Visual Motor Integration Test (Beery, 1967). Tests requiring the recognition response include the Discrimination of Forms subtest of the Stanford Binet Intelligence Scale (Terman & Merrill, 1973), tests of non-verbal reasoning such as the Raven's Progressive Matrices (Raven, 1960), and measures designed for research of perceptual abilities (Birch & Lefford, 1967).

Methods of stimulus presentation appear more diverse. A distinction can be made between the presentation of stimuli contemporaneously with the subject's response, i.e., with the stimulus in full view while the subject forms a response, or non-contemporaneously with response, i.e., with stimulus removed after presentation, requiring a response from memory. An example of stimulus presentation
contemporaneously with response is the Visual Motor Gestalt test (Bender, 1938), while an example of stimulus presented non-contemporaneously with response is Graham and Kendall's Memory for Designs test (1960).

Birch and Lefford's (1967) use of segregated forms in the study of perceptual abilities gives rise to a second distinction among presentation variables, i.e., the presentation of segments of geometric forms instead of the more familiar presentation of whole geometric forms found on tests such as the Visual Motor Gestalt. Greenburg (1972) and McDaniel (1972) have also made use of tasks involving the presentation of segregated forms.

A recent and as yet only minimally explored parameter is the presentation of segments of geometric forms in a temporally ordered sequence, requiring the subject to remember the stimulus segments and integrate them over time in order to construct a response. McDaniel's Successive Figures task (1972) is an example of this type of test.

It is seen, then, that perceptual motor tasks have emerged from differing theoretical rationales, have been used in a number of contexts and have been defined by a variety of task parameters. In some cases, a given task
parameter is explicitly stated as a variable of interest and hypothesized to have some discriminatory significance, for example, the motor response on the Visual Motor Gestalt test. In other cases the theoretical rationale behind the choice of task parameter is less than explicit, for example, the choice of a motor response, rather than simple matching, on the Memory for Designs test. The choice of any given task parameter over all possible alternatives contains the implicit assumption of the significance of that particular parameter. The rationale for choice of task parameters in some cases remains unexplained, and the effect of varying task parameters on the measurement of perceptual motor abilities has been underexplored.

Several of the theoretical orientations discussed above have recently been brought to bear on the reading literature. Kindergarten screening studies, investigations of spatial and perceptual processes, neurological theory and central process research have particular implications for the study of reading (Doehring, 1968; Leong, 1976a&b; Satz, Taylor, Friel & Fletcher, in press). The relationship between perceptual motor integration processes and complex variables associated with reading, observed by these authors, suggests that the study of perceptual motor
integration tasks could appropriately be pursued within the context of reading.

It is the purpose of this study, by exploring the parameters of perceptual motor tasks systematically across presentation and response variables, to compare the effectiveness of varying task parameters in differentiating between subject groups. The patterns of cognitive processes used in the performance of task variations by different subject groups will also be explored. A comparative evaluation of the performance of a group of children with average ability and a group of children who might be expected to experience difficulty with perceptual motor tasks, that is, below average readers, will be used for this investigation.
A Perspective

At present, tests of perceptual motor integration are characterized by varying task parameters. However, the relative significance of different task parameters in the measurement of perceptual motor integration has yet to be established. There is a "lack of detailed information about the normal mechanisms subserving the development of perceptually guided motor performance" (Birch & Lefford, 1967, p.1).

Efforts directed toward explicating perceptual motor integration ability can be roughly grouped according to two main orientations: first, those researchers that have concentrated on the specifics of the tasks who emphasize, implicitly or explicitly, the significance of particular task parameters in discriminating among subject groups or among different perceptual abilities; and secondly, researchers that view perceptual motor integration as but one aspect of central cognitive functioning, who theorize that a single process underlies performance
on variations of the task.

A well-documented example of task-specific orientation is represented in the work of Bender (1938), Ilg and Ames (1964), Roach & Kephart (1966), and others who have emphasized the importance of the motor parameter. The diagnostic validity of tests requiring the copying of a visual stimulus has been substantiated, but whether the underlying integrative ability hypothesized to be measured by the tasks (Bender, 1938; DeHirsch, Jansky & Langford, 1966) can only be tapped by the demand of a motor response from the subject has not been established beyond question. Recent variations in method and type of stimulus presentation requiring a high degree of visual perceptual integration (Birch & Lefford, 1967; McDaniel, 1972) suggest a potentially significant direction for the investigation of perceptual integration ability without the demand of a motor response.

Variation of specific task parameters, in attempts to identify components of perceptual abilities, in some studies have yielded support for a hypothesis of global perceptual ability underlying task variations (Greenburg, 1972; McDaniel, 1972), and in others have yielded support for a hypothesis of different perceptual abilities (Birch & Lefford, 1967).
An example of a central processing orientation to the explication of perceptual motor integration is found in Luria (1973). He theorized that a single central processing ability, simultaneous synthesis, underlies the ability to perform on variations of visual-perceptual, perceptual cognitive and perceptual motor tasks. This suggests that, in normal subjects, tasks with varying parameters would in effect measure the same process.

This theory has been pursued by Das and colleagues (Das, Kirby & Jarman, 1975; Jarman, 1978a, 1978b, 1978c; Jarman & Das, 1977; Kirby & Das, 1977). They have found, in repeated investigations, that different visual perceptual and perceptual motor tasks, such as Figure copying, Memory For Designs and Raven's Progressive Matrices load on the same factor, which they have identified as simultaneous synthesis.

The present review will focus on the emergence of major task parameters in the literature, and the influence of theoretical orientation on the explication of perceptual motor integration and related phenomena.
Task Parameters

Motor Response. In describing the use of the Visual Motor Gestalt test to explore growth patterns, maturational levels and psychopathology, Bender (1938, 1967) described the global nature of gestalt function and the interdependence of perceptual and motor capacities. Her adaptation of nine of Wertheimer's (1923) visually perceived gestalten for diagnostic purposes was based on the conviction that response is a "motor process of patterning the perceived gestalt" (1967, p.544) determined by the integrative state of the organism. The hypothesized tendency of a subject to complete and reorganize gestalten according to principles determined by sensori-motor experience suggests the importance of the motor response in an evaluation of the inner integrative state of the individual.

The importance of motor activity in the development of perceptual abilities has been investigated by Kephart (1960; Sträuss and Kephart, 1955) drawing on the earlier work of Piaget and Hebb. He suggests that perceptual and motor skills should not be considered as two separate activities, but that perceptual motor ability should be considered a combined activity. He states that perceptual learning depends on prior motor learning for
its foundations, with new perceptual information being matched to the system of motor information established earlier in the course of development. This line of reasoning derives from the theory that early, purposeful motor exploration and manipulation of the environment develops within the child a series of structures, or "schemata" (Piaget, 1952) that form the basis for more complex perceptual and higher order cognitive processes.

