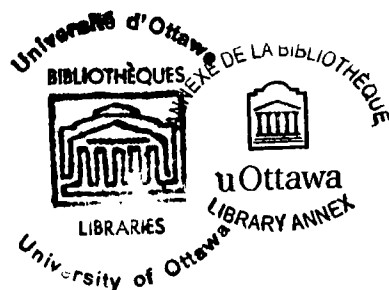


HYPERKINESIS - A THEORETICAL AND  
EXPERIMENTAL STUDY

by

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Thesis submitted to the School of  
Graduate Studies as partial fulfilment  
of the requirements for the degree of  
Ph.D. in Education



UNIVERSITY OF OTTAWA  
OTTAWA, CANADA, 1974

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## ACKNOWLEDGEMENTS

I wish to express my deep appreciation to my director, Dr. André D. Côté, Faculty of Education of the University of Ottawa, for his guidance, understanding, and supervision of this research.

The writer is also indebted to Drs. Jean-Marie Beniskos, and Martin Cooper, Faculty of Education, University of Ottawa, and to Dr. Yvon D. Lapierre, Faculty of Medicine, University of Ottawa, for their constructive suggestions and criticisms.

The writer is grateful to the staff of Hôpital Pierre Janet, Hull, Quebec, and especially to Mr. André Blanchard, for his technical assistance.

Finally, to my wife Patricia, my daughter Andreana, and my parents, I express my sincere appreciation for their many sacrifices over the past two years that made the work possible.

## TABLE OF CONTENTS

|                                                                       | page |
|-----------------------------------------------------------------------|------|
| ACKNOWLEDGEMENTS . . . . .                                            | ii   |
| TABLE OF CONTENTS . . . . .                                           | iii  |
| LIST OF TABLES . . . . .                                              | v    |
| LIST OF FIGURES . . . . .                                             | vi   |
| ABSTRACT . . . . .                                                    | vii  |
| <br>Chapter                                                           |      |
| I.- THE HYPERKINETIC SYNDROME . . . . .                               | 1    |
| Overview                                                              | 2    |
| Hyperkinesis - Definition in the Literature                           | 3    |
| Characteristic Dysfunctions Associated with<br>Hyperkinesis           | 6    |
| Etiology of Hyperkinesis                                              | 12   |
| Rationale of the Present Study                                        | 15   |
| Summary                                                               | 19   |
| II.- FUNCTIONAL MATURATIONAL ORIENTATION OF<br>HYPERKINESIS . . . . . | 20   |
| The Neurobiochemical Research on Hyperkinesis                         | 21   |
| The Neurophysiological Research on Hyper-<br>Kinesis                  | 25   |
| Luria's Model                                                         | 30   |
| Review of Research on Stimulus Integration                            | 34   |
| The Present Investigation                                             | 39   |
| Summary                                                               | 41   |
| III.- ASSESSMENT OF STIMULUS INTEGRATION . . . . .                    | 42   |
| Methodology of Assessment                                             | 42   |
| Rationale of Perceptual Measures                                      | 43   |
| Summary                                                               | 48   |

| Chapter                                        | page |
|------------------------------------------------|------|
| IV.- SAMPLE, INSTRUMENTS, AND DESIGN . . . . . | 49   |
| Sample                                         | 49   |
| Instruments                                    | 51   |
| Procedure                                      | 56   |
| Design                                         | 56   |
| Summary                                        | 61   |
| V.- STATISTICAL ANALYSIS AND RESULTS . . . . . | 63   |
| Analysis of Data - Part I                      | 63   |
| Summary                                        | 67   |
| Analysis of Data - Part II                     | 69   |
| Summary                                        | 88   |
| VI.- CONCLUSIONS AND IMPLICATIONS. . . . .     | 89   |
| Conclusions                                    | 89   |
| Theoretical and Educational Implications       | 90   |
| Further Research Implications                  | 94   |
| Summary                                        | 95   |
| REFERENCES . . . . .                           | 97   |
| APPENDICES . . . . .                           | 121  |

## LIST OF TABLES

| Table                                                                                                                  | page |
|------------------------------------------------------------------------------------------------------------------------|------|
| 1.- Sequences and Combinations of Stimuli<br>of the HPJSK . . . . .                                                    | 55   |
| 2.- Multivariate Results of Analysis of<br>Variance with the Three ITPA Scores as<br>Dependent Variables . . . . .     | 65   |
| 3.- 95% Simultaneous Confidence Limits for<br>Simple Contrasts Between Means of Degrees<br>of Hyperkinesis . . . . .   | 68   |
| 4.- Results of Analysis of Variance of HPJSK<br>Scores for Visual and Auditory Stimuli<br>Combinations . . . . .       | 71   |
| 5.- Results of Analysis of Variance of HPJSK<br>Scores for Auditory and Tactile Stimuli<br>Combinations . . . . .      | 73   |
| 6.- Results of Analysis of Variance of HPJSK<br>Scores for Visual and Tactile Stimuli<br>Combinations . . . . .        | 75   |
| 7.- Results of Analysis of Variance of HPJSK<br>Scores for Visual-Auditory-Tactile Stimuli<br>Combinations . . . . .   | 77   |
| 8.- Scheffé's Contrast of Successive and<br>Simultaneous Modality Means Within Each<br>Level of Hyperkinesis . . . . . | 80   |
| 9.- Scheffé's Contrast of Means for Successive<br>and Simultaneous Modality Stimuli Presen-<br>tation . . . . .        | 81   |

## LIST OF FIGURES

| Figure                                                                                                                                                        | page |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1.- Experimental Design for Intrасensory<br>Evaluation . . . . .                                                                                              | 58   |
| 2.- Experimental Design for Intersensory<br>Evaluation . . . . .                                                                                              | 60   |
| 3.- Illustration of Interaction Between Degrees<br>of Hyperkinesis and Modality Presentation<br>Within Visual and Auditory Stimuli<br>Combinations . . . . .  | 83   |
| 4.- Illustration of Interaction Between Degrees<br>of Hyperkinesis and Modality Presentation<br>Within Auditory and Tactile Stimuli<br>Combinations . . . . . | 84   |
| 5.- Illustration of Interaction Between Degrees<br>of Hyperkinesis and Modality Presentations<br>Within Visual and Tactile Stimuli<br>Combinations . . . . .  | 86   |

## ABSTRACT

The present study compared the performance of 32 hyperkinetic children with a sample of 11 normal children on several perceptual measures. The instruments of assessment included clinical examinations, the Illinois Test of Psycholinguistic Ability, and the Hôpital Pierre Janet Stimulus Kit.

Hyperkinetic children were selected from the out-patient Children's Clinic of Hôpital Pierre Janet. The clinical diagnosis of hyperkinesis was established by three child psychiatrists in a series of independent examinations prior to the children's inclusion in the study. Then, by means of David's rating scale, they were grouped in clusters of high, medium and low degrees of hyperkinesis. Hyperkinetic and normal children were also grouped in three chronological age levels.

Significant intrasensory differences were found among degrees of hyperkinesis. That is, hyperkinetic children who demonstrated a marked degree of hyperkinesis, differed significantly from children who manifested a lesser degree of hyperkinetic behavior in the reception and processing of tactile stimuli. No significant differences were found between hyperkinetic and normal children in the ability to receive and process monosensory stimuli of a visual and auditory nature.

Significant intersensory integration differences were found between degrees of hyperkinesis and modality presentation. That is, a successive modality presentation in a bisensory or trisensory stimuli combination failed to discriminate between the perceptual functioning of hyperkinetic children and that of normal children. However, simultaneous stimuli presentation in either bisensory or trisensory stimuli combinations significantly discriminated between the performance of hyperkinetic and normal children. The results supported Luria's theory of a functional maturational disturbance being an explanation of hyperkinesis. Theoretical and practical educational implications of the functional maturational disturbance explanation of hyperkinetic behavior were discussed, and suggestions were made for future research.

## CHAPTER I

### The Hyperkinetic Syndrome

Educators and clinicians have long been challenged by the behavior of the hyperkinetic child and by the etiology of the hyperkinetic syndrome (Clements and Peters, 1962; Clements, 1966). A century ago a German physician, Heinrich Hoffman, described the "restless" child, whose behavior appears to be similar to that of the present day "hyperkinetic" child (Stewart, 1970, p. 94).