Pursuant to this, research of the relationship of motor functioning and academic achievement (Ismail, Kephart & Cowell, 1963) has suggested a relationship between aspects of motor ability and achievement. However, as the authors note, an observed relationship does not establish causality. The relationship between perceptual motor ability and academic performance may simply be due to the two areas developing simultaneously, especially in view of the lack of support for the theory of transfer from perceptual motor training programs to improved academic performance (Thomas, Chissolm, Stewart & Shelly, 1975).

Research in the evaluation of school readiness has employed copy forms tasks (DeHirsch, Jansky & Langford, 1966; Ilg & Ames, 1964; Satz, Taylor, Friel & Fletcher, in press). DeHirsch et al. used the Visual Motor Gestalt
test in their predictive battery and found it to be significantly related to later reading achievement. They attribute the relationship to the maturation sensitivity of the test, and, interestingly, point out that its predictive efficacy depends not on the specific skills involved so much as the degree to which they measure integrative ability.

Figure copying is of primary significance in the work of Ilg and Ames (1964) on the evaluation of school readiness. They have found it to be a valid, measurable expression of the matrix of inner developmental processes of the child, yielding specific information of the child's state of readiness for learning. In the description by Satz, Taylor, Friel & Fletcher (in press) of a longitudinal study of readiness, the predictive validity of perceptual motor tasks, such as the Visual Motor Gestalt test, are seen in the context of their relationship to central processing ability, of which perceptual motor skills are hypothesized to be an early manifestation. Satz, et al. have explained developmental reading disabilities as "disorders in central processing, the nature of which varies according to the chronological age of the child". The primacy of developing perceptual motor skills at Kindergarten level make evaluation of perceptual motor
skills in readiness batteries effective predictors of later reading disability. A maturational lag in the cerebral cortex is hypothesized to be responsible for both deficiencies. Further support for the maturational lag hypothesis is found in Leong (1976a).

The major parameter emerging from the above lines of reasoning is the central role of motor activity, seen as forming the basis for perceptual learning, and as functioning interdependently with perception. An obvious question raised by the use of the motor parameter in evaluation of perceptual motor integration is that primary motor dysfunction in and of itself could lead to defective performance on a task. Competency in the performance of the task necessitates an adequate level of motor proficiency and it is difficult to ascertain whether defective task performance originates in the perception of the stimulus, the motor response, or the integrative function.

That purposeful motor action directed to exploration and manipulation of the environment has a significant role in the development of perceptual motor integration abilities (Strauss & Kephart, 1955) is a reasonable hypothesis. However, the diagnostic significance of perceptual motor tasks appears more closely associated with
their sensitivity to the integrative abilities of the organism than their measurement of either perceptual or motor abilities considered separately (Bender, 1938; DeHirsch, Jansky & Langford, 1966). The importance of the motor parameter per se can therefore be seen as relative to its capacity for revealing the inner, integrative processes of the individual.

Recognition Response. The development of the ability to recognize and discriminate among forms is generally thought to precede the ability to copy forms (Strauss & Kephart, 1955) and to be less affected by brain damage (Birch & Lefford, 1967). A comprehensive examination of the relation between visual perceptual abilities, intersensory integration and perceptual motor skill is found in Birch and Lefford (1967), who recognized a need for more detailed and systematic information about the developmental course of functions underlying the development of perceptual motor integration. They advanced a theory of perceptual levels, distinguishing the early developing ability of form recognition from the later developing abilities of perceptual differentiation and the ability to copy forms. The possible differential importance of visual perception, visual differentiation, intersensory integration and motor skill was studied by developing a series of tasks ranging
from form recognition through increasingly complex visual perceptual abilities to the copying of geometric forms under varying conditions of perceptual support.

Visual analysis, defined as the ability to separate the elements of a gestalt and use them selectively, and visual synthesis, defined as the ability to reorder fragments of forms into a whole figure, were hypothesized to tap higher order perceptual abilities than the simpler form recognition task.

The results of the study supported the hypothesis of differential abilities. Perceptual synthesis, perceptual analysis and motor skill were found to have only weak associations with each other, although a strong association with intersensory functioning was reported for all three abilities.

Pursuant to the work of Birch and Lefford, Greenburg (1972) reexamined the constructs "visual analysis" and "visual synthesis". She defined visual analysis as the ability to point out specified lines or angles on whole figures, and visual synthesis as the ability to recognize a whole geometric figure after the parts had been shown and then removed. Her data yielded a substantial correlation between the constructs, supporting a hypothesis of a single ability underlying performance on varying
perceptual tasks, thus contradicting the results of Birch and Lefford.

A significant aspect of the work of Birch and Lefford is the use of segregated geometric forms as stimuli and response choices, requiring the subject to integrate elements of a visually perceived stimulus in order to formulate a response. This task variation may have some significance in the measurement of the perceptual integrative capacity of the individual at a more complex level than form recognition, but without the demand of a motor response.

Response from Memory. Patterns of impairment displayed by subjects with brain damage have been observed to include memory (Chalfant and Scheffelin, 1969; Luria, 1973). The effect of a memory component on the performance of perceptual motor tasks has been explored by Graham and Kendall (1960), whose Memory For Designs test was shown by the authors to differentiate brain-disordered subjects from those without brain disorders. These results find some support in the later work of Benton (1974). However the ability of the Memory For Designs test to discriminate among other subject groups has not been clearly demonstrated (Hunt, 1955).
The role of memory may be worth pursuing within the context of perceptual motor functioning. Jensen (1970) has emphasized the role of memory in cognitive functioning in his hierarchical theory of Level I and Level II abilities. He has classified the task of figure copying as a measure of reasoning (Level II) ability and, by definition, functionally dependent on the hierarchically lower ability of memory (Level I) for its completion. An analysis of inconsistencies in this position and a model for its reinterpretation has recently been proposed by Jarman (1978c).

Successive Presentation of Stimuli. In his investigation of four constructs hypothesized to be components of more complex perceptual processes, McDaniel (1972) used motion picture film to present segments of geometric forms in a temporally ordered sequence. This task was designed to measure the construct "serial integration", defined as the ability to accumulate visual stimuli over time and organize them into meaningful patterns. The results of the study did not support the hypothesis of different component abilities, but instead indicated that a single factor was involved in the performance of all task variations included in the study. Two of the serial integration tasks loaded on a second factor, but McDaniel's
conclusions about the significance of the serial integration component remained tentative.