Fidgety Phil  
He won't sit still;  
He wriggles,  
And giggles...

And at the dinner table when his father admonishes him it results only in

The naughty restless child  
Growing still more rude and wild.

More recent accounts indicate that hyperkinetic (HK) children are still with us and that they make up as much as 5-10% of the elementary school population (Stewart, Pitts, Craig, and Dieruf, 1966; Werry, 1968a). The behavioristic approach to the treatment of HK children has been amply documented (Bandura, 1969; Patterson, 1965; Patterson, Cobb, and Ray, 1972; Patterson, Jones, Whitter, and Wright, 1965). However, little attention has been given to the physiological perspective of the etiology of hyperkinesis. One of the chief

proponents of the physiological explanation of hyperkinesis is Luria (1966a) who stresses the importance of the interaction between the maturing system and its environment. Luria concludes that dysmaturation is evidenced in the faulty stimulus processing of the HK child.

The present study, based on a multivariate paradigm and employing a theoretical rationale developed from the work of Luria, (a) describes and identifies the HK syndrome; (b) clarifies the global etiology of hyperkinesis; and, (c) considers the psychological and educational significance of quantitative and qualitative differences between HK and normal children.

It is hoped that the findings presented will distinguish the differences between HK and normal children, will provide educators with theoretical and practical information on the learning problems of HK children, and will result in the educational rehabilitation of HK children.

### Overview

Chapter I reviews the definition of the term "hyperkinetic syndrome", and discusses and specifies the etiology of hyperkinesis as being (a) minimal brain damage, and/or (b) a functional maturational disturbance. The latter view is endorsed in the current study.

Chapter II reviews the neurobiochemical and neurophysiological research on hyperkinesis as a functional

maturational disturbance. The chapter continues with the explanation of Luria's model and shows that the functional maturational disturbance manifests itself in the perception and processing of sensory stimuli. The research on intra-sensory and intersensory stimuli integration is reviewed in the light of the present investigation's general hypotheses and objectives.

Chapter III explains the methodology and rationale of the perceptual measures.

Chapter IV discusses and explains the sample, measures, procedure, and treatment of statistical data.

Chapter V reports and interprets the statistical results.

Chapter VI summarizes the results reported in Chapter V and discusses theoretical and practical educational modifications.

#### Hyperkinesis — Definition in the Literature

The term "hyperactivity" appears frequently in the literature with a bewildering variety of meanings. The term has been used to describe a characteristic feature of young normal children. It has also been used to refer to the dominant symptom in such neuropathological conditions as encephalitis (Kahn and Cohen, 1934), cerebral palsy (Denhoff, 1964), epilepsy (Ounsted, 1955), anoxia (Rosenfeld and Bradley, 1948), and mental retardation

(Cromwell, Baumeister, and Hawkins, 1963; Luria, 1963). But, as employed in the present study, the term identifies a distinct behavioral syndrome in children who exhibit supranormal levels of activity without evidence of neural pathology or brain injury. The definition covering that use appears in the American Psychiatric Association Diagnostic and Statistical Manual of Mental Disorders (1968, p. 50).

A number of authors (Burks, 1960; Eisenberg, 1966; Laufer, Denhoff, and Solomons, 1957; Werry, Weiss, and Douglas, 1964) have described syndromes in which hyperactivity is the core symptom, accompanied by such behavior traits as inability to concentrate for more than a few minutes, impulsive speech and action, continuous movement, impatience, and emotional instability. But wide disagreement exists among clinicians over the terms used to designate the hyperactive syndrome itself. Some, in the past, used the term "brain-damage" to designate the hyperactive syndrome (Strauss and Lehtinen, 1947). To-day, clinicians no longer accept this term "brain-damage" for the hyperkinetic syndrome; hyperactivity is now regarded simply as one of the symptoms of cerebral damage. The term "brain-damage" itself implies that brain abnormalities have been demonstrated to exist, which is not necessarily the case with hyperactivity.

The term "minimal brain dysfunction" avoids the connotation that brain damage has actually been diagnosed. It encompasses a wide variety of behavior and learning disorders in children who are functioning within or above the mean range of intelligence and who do not have major detectable brain damage or a history of severe environmental deprivation (Clements, 1966; Clements and Peters, 1962; Stevens, D.A., Boydstun, Dykman, Peters, and Sinton, 1967,; Wender, 1971). Other investigators have coined diagnostic terms based on the syndrome's most frequently reported characteristic, namely, hyperactivity. These writers refer variously to the "hyperkinetic syndrome", (Burks, 1960; Eisenberg, 1966; Millichap and Boldrey, 1967), "hyperkinetic impulse disorder" (Laufer and Denhoff, 1957), and "hyperactive syndrome" (Stewart et al., 1966; Werry et al., 1964).

It is evident that very little homogeneity exists among researchers regarding a definite appellation of the syndrome. The term employed throughout the present work was "the hyperkinetic syndrome", the reason for the choice being that hyperactivity is usually the main and most evident symptom. The term "hyperkinetic syndrome" encompasses not only the amount of activity but also other behavioral, physiological, and pharmacological correlates that may possibly differentiate hyperkinetic (HK) children from normal children.

The review of the literature on hyperkinesis included not only those studies in which children were actually diagnosed as HK; it also considered highly relevant studies of children who fit the criteria used to identify HK children in the present study but who had not been adjudged to be HK by previous researchers since they did not exhibit an abnormal degree of motor behavior. Nevertheless, despite differences in terminology, descriptions of the main characteristic dysfunctions contain many similarities.

#### Characteristic Dysfunctions Associated with Hyperkinesis

Until recently, the research dealing with the behavioral characteristics of the HK syndrome has focused on the symptoms, etiology, diagnosis, treatment, and deficiencies of HK children, without actually comparing them to an appropriate group of normal children. The following sections discuss some of the controlled experiments in which HK children were compared with an appropriate group of normal children on motor behavior (Douglas, Weiss, and Minde, 1969; Pope, 1970), impulsivity (Campbell, Douglas, and Morgenstern, 1969), attention (Cohen, 1970), and perception and cognition (Freiberg, 1965; Palkes, Stewart, and Kahana, 1968).

#### Motor Behavior

The HK child has been described as restless, unable to sit still, always on the go, and continually shifting

from one activity to another (Burks, 1960; Clements and Peters, 1962; Eisenberg, 1957; Laufer et al., 1957). It is still an open question, however, as to whether it is the quantitative (amount of activity) or the qualitative (direction of activity) aspect of activity that differentiates the HK child from his normal age mates. The fact that his activity appears to be inappropriate and exaggerated to the observer may very well contribute to the impression that he is excessively active (Buddenhagen and Sickler, 1969; Werry, 1968a). When the behavior of HK and normal children was observed and rated in the classroom (Douglas et al., 1969), the HK children were found to exhibit more non-purposive behavior that is not the classroom activity and more impulsive and disorderly behavior toward the teacher than did the normal children. Tests to measure activity level differentiated HK children and controls only in qualitative activity (Pope, 1970). Cromwell, Baumeister, and Hawkins (1963) have noted that a subject with a short attention span who alternates from one goal-directed task to another, may be considered by an observer to exhibit a greater amount of activity than a subject who displays the same amount of activity, but who concentrates on one task. Although chronic sustained activity is reported to be the main symptom of the HK child, the possibility must be considered that at least some of this excessive activity is due to his inability to sustain attention and his tendency to shift

attentional focus (Werry, 1968b), both of which are associated with impulsivity, another main dysfunction of the HK syndrome.

### Impulsivity

The HK child has been described as acting and speaking without sufficient forethought (Clements and Peters, 1962; Eisenberg, 1966; Laufer et al., 1957). Experimental evidence has supported the clinical descriptions of the HK child's impulsiveness in thought, as indicated in the child who dashes across the street without checking the traffic. Campbell et al. (1969) have shown that HK children exhibit a more impulsive cognitive style than do normal children of the same age and IQ. Palkes et al. (1968) found that performance by a group of HK boys on the Porteus Maze Test could be improved by training them to verbalize commands designed to diminish such impulsive work habits as crossing lines and cutting corners. Hyperkinetic children have also been shown to make a significantly greater number of random and anticipatory motor responses than normal children on a continuous performance task (Sykes, Douglas, and Morgenstern, 1969). When compared to a group of anxious (hypoactive) children, HKs were found to be less able to inhibit the magnitude of their voluntary response to a noxious stimulus (Connors and Greenfield, 1966).