Strauss and Kephart (1955) state that temporal integration aids in the perception of complex spatial stimuli by allowing the subject to attend to a succession of individual features without losing his impression of the whole. The role of temporal integration in complex perceptual processes associated with reading (Bakker, 1972) and language acquisition (Hearnshaw, 1956; Luria, 1973) suggest that it is a construct deserving further investigation.

Central Processing

Although the task parameters described above appear diverse, it has been suggested that they share a relationship to the central process of intersensory integration (Birch & Lefford, 1967). Strauss and Kephart (1955) emphasized the "central origin of the perceptual process," describing it as a "complex system of integrations between various sense fields" (p. 578). This concept of intersensory integration in perceptual motor functioning relates to the gestalt concept of the whole being more than the sum of its parts, i.e., the ability to integrate visual with
motor functioning has more diagnostic significance than 
either visual or motor functioning evaluated separately.

The fundamental importance of the integrative 
capacity of the brain in perceptual and conceptual 
cognitive processing has been explored in a neuropsycho-
logical context by Luria (1973). Through the study of 
patients with lesions in the cortical zone influencing 
 intra-sensory and inter-sensory integration, he has 
identified disturbances in functions that appear similar 
to the perceptual motor and integrative processes touched 
on in the preceding discussion. The recognition of 
objects, the drawing of objects both in direct reproduction 
and from memory, difficulty with fitting together the 
elements of incoming impressions into a single structure, 
converting consecutive presentation of elements into a 
simultaneous perception, and the acquisition of language 
skills are adversely affected by disturbances in this 
area of the cortex. Luria also explicates the neurological 
basis for the relationship between language (symbolic) 
disturbances and perceptual difficulties and posits that 
a single construct, "simultaneous (spatial) synthesis", 
describes an ability that underlies both perceptual motor 
and linguistic processes.
Further investigation of Luria's theories has been carried out by Das and colleagues (Das, Kirby & Jarman, 1975; Jarman, 1978a, 1978b, 1978c; Jarman & Das, 1977; Kirby & Das, 1977). They note a recent shift from the study of abilities to an inquiry into processes, and propose a model for the interpretation of cognitive abilities based on Luria's paradigm of simultaneous and successive synthesis. Briefly, "simultaneous synthesis refers to the processing of information in integrated, semispatial forms, and successive synthesis refers to processing in a sequence dependent, temporal-based series" (Jarman, 1978a). The theory has been operationalized by investigations using a battery of tests designed for this line of research. In factor analysis of the results of these studies, the tasks of form copying, Memory For Designs and Raven's Progressive Matrices have loaded repeatedly on the same factor, suggesting the importance of a single process in the performance of all three tasks. The process was identified as simultaneous synthesis.

Although not all existing variations of perceptual motor tasks have been explored in this context, the central processing theory suggests that the process of simultaneous synthesis would underly performance on the tasks regardless
of variations in task parameters. A significant aspect of the theory for the present investigation is that it suggests the conceptualization of apparently disparate aspects of perceptual abilities within the more comprehensive framework of underlying cognitive processes.

Central Processing, Perceptual Motor Integration and Reading

A predictive relationship between perceptual motor tasks administered at Kindergarten level and later reading ability has been observed (DeHirsch, Jansky & Langford, 1966; Satz, Taylor, Friel & Fletcher, in press). Satz et al. have suggested that the relationship may be due to the same central processing functions underlying the development of both perceptual motor integration abilities and reading achievement. The work of Leong (1974, 1976a, 1976b) has yielded results consonant with those of Satz et al. Leong (1976b) also suggests the potential of the Luria - Das model of cognitive processing (Das, Kirby & Jarman, 1975) for interpreting patterns of impairments in disabled readers.

Fundamental antecedents to the acquisition of reading skill include an adequate level of proficiency in the discrimination of visual stimuli and subsequent develop-
ment of more complex visual perceptual capacities, such as visual analysis (differentiation) and synthesis (integration) (Birch, 1962). Other abilities significant in the reading process are the sequential processing of stimuli (Doehring, 1968), intersensory integration, particularly across the auditory and visual modalities (Birch and Belmont, 1962) and temporal integration (Bakker, 1972).

Both the differential etiology of reading disability (Doehring, 1968; Birch, 1972), and some evidence of its occurrence not in isolation, but accompanied by impairment in spatial temporal abilities (Doehring, 1968), seem to preclude the treatment of reading disability as a unitary phenomenon. "Heterogeneity of associated disorders rather than any single disturbance has tended to characterize the group (disabled readers)" (Birch, 1962, p. 161). Doehring has suggested that the whole matrix of spatial temporal integration may suffer a degree of impairment in disabled readers.

Doehring also states that previous studies have been narrowly conceived, with a resulting scarcity of acceptable explanations of reading disability despite a large number of investigations. He takes the view that reading deficits should be considered in terms of their correlations with nonreading deficits, and suggests investigation
of sequential processing tasks, taking full cognizance of neurological theory, as a promising direction for future research.

A relationship between the acquisition of reading skills and abilities associated with the development of perceptual-motor abilities is suggested by these observations. Further investigation of reading disability within the context of central processing abilities may serve to illuminate the nature of the relationship. A framework for this line of inquiry has been proposed by Cummins and Das (1977).

Summary

Contexts in which perceptual motor integration tasks have been used range from the pragmatic orientation of clinical and educational diagnosis to more theoretical research orientations.

The most commonly used and widely researched type of perceptual motor integration test is the copying of two dimensional forms, as in the Visual Motor Gestalt Test developed by Bender, and the copy forms task of Ilg and Ames. The observable characteristics of the development of the ability to copy forms have been thoroughly documented, and, together with the theory that
has evolved from the work of Bender, Ilg and Ames, and others, form the basis for the diagnostic interpretation of task performance.

Several researchers have used different task demands in attempts to explore the processes involved in perceptual motor integration. Existing tasks vary across several parameters. Some tasks demand a recognition response (Birch & Lefford's Visual Synthesis task) while others demand a motor response (Visual Motor Gestalt test). Some tasks allow presentation of stimuli contemporaneously with the response (Visual Motor Gestalt test) while others demand a response from memory (Memory For Designs test). Task stimuli may consist of whole geometric forms (Visual Motor Gestalt test) or segregated forms (Birch & Lefford's Visual Synthesis task). Presentation of segregated stimulus forms may also vary between a contemporaneous display of all elements of the form (Birch & Lefford's Visual Synthesis task) and presentation of the form elements in a temporal sequence (McDaniel's Successive Figures task).