Impulsivity as a dysfunction is characterized by a "decreased ability to inhibit" (Wender, 1971, p. 17). That

decreased ability leads to low frustration tolerance and anti-social behavior, including destructiveness, stealing, lying, and poor attention, each of which decreases the HK child's chances of adapting effectively to the school setting.

### Attention

Using tests to measure the ability to sustain attention, recent investigators have determined the existence of attention deficits in HK children. By means of visual and auditory continuous performance tasks, Cohen (1970) and Sykes et al. (1969) compared HK children and normal controls who had been matched for IQ. The HKs made more incorrect responses and showed a greater deterioration in their performance over a period of time. Hyperkinetic children have also been found to do less well than neurotic children on a rapid discrimination task (Eisenberg, Connors, and Sharpe, 1965). A limited attention span on a variety of tasks has also been observed in children who exhibit HK "symptoms" but who were diagnosed as having "minimal brain dysfunction" (Stevens, D. A., Boydstun, Ackerman, and Dykman, 1966; Stevens, D. A. et al., 1967) or learning disabilities (Dykman, Walls, Ackerman, and Peters, 1969).

Evidence suggests that one of the reasons the HK child responds incorrectly to a particular stimulus is that he is distracted by irrelevant stimuli. For example, Campbell et al. (1969) found that on the Children's Embedded Figures Test, HK children have more difficulty in excluding

background stimuli.

Freiberg (1965) noted a difference between HK and control subjects at the beginning of a concept formation task. They did not differ on criterion measures; however, on pre-criterion trials the mean proportion of errors was significantly higher for the HK than for the control subjects. Freiberg suggested that HKs formed a larger number of irrelevant hypotheses before hitting on the correct concept because they did not direct their attention systematically to "task-relevant" aspects of the stimulus situation. For example, the HK child spends a greater amount of time in "task-irrelevant" activities, such as handling the equipment and asking numerous questions, than does the normal control. The difficulty of HKs in directing their attention to task relatedness is further manifested in their perceptual and cognitive behavior.

### Perception and Cognition

It is generally agreed that HK children perform poorly in school even if they are of average intelligence (Burks, 1960; Clements and Peters, 1962; Laufer et al., 1957; Stewart et al., 1966). When compared with a group of normals of the same age and sex, HKs were found to have failed a significantly greater number of school grades and to have had significantly lower marks than normals in almost all academic subjects (Douglas et al., 1969). There is little agreement in the literature as to which subtests

reflect the HK's deficiencies. The only finding which appears to be consistent throughout a number of studies is that HKs show a greater amount of subtest variability than do controls (Clements and Peters, 1962; Douglas et al., 1969; Stevens, D. A. et al., 1966).

While attempting to delineate the problem areas which lead to academic difficulties, some investigators found deficits in HKs in specific learning abilities, most notably reading and arithmetic, as well as in visual-motor skills and general motor coordination (Burks, 1960; Clements, 1966; Clements and Peters, 1962; Douglas et al., 1969; Laufer et al., 1957). Only one of these investigators (Douglas et al., 1969) has actually compared HKs with a group of normal children matched on related variables, such as age, sex, IQ, in order to examine systematically the differences between these two groups on a battery of tests which purport to measure specific learning disabilities. The only significant deficits observed in the HK subjects became evident on tests measuring visual-motor and motor skills. Those tests were the Bender Visual-Motor Gestalt Test, the Goodenough Draw-a-Man Test, one subtest of the Frostig Developmental Test of Perception, and the Lincoln-Oseretsky Schedule of Motor Development.

Hyperkinetic children have also been described as being deficient in conceptual skills (Burks, 1960; Clements and Peters, 1962; Laufer et al., 1957). On a concept formation task, Freiberg and Douglas (1969) found no difference

between HKs and controls of the same age and IQ when continuous reinforcement was given. In addition, HKs were able to reverse hypotheses to transfer from one task to another. Only when a partial reinforcement schedule was employed did HKs do less well than controls. Those findings seem to indicate that the HK child is not deficient in conceptual skills although he may have attentional and motivational deficiencies.