Most task variations have had limited use, with a narrower range of application than tests of the Visual Motor Gestalt type. For example, the Memory For Designs
test was formulated specifically for the diagnosis of organic brain dysfunction, and the tasks developed by Birch and Lefford, Greenburg and McDaniel are still in the research stage.

Some studies directed towards identification of aspects or components of perceptual processes have found support for the hypothesis of different perceptual and perceptual motor tasks. An example of such a study is Birch and Lefford (1967) possibly the most comprehensive investigation of the subject to date. However, subsequent studies using similar task parameters have failed to yield consistent support for a hypothesis of separate perceptual abilities, but instead suggest a more global perceptual function underlying performance on varying tasks (Greenburg, 1972; McDaniel, 1972).

The importance of the integretive process in perceptual motor integration has been emphasized throughout the literature. Recent research on central processes has advanced the theory of a central process underlying performance on variations of perceptual motor tasks (Das, Kirby & Jarman, 1975). The process has been identified as simultaneous synthesis, and repeated investigations have shown task variations loading on the same factor,
indicating support for the hypothesis (Jarman & Das, 1977; Kirby & Das, 1977). Also, the results of task specific research suggesting a global perceptual ability rather than separate abilities could be construed as supporting a central process theory (Greenburg, 1972; McDaniel, 1972).

Recent literature in the area of reading disability has suggested relationships among central processing, perceptual motor integration abilities and variables associated with reading. Impairments accompanying reading disability have, in some cases, been observed to include difficulty with spatial and temporal integration (Doehring, 1968; Bakker, 1972). Satz's (in press) observation that central processing disorders may underly both perceptual motor integration deficiencies and reading disability is consonant with the findings of Leong (1976a & b) and the central process research of Das, Kirby and Jarman (1975). The use of perceptual motor integration tasks in the prediction of reading disability has yielded further indications of a relationship between the two abilities (DeHirsch, Jansky & Langford, 1966).

Evaluation of the relative merit of various task parameters in the measurement of perceptual motor integration is made difficult by the lack of a systematic
investigation across task parameters. A comprehensive comparison of subject performance across existing task parameters would appear necessary to determine if certain task parameters appear more robust than others in the measurement of perceptual motor integration, or if a more global ability appears to underly performance on all variations of the task. The literature suggests that an exploration of perceptual motor task parameters might be appropriately pursued within the context of the relationship between perceptual motor integration and reading ability.
CHAPTER 3

STATEMENT OF THE PROBLEM

Statement of the Problem

Tests of perceptual motor integration have emerged from differing theoretical rationales, have been used in a variety of contexts, and have been defined by a variety of task parameters. By varying task demands, clinicians and researchers have suggested, explicitly or implicitly, that specific task parameters may be differentially important in the measurement of perceptual motor integration. However, the relative robustness of different task parameters has been underexplored. In spite of the widespread acceptance and use of perceptual motor integration tasks, the literature is characterized by a paucity of comprehensive investigations of the processes involved in the performance of the tasks across varying parameters.

It is the purpose of this study to explore the parameters of perceptual motor tasks systematically across presentation and response variables. By investigation of the performance on a systematic battery of visual
perceptual and perceptual motor integration tasks, by a group of below average readers and a group of average readers, the study will attempt to answer the following research questions:

1. Do certain categories of visual perceptual and perceptual motor tasks differentiate average and below average readers more effectively than other categories?

2. Do the cognitive processes used in the performance of task variations appear to differ between average and below average readers?
Subjects

Eighty grade three children were included in the sample, selected from 11 schools in areas ranging from lower middle to upper middle socio-economic status.

Sample selection involved two phases, beginning with administration of the Gates MacGinitie Reading Test (Primary C, Form 1) to all grade three children in the target schools. The Gates MacGinitie test is composed of a vocabulary and a comprehension subtest, each yielding separate standard scores, percentile ranks, and grade equivalents. The average of the standard scores of the two subtests yields a composite standard score. A group of below average readers was identified on the basis of composite standard scores of 43 (approximate grade equivalent 2.9, or one year below placement) or below. A group of average readers was identified on the basis of composite standard scores of 48 (approximate grade equivalent 3.9, or grade-appropriate) and above, with the majority selected scoring between 50 and 55.
In the second phase of selection, the Peabody Picture Vocabulary Test (PPVT) was administered individually to children in each of the above groups. The PPVT consists of a booklet of pictures, to which the subject points in response to vocabulary questions. It yields IQ, percentile rank and mental age scores. On the basis of IQ scores, 40 below average readers were matched with 40 average readers.

In the resulting sample groups, the below average readers (group 1) consisted of 22 boys and 18 girls, while the average readers (group 2) consisted of 14 boys and 26 girls. Sample characteristics are summarized in Table 1.

Tasks

The tasks were conceptualized within the framework of a grid formed by the intersection of a task presentation axis and a subject response axis (Figure 1.). Classification of tasks was based on the following task parameters:

1. **Type of stimulus presented** (Whole, Segregated)
2. **Method of presentation** (Contemporaneous with response; non-contemporaneous with response, i.e.,
TABLE 1
Sample Characteristics of the Two Reading Groups

<table>
<thead>
<tr>
<th>Measure</th>
<th>Below Average Readers</th>
<th>Average Readers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Gates-MacGinitie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Scores*</td>
<td>38.72</td>
<td>3.83</td>
</tr>
<tr>
<td>PPVT IQ</td>
<td>92.42</td>
<td>9.91</td>
</tr>
<tr>
<td>CA (months)</td>
<td>108.10</td>
<td>4.60</td>
</tr>
</tbody>
</table>

*Note: Mean 50, Standard Deviation 10
Figure 1: Grid for classification of Tasks by presentation and response variables.
response from Memory; presentation of stimulus elements in a Temporal Sequence)

3. Response format (Recognition, i.e. matching response; Reproduction, i.e., motor response)

Most categories of tasks thus identified are represented by existing variations of visual perceptual or perceptual motor tasks. In cases where no existing test was within the parameters of the particular grid classification, task variations were constructed, until each cell of the grid had a corresponding task.

In this way, a battery of 10 tasks systematically varied across presentation and response parameters, was assembled for the present investigation.

Examples of items from each task are presented in Appendix A. The tasks are described as follows:

Task 1.
Description: The Wepman Visual Discrimination Test. The children were presented with a test booklet with five shapes printed on each page. The task was to match the stimulus form in the centre of the page with the one other shape on the page that was identical.
Task 2.
Description: The Beery Visual Motor Integration Test (VMI). The children were presented with a test booklet with three stimulus forms at the top of each page and corresponding blank spaces below. The task was to copy each form in the space below.

Task 3.
Description: Adaptation of Birch and Lefford's Visual Synthesis task (cf. Greenburg's Visual Construction). Twelve stimulus shapes were used to construct the test booklet. On the top of each page was a whole geometric form, and on the bottom half of each page were four groups of lines in mixed horizontal and vertical orientation. The task was to select the group of lines that would construct the shape at the top of the page.

Task 4.
Description: Adaptation of Greenburg's Visual Synthesis task. A test booklet similar in format to the Beery VMI (Task 2) was constructed. The stimuli were dissected, i.e., all component lines were separated but maintained the
orientation and relative positions of the original form. The task was to draw the figure that would be made by integrating the elements of the stimulus form.

Task 5.
Description: The Wepman Visual Memory Test. This test was adapted for group administration by placing the stimulus shapes on slides and giving each child a printed response booklet. Slides of stimulus forms were displayed for 3 seconds, then removed. The task was to match the stimulus shape, from memory, from among four alternatives.

Task 6.
Description: The Memory For Designs Test. This test was adapted for group administration by placing the stimulus shapes on slides. Each slide was displayed for 3 seconds, then removed. The task was to draw the shape from memory.

Task 7.
Description: Second variation of Greenburg's Visual Synthesis task. Dissected stimulus shapes, different from those used in Task 4, were displayed on slides for 3 seconds, then removed. The task was to select, from four alternatives,
the whole geometric shape that would be formed by integrating the segments.

**Task 8.**
Description: Third variation of Greenburg's Visual Synthesis task. Dissected stimulus forms, different from those used in Tasks 4 and 7, were displayed for 3 seconds, then removed. The task was to draw the figure that would be made by integrating the form segments.

**Task 9.**
Description: Jarman's Sequential Shapes. This is a recently constructed research instrument in which individual form segments are oriented on a line grid, and presented on slides in a temporal sequence. Each slide was presented for 3 seconds, and at the end of each series (elements of one form) the screen was left blank. The task was to choose the integrated version of the stimulus form from among four response choices, also oriented on dot grids, in a printed response booklet.
Task 10.


Description: McDaniel's Successive Figures Task, adapted for motor response. This research instrument presents the elements of dissected forms in temporal sequence on film. Each segment remains exposed for three seconds, and after each series (elements of one form), the screen is left blank to allow response time. The task was to draw the figure that would be formed by the elements.

Procedure

The tasks were administered to small groups of six to ten children each. Testing sessions were 30 to 45 minutes in length, with three or four tasks administered in random order in each session. All tasks were administered and scored by the same person, a graduate student trained in test administration and with considerable experience in testing and conducting research in the schools. Testing was done "blind", i.e., without prior knowledge of the group to which a given child belonged, resulting in a mixed group of low and average readers in each administration session. All tasks were given within a three week
time period.

When a published test was used, the accompanying scoring criteria were the basis for evaluating test performance. For unpublished tests requiring a matching response, the test score was simply the number of correct responses. The unpublished tests requiring a motor response were scored on criteria adapted from the test manual from the Beery Visual Motor Integration test.
CHAPTER 5

RESULTS

Group Mean Differences

A 2 x 2 non-orthogonal analysis of covariance was performed on the data. Sex x reading group analysis of variance, covaried for CA and IQ, revealed no main effects for sex and no significant interactions for sex. The data were collapsed, therefore, across sex groups. Means and standard deviations for the raw data on each task are presented in Table 2. T-tests, covaried for CA and IQ, were then performed to obtain the adjusted means and significance levels presented in Table 3.

Those tasks that were shown to differentiate between the two groups at a significant level were Task 2 (Beery Visual Motor Integration Test), significant at the .005 level; and Task 3 (Birch & Lefford's Visual Synthesis task, cf. Greenburg's Visual Construction), Task 8 (Greenburg's Visual Synthesis), Task 9 (Jarman's Sequential Shapes), and Task 10 (McDaniel's Successive Figures), all significant at the .05 level. The other two versions of Greenburg's Visual Synthesis task (Tasks
<table>
<thead>
<tr>
<th>TASK</th>
<th>MAXIMUM POSSIBLE SCORE</th>
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<th>AVERAGE READING GROUP</th>
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</thead>
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<td>SD</td>
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</tr>
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<td>16.50</td>
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<td>3</td>
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<td>4</td>
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<td>11.30</td>
<td>3.44</td>
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<td>5</td>
<td>(16)</td>
<td>13.30</td>
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<td>(45)</td>
<td>40.90</td>
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</tr>
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<td>7</td>
<td>(16)</td>
<td>12.47</td>
<td>1.81</td>
</tr>
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<td>(13)</td>
<td>8.60</td>
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<td>9</td>
<td>(20)</td>
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</tr>
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<td>10</td>
<td>(26)</td>
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</tr>
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<td>TASK</td>
<td>LOW READING GROUP M</td>
<td>AVERAGE READING GROUP M</td>
<td>t value</td>
</tr>
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<td>---------------------</td>
<td>------------------------</td>
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<td>15.15</td>
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<td>5.66</td>
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<tr>
<td>10</td>
<td>12.64</td>
<td>15.39</td>
<td>7.32</td>
</tr>
</tbody>
</table>
those tasks which did not discriminate between groups at a significant level were Task 1 (Wepman Visual Discrimination Test), Task 5 (Wepman Visual Memory Test) and Task 6 (Memory For Designs).

**Task Intercorrelations**

The correlations among the 10 tasks for each reading group are presented in Table 4. Correlations among the classification variables and tasks are presented in Table 5.

Correlational patterns were examined for each group to determine relationships among task performances, particularly between those tasks that had been shown to discriminate significantly between the two groups. With few exceptions, the correlational patterns that emerged were different in each of the two groups, with correlations among the tasks in the average group being consistently higher than the correlations in the below average group. In the low group, the highest correlation was between Tasks 4 and 8 (.53). Task 8 showed the highest number of significant correlations with other tests in the low reading group. In the average group, the highest correlations were between Tasks 6 and 8 (.62) and between Tasks
### TABLE 4
**TASK INTERCORRELATIONS**

<table>
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<tr>
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<td>.33*</td>
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<td>.31*</td>
<td>.31*</td>
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<td>.15</td>
<td>.08</td>
<td>.45**</td>
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<td>.05</td>
<td>.45**</td>
<td>.33*</td>
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<td>.31*</td>
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<td>.04</td>
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<td>.11</td>
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<td>.04</td>
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<td>.34*</td>
<td>.25</td>
<td>.30*</td>
<td>.33*</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Average reading group above the diagonal; below average reading group below the diagonal.