It is difficult to determine whether problems of attention or whether "special learning problems" contribute more to the HK child's academic troubles, since either problem in itself would be sufficient to cause learning difficulties. In any event, academic retardation is almost always a hallmark of the HK syndrome. The etiological problem is compounded by the psychological consequences of early underachievement. A vicious circle is produced; poor performance generates criticism and poor self-image, both of which tend to decrease motivation.

The following section will elaborate on the multi-determinate etiology of the HK syndrome.

### Etiology of Hyperkinesis

Although no unanimity exists on the exact cause of hyperkinesis, some investigators maintain that brain damage underlies the HK symptomatology. In trying to identify factors in the histories of HK children which would indicate

neurological impairment, a number of authors have suggested the possibility of a higher incidence of prenatal and perinatal complications (Gross and Wilson, 1964; Laufer and Denhoff, 1957; Levy, 1959; Martin, 1967). Rosenfeld and Bradley (1948) have reported that HK behavior patterns appeared eight times more frequently in patients with a history of anoxia at birth than in a control group.

Pasamanick and Knoblock (1959) have hypothesized that there is a continuum of behavior disorders which are dependent on the location and extent of brain damage resulting from complications of pregnancy and premature and abnormal births, and that HK children fall somewhere within this continuum. However, other comparisons of the birth histories of HK and normal children have shown the incidence of such complications to be slight or non-existent (Minde, Webb, and Sykes, 1968; Stevens, J., Sachdev, and Millstein, 1968; Stewart et al., 1966; Werry et al., 1964).

Neurological examinations, such as the electroencephalogram (EEG) do not usually reveal the presence of conventional signs of brain damage (Satterfield, 1973). However, such minor or "soft" neurological signs as poor motor coordination and speech problems, have been observed clinically (Burks, 1960; Clements and Peters, 1962; Laufer et al., 1957; Satterfield, 1973). In three controlled studies (Stevens, J. et al., 1968; Stewart et al., 1966; Werry, Guzman, Weiss, Minde, and Douglas, 1965), it was

noted that hyperkinesis may also exist in children without the accompanying soft neurological signs. Some authors have reported a high incidence of borderline or abnormal EEG tracings in HK children (Burks, 1960; Clements and Peters, 1962; Laufer and Denhoff, 1957; Paine, 1962). The occurrence of mild dysrhythmias seem to be the most frequent finding in the tracings (Klinkerfuss, Lange, Weinberg, and O'Leary, 1965; Solomons, 1965; Werry et al., 1964). Additional irregularities such as abnormally slow frequency changes (Klinkerfuss et al., 1965; Stevens, J. et al., 1968), and paroxysmal discharge (Burks, 1960; Klinkerfuss et al., 1965; Stevens, J. et al., 1968) have been reported. Alternatively, other investigators (Laufer and Denhoff, 1957; Paine, 1962) have found no specificity in the EEG abnormalities. Moreover, the significance of these findings is not clear since the EEG abnormalities are frequently observed both in children with behavior problems (Taterka and Katz, 1955) and in normal children (Stewart et al., 1966; Werry et al., 1964). A careful review of literature indicated that the neurological evidence linking hyperkinesis to brain damage is largely inconclusive. Signs indicative of brain damage or at least suggestive of it are present in some HKs in whom organic involvement cannot be demonstrated. A few writers have agreed that hyperkinesis in these cases is simply a manifestation of anxiety or a reaction to environmental stress (Blau, 1954; Pond,

1961). Others have gone to the opposite extreme and proposed that a diagnosis of brain injury be made on the basis of the behavioral symptoms alone, even in the absence of any other evidence (Clements, 1966; Laufer et al., 1957; Levy, 1959; Strauss and Lehtinen, 1947). In more recent literature there is agreement that brain damage accompanied by definite loss of tissue accounts for only a minority of the cases of the HK syndrome (Gibbs, Gillen, and Gibbs, 1968; Millichap, 1972; Paine, Werry, Quay, 1968; Satterfield, 1973; Wender, 1971). Obviously much confusion exists among researchers in the field.