*significant at the .05 level.
**significant at the .01 level.
### TABLE 5
CORRELATIONS AMONG CLASSIFICATION VARIABLES AND TASKS*

<table>
<thead>
<tr>
<th></th>
<th>LOW READING GROUP</th>
<th></th>
<th>AVERAGE READING GROUP</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CA</td>
<td>READ</td>
<td>IQ</td>
<td>CA</td>
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<td></td>
<td>.02</td>
</tr>
<tr>
<td>READ</td>
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<td></td>
</tr>
<tr>
<td>IQ</td>
<td>-.39**</td>
<td>.06</td>
<td></td>
<td>.15</td>
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<td>TASK 1</td>
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<td>10</td>
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<td>.20</td>
<td>.07</td>
<td>.12</td>
</tr>
</tbody>
</table>

*significant at the .05 level.

**significant at the .01 level.
8 and 10 (.61). Tasks 6, 8 and 10 showed the highest number of significant correlations with the other tasks in the average group.

An examination of correlations among those tasks shown to discriminate significantly between groups, revealed that Task 2 (Beery Visual Motor Integration) was not highly correlated with Task 3 (Birch & Lefford's Visual Synthesis task), but was significantly correlated with Task 9, (Jarman's Sequential Shapes), and, in the average reading group, with Task 8 (Greenburg's Visual Synthesis) and with Task 10 (McDaniel's Successive Figures). Among the four segregated forms tasks that were shown to discriminate between groups at a significant level, correlations between Task 3 and the two temporal sequence tasks (9 and 10) were surprisingly low, with only the value between Task 3 and Task 10 in the average group reaching significance (.32). Task 8, however, showed significant correlations with Tasks 3, 9 and 10 in both groups. Correlations between the two temporal sequence tasks (9 and 10) were significant at the .05 level in the low reading group, and at the .01 level in the average group.

Correlational values among classification variables
are probably spuriously low due to the restriction of range within the sample on these three variables. For example the correlation between CA and reading achievement is only .02 in each group, smaller than could be expected in a sample with a wider range. An exception is the relatively strong negative correlation between CA and IQ in the low reading group (−.39). Another characteristic of the low reading group is the pattern of negative correlations between reading achievement and task performance observed on the first five tasks suggesting that this group scored higher on these tasks than their reading scores would indicate probable. The low readers may have progressed developmentally to the point where they could successfully deal with the less complex demands of these five tasks, but not with the more complex demands of the last five tasks.

Two main features emerge in the examination of Table 4. First the correlational patterns are different for the two reading groups, as they were in the task intercorrelation matrix. Secondly, the overall correlational values of classification variables and tasks are higher for the low-reading group than for the average reading group, the reverse of the pattern revealed in the task intercorrelation matrix.
Principal Components Analysis

Exploratory principal components analysis for the 10-task correlational matrix was performed for each group, with a criterion of eigenvalues greater than 1.0 given for factor extraction. The resulting factors were then rotated by Varimax to yield the matrices presented in Table 6. Interpretation of the factor loadings must be tentative because of the small size of each group (n=40).

Below average readers. Four factors emerged in this group. Examination of the parameters of tasks loading on each of the factors indicated that the factors represented parameter-specific performance. For example, the three tasks loading on Factor 1 were Task 3, Birch and Lefford's Visual Synthesis, Task 4, Greenburg's Visual Synthesis, and Task 8, the third variation of Greenburg's Visual Synthesis. These tasks share the same type of stimulus, i.e., segregated forms, but diverge on method of presentation (contemporaneous, memory) and response mode (recognition, reproduction). Factor 1 would appear to represent the performance on tasks with segregated stimulus forms. Interestingly, Tasks 3 and 8 were shown to be powerful discriminators between the two groups, and
### TABLE 6
PRINCIPAL COMPONENTS WITH VARIMAX ROTATION

<table>
<thead>
<tr>
<th>TASK</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
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<td>10</td>
<td>136</td>
<td>299</td>
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<td>285</td>
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</table>

% Component Variance 20.85 19.90 14.72 13.49

### AVERAGE READING GROUP

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<tr>
<th>TASK</th>
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<th>II</th>
<th>III</th>
</tr>
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% Component Variance 26.05 18.52 20.62
Task 4 approached significance.

The three tasks loading on Factor 2 were task 1, the Wepman Visual Discrimination Test, Task 5, the Wepman Visual Memory Test, and Task 9, Jarman's Sequential Shapes. These tasks share a response parameter, i.e., recognition response, but diverge on stimulus type (whole, segregated), and method of stimulus presentation (contemporaneous, memory, temporal sequence). Factor 2 appears to represent the recognition response.

Task 6, the Memory for Designs Test and Task 10, McDaniel's Successive Figures task, loaded on Factor 3. These two tasks share a reproduction (motor) response, but diverge across stimulus type and method of stimulus presentation. Factor 3 appears to represent the motor response.

Factor 4 was made up of the remaining two tasks (2 and 7) that shared no common parameter.

Average Readers. Three factors emerged in this group. Five tasks (i.e., Tasks 3, 5, 6, 9 and 10), representing diverse task parameters, and including both temporal integration tasks (9 and 10), loaded on Factor 1. This cross-parameter loading suggests that Factor 1 represents a process independent of the specific parameters of the
tasks, that underlies performance on the different task variations. Factor 1 could be described as representing a process that is not dependent on specific task parameters for its performance.

Factors 2 and 3 could be interpreted on the basis of task parameters. However, in each case, tasks loading on the factors shared not one, but two task parameters with the exception of Task 7, which had split loadings between Factors 2 and 3. Factor 2 had its main loadings from Tasks 1 and 2. Both tasks share the same stimulus type (whole form) and the same method of stimulus presentation (contemporaneous). They differ only across response parameters (recognition, reproduction). Factor 2 appears to represent the recognition and reproduction of whole, contemporaneously-presented stimulus forms. Tasks 4 and 8, both segregated stimulus tasks requiring a motor response, loaded on Factor 3. The tasks diverged on the memory - non-memory parameter. Factor 3 appears to represent a motor response to segregated stimulus form.

The main characteristic emerging from the principal components analysis is the different patterns of factor loadings between the two groups. Factors emerging in the low reading group appears to represent parameter-specific
performance, while in the average group, Factor 1, at least, appeared to represent a process independent of task parameters.
Discussion

In addressing the initial research question posed in the study, it is seen that certain categories of visual perceptual and perceptual motor tasks differentiated average and below average readers more effectively than other categories, but that no single parameter emerged as uniquely important in this respect. The form copying task was shown to discriminate between reading groups at a highly significant level. Visual synthesis and temporal sequence tasks, using both recognition and motor response formats, were also shown to discriminate at a significant level.

The finding that form copying (Task 2) was powerful in differentiating between reading achievement groups is consonant with earlier studies (DeHirsch, Jansky & Langford, 1966; Koppitz, 1963). The visual discrimination task (Task 1), however, was not shown to be a powerful discriminator between the groups. These tasks both involved the presentation of whole forms contemporaneously with response, and it is probable that the difference in
significance is due to the parameter across which they diverged, i.e., the motor response. The segregated forms and temporal sequence tasks that were found to differentiate significantly between the groups (Tasks 3, 8, 9 and 10) also diverged across the response parameter. However, unlike Tasks 1 and 2, the motor response in segregated form tasks did not appear consistently to increase the level of significance of the task. Birch and Lefford's visual synthesis task (Task 3) was not correlated significantly with form copying, a finding comparable to Birch and Lefford's (1967) results, in which visual synthesis was found to have only a weak association with motor functioning. However, the form copying task was significantly correlated to Greenburg's Visual Synthesis task and to both versions of the temporal sequence tasks in the average group. This apparent contradiction may be at least partly explained by the observed independence of the discriminatory power of visual synthesis tasks from the motor parameter. It can therefore be concluded that while the motor response adds significantly to the discriminatory power of tasks using whole, contemporaneously presented visual stimuli, its importance diminishes in segregated form and temporal
sequence tasks.

Conclusions regarding the significance of parameters in discriminating between groups could be drawn in either a task-specific or a central processing context. A task-specific interpretation might posit, as some tasks were shown to be significant discriminators between groups and others were not, that certain task parameters are indeed more important than others, and that the difference between reading groups in this particular study was not wide enough for the pattern to emerge distinctly. The differential significance of similar segregated forms tasks, with some reaching significance and others not; the relatively inconclusive emergence of factors in the principal components analysis, and the cross-factor loadings of several tasks suggest the possibility that a pattern could be more clearly delineated by the use of more disparate sample groups. However, the potential of a parameter-specific orientation for generating hypotheses about the underlying nature of this pattern is somewhat limited.

A central process interpretation would suggest, as no task parameter was uniquely important in differentiating between groups, that a single process underlies numerous
variations of visual perceptual and perceptual motor tasks. This position would be supported by the findings of Greenburg (1972) and McDaniel (1972), who both found that a basic visual perceptual process was responsible for performance on a variety of tasks. However, neither author explored tasks with a motor component. In the present study, the wide variety of tasks suggests that the interpretation of this single process might be pursued more appropriately in the context of central processes, rather than specific visual or perceptual processes.

If the central process interpretation is adopted, the question remains of how to explain the differential significance of certain tasks. The differences could simply be idiosyncratic to particular tasks. That is, specific characteristics of individual tasks may tap extraneous abilities or skills, or otherwise confound the pure measurement of the underlying process. Alternately, the differences could be due to the characteristics of certain categories of tasks. That is, tasks that not only differentiate powerfully between groups, but also intercorrelate significantly with each other, could be construed as particularly robust with respect to the measurement of a central process. For example, Tasks 2, 8, 9 and 10 were shown to be powerful discriminators.
and to intercorrelate significantly in the average group, even though they varied across every parameter included in the study. This suggests that the task variations are measuring different aspects of the same underlying process, an observation which is consonant with the Luria-Das central processing theory (Das, Kirby and Jarman, 1975), in which the process would be identified as simultaneous synthesis. The balance of the tasks, i.e., those that were not found to be powerful discriminators between groups (Tasks 1, 4, 5 and 7), generally showed lower overall correlations with other tasks, suggesting the dominance of task-specific characteristics over central process measurement in these tasks. An exception to this pattern was Task 6.

This discussion relates directly to the second research question posed in the study, i.e., whether cognitive processes used in performance of the tasks differ between the groups. Disparate task intercorrelation matrices and factor analytic results between groups suggest that different patterns of cognitive processes were used in the performance of the tasks by the two reading groups. The temporal sequence tasks appeared to have particular significance in the performance of the average group, while visual synthesis and, to a lesser extent,
temporal sequence tasks, appeared significant within the low reading group. The average readers tended to use a similar process across a variety of tasks, while the low readers tended to be influenced more strongly by the specific demands of a given task.

In the average reading group, a relatively high number of significant task intercorrelations suggest that a similar process was used across the tasks. This observation is supported by the cross-parameter loadings of five tasks on Factor 1 in the principal components analysis for the average group. It could be suggested that average readers possess a facility in this process that enables them to perform a variety of diverse tasks ranging from visual-perceptual through perceptual motor integration and temporal sequencing to complex cognitive tasks, such as reading, with a similar degree of success. Their performance could be described as "process-dominant", characterized by a high degree of generalizability among tasks and consistently high rates of success. The loading of both temporal sequencing tasks on Factor 1 in the average group suggests that tasks of this type may be especially useful in the measurement of central process ability. This is supported by the high number of significant task inter-
correlations shown by the temporal sequence tasks, especially Task 10.

In the low reading group, relatively few significant task intercorrelations suggest that different processes were used by this group across task variations. This is supported by the factor loadings in the principal components analysis for the low reading group, which suggests that task-specific demands appear to become dominant over the central process function in this group. The group could be described as "stimulus-bound", that is, responding to each task in a way defined by the parameters specific to that particular task, and characterized by a lack of the facility, displayed by the average reading group, of applying general principles to the performance of diverse tasks ranging from visual perceptual to complex cognitive tasks. This facility in the performance of tasks varying in type of demand and in levels of complexity could be interpreted within the context of human abilities (Jensen, 1970) or, more recently, within the context of strategies (Jarman, 1978c).

The loadings of three visual synthesis tasks that defined Factor 1 in the low reading group suggest that visual synthesis tasks may be particularly robust in
the measurement of central processing ability with this group. This is supported by the high number of significant task intercorrelations for Task 8 (Visual Synthesis), in the low reading group. Also, the significant correlation of chronological age with Tasks 8 and 10 (Successive Figures) suggest that visual synthesis and temporal sequencing may be more closely associated with maturational factors in low readers than in average readers.

It is seen, then, that the shift from the dominance of task-specific demands to the dominance of central process functioning in task performance is concurrent with the change in level of reading achievement of the two groups. Some current theories about the relationship of perceptual motor integration, central processing and reading performance provide an interpretive context for this observation.

Leong (1976b) similarly found different "structures", or patterns of performance, shown by disabled and non-disabled readers. His results showed disabled readers to be deficient in the use of "strategies", i.e., the understanding and use of rules, in solving tasks antecedent to reading. Cummins and Das (1977), discussing reading ability within the context of the Simultaneous and
Successive synthesis model, suggest that methods of information processing are differentially important in reading depending on both the subject's reading ability and the specifics of the task, thus viewing the observed differences between reading groups as due to the patterning and level of efficiency of central processes.