However, one point of agreement among many diagnosticians is that the HK syndrome is better understood from a psycho-physiological viewpoint than from within a conventional "psychodynamic" framework (Bradley, 1950; Buchsbaum and Wender, 1973; Burks, 1960; Chess, 1960; Clements, 1962; Ounsted, 1955; Sutherland, 1961; Weithorn, 1973; Wender, 1971).

#### Rationale of the Present Study

The present study approached the investigation of the etiology of hyperkinesis from a psycho-physiological perspective; that perspective postulates a maturational dysfunction in the central nervous system. Support for maturational dysfunction as an explanation of hyperkinesis is found in Werry's (1968a) observation of the disappearance

of the syndrome, except for residual social problems and learning disabilities, by the time the HK child reaches adolescence. Further support is provided by Buchsbaum and Wender, 1973, Omenn (1973), and Satterfield (1973). Satterfield showed that EEG anomalies detected in HK children tend to be fewer in those who are chronologically older. The study by Buchsbaum and Wender revealed that the average evoked responses in HK children were similar to those characteristic of relatively younger normal children. The fact that HK males far outnumber HK females seems to support the idea that physical maturation may be a factor in social maturation, since males are known to mature physically more slowly than females (Omenn, 1973). The hypothesis gains even further support from Werry's observation that the overall behavior of HKs is normal for an age range downward by four or five years.

On the basis of the foregoing, the maturational dysfunction of the central nervous system has been described conceptually in the literature as either a minimal brain dysfunction or as a functional maturational disturbance.

In studies done by Clements (1966) and Wender (1970) in which minimal brain dysfunction was accepted as an explanation of hyperkinesis, HK children were described as being of average, or above average general intelligence, and as having certain mild to severe learning or behavioral

disabilities which were associated with deviations of function of the central nervous system. These deviations may manifest themselves in various combinations of impairment in perception, conceptualization, language, control of attention, and impulse or motor function. According to Clements, those dysfunctions may result from genetic variations, biochemical irregularities, perinatal brain insults, or from illness or injury sustained during the critical years of development and maturation of the central nervous system.

The second view of the maturational explanation of hyperkinesis, namely functional maturational disturbance, postulates that the functions of the brain are hierarchically structured and that therefore the functioning of the higher mental systems requires both interconnection with highly differentiated cortical zones and the integrity of the whole brain itself (Luria, 1966b). Thus, functional maturational disturbance may be present in cortical zones as well as in the adaptive processes of the organism.

According to Luria, the terms "function" and "functional" refer to (a) what the part or organ does, and (b) the adaptation processes of the brain itself within the total context of the organism. Differences in localized functions between areas of the brain can be determined by present neurological and neuropsychological tests. But the adaptive roles of the brain are much more

difficult to describe. As Luria (1966a) says,

lesion of a single, circumscribed area of the cerebral cortex often leads to the development, not of an isolated symptom, but of a group of disturbances, apparently far removed from one another (p. 74).

Because higher mental functions often share common links, the impact of primary defects may result in disturbances of several different systems, manifested by seemingly unrelated symptoms. In other cases the higher function may simply be depressed, as evidenced by a weakening or inadequate mobility of the processes. If the cortical intercentral relationships differ at the various stages of development, then the effects of an immaturity will show specificity according to the subject's age level and degree of characteristic dysfunctions exhibited.

Let us briefly consider the implications of endorsing one hypothesis over the other. The criticism of the minimal brain dysfunction concept is that a complex syndrome and etiology are described in broad, non-specific terms. Because of the multideterminate etiology of hyperkinesis and the complexity of the syndrome, the minimal brain dysfunction view can only cause more confusion, anxiety, and despair in the minds of the clinician and the parents of HK children.

The more recent view (Buchsbaum and Wender, 1973; Luria, 1966a, 1966b; Satterfield, 1973; Weithorn, 1973) that hyperkinesis is caused by a functional maturational

disturbance in the central nervous system permits a more specific diagnosis and treatment. The second explanation offers challenge to the researcher, and hope to the child, parent, and educator