Cummins and Das (1977) also suggest viewing reading disability as one aspect of a more pervasive sequencing deficit. Other authors (Doehring, 1968; Bakker, 1972) have also noted the importance of sequencing ability, or temporal order processing, in the reading process. These observations are consonant with the findings in the present study that average readers tended to perform better on the temporal sequence tasks than the low readers. Temporal sequencing also emerged in the present study as a significant measure of central process functioning in the average group, with Task 10 (McDaniel's Successive Figures) showing significant correlations with eight of the other tasks in the study. McDaniel (1972) similarly found that the Successive Figures task almost always showed significant correlations with the other tests in his visual perceptual battery,
and consistently loaded on Factor 1 in his study.

The pattern of lower overall task intercorrelations in the low reading group has been described as suggesting the dominance of task-specific demands over a single process in performance of the tasks by this group. An exception to the pattern was Task 8 (Visual-Synthesis), which showed a number of significant correlations with other tasks. It is interesting to note that the correlation between chronological age and performance on Task 8 and Task 10 (Successive Figures) accounted for the only significant correlations between classification variables and task performance, and occurred only in the low reading group. These observations suggest that visual synthesis and, to a lesser extent, temporal sequencing tasks, may be especially important in assessing central process functioning in below average readers.

Within a neuropsychological context, the interaction between visual synthesis, temporal sequencing, and reading could be interpreted as related to the function of the cortical zone influencing intra-sensory and inter-sensory integration, shown by Luria (1973) to affect visual perceptual, spatial, temporal sequencing and language abilities. Satz and associates (Satz & Sparrow, 1970; Satz, Taylor, Friel & Fletcher, in press; Satz & Van Nostrand, 1973) have postulated that a maturational lag
in the development of the cerebral cortex is responsible for impaired performance in these areas. The significant difference in form copying ability between the low and average readers at the age level represented in this study (grade three) contradicts the suggestion by Satz, et al. (in press) that poor readers catch up to their average counterparts in perceptual motor ability by grade three. The correlation between chronological age and visual synthesis ability in the low reading group does, however, suggest some relationship between maturation and task performance in this group.

The memory parameter, per se, did not emerge as a significant discriminator between groups, suggesting that a hierarchical interpretation of group differences based on Jensen's (1970) theory is inappropriate. Differences in correlational and factor analytic patterns between the two achievement groups are, however, consonant with the central process research of Das and colleagues (Cummins & Das, 1977; Das, Kirby & Jarman, 1975; Jarman & Das, 1977; Kirby & Das, 1977) who conceptualize the differences in terms of different patterns of cognitive processes.
The results of the present investigation strongly suggest the potential usefulness of visual synthesis and temporal sequence tasks in both theoretical and applied contexts. In research, the tasks could be appropriately used in further investigation of the complex processes underlying the ability commonly referred to as perceptual motor integration, and in studies of visual perceptual and cognitive processes. The implications of the tasks for clinical and educational diagnosis may also be important. The significance of visual synthesis and temporal sequence tasks in the concurrent evaluation of reading difficulties and central process functioning is suggested by the results of the present investigation. However, the predictive efficacy of the tasks cannot be determined from the present data. Nonetheless, the ability of the tasks to discriminate between average and below average readers, and the significant correlations of form copying ability to visual synthesis and temporal integration tasks, suggest that the latter tasks may also be good predictors of reading achievement.

Limitations

The interpretation of these results must take into consideration certain limitations of the study.
Sample size (n=40 in each group) did not allow a definitive principal components analysis, with resulting conclusions about the nature of differing processes between the two groups being tentative, at best. In sample selection, the criteria for identifying low and average readers may have been more appropriately based on subtest scores of the Gaites MacGinitie test, or, on an examination of target population percentile ranks, instead of the published test norms. Mean IQ's closer to 100 would have increased generalizability. No controls for socio-economic status and cultural background were used, although those children who could not score within the Low Average range on the Peabody Picture Vocabulary Test were excluded, indicating some degree of functional homogeneity in oral language among the subjects.

Aside from sampling considerations, problems attendant upon the construction of new research instruments, such as reliability of the measures, must be addressed as a limitation on interpretation of results. Means and standard deviations, however, suggested that the newly constructed instruments had an appropriate level of difficulty for the population represented by this sample.
Suggestions for Further Research

The results of this exploratory investigation suggest that further study of the problem is warranted. The present wide application of perceptual motor integration tasks suggests similarly extensive implications for future research. The emergence of visual synthesis and temporal sequence tasks as significant discriminators between subject groups not only has immediate implications for research, but also long range significance for clinical and educational practice.

Future studies could be conceived along lines similar to the present study, but rendered more powerful by increasing sample size, and controlling extraneous variables more stringently. Studies could be structured to include children of the same age, as in the present investigation; a cross-section of ages, as in Birch and Lefford's (1967) study, or, most powerfully, a longitudinal study allowing a full investigation of processes as they emerge in the developing child.

Comprehensive, systematic investigation of the processes involved in the performance of variations of visual perceptual and perceptual motor tasks should serve to enhance our understanding of cognitive
functioning in general, and contribute to the inception of new directions in research.
REFERENCES


Birch, H. G. & Lefford, A.  *Visual differentiation, inter-
sensory integration, and voluntary motor control.


McDaniel, E. *The Purdue motion picture tests of visual perception*. In L. J. Cronbach & P. J. Drenth (Eds.),


appraisal of a current theory (in press).


APPENDIX A

Examples of Items from each Task
TASK 1
WEPMAN VISUAL DISCRIMINATION
TASK 2
BEERY VISUAL MOTOR INTEGRATION
TASK 3
BIRCH AND LEFFORD'S VISUAL SYNTHESIS
(Modified)
**TASK 4**

**GREENBURG'S VISUAL SYNTHESIS**

(Modified)

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TASK 5
WEPMAN VISUAL MEMORY TEST
(Modified)

SLIDE:

RESPONSE:
TASK 6
MEMORY FOR DESIGNS
(Modified)

SLIDE:

RESPONSE:
TASK 7
GREENBURG'S VISUAL SYNTHESIS
(Modified)

SLIDE:

RESPONSE:
TASK 8
GREENBURG'S VISUAL SYNTHESIS
(Modified)

SLIDE:

RESPONSE:
TASK 9
JARMAN'S SEQUENTIAL SHAPES

SLIDE 1

SLIDE 2

RESPONSE:
TASK 10
McDANIEL'S SUCCESSIVE FIGURES
(Modified)

FILM:

First Element

Second Element

RESPONSE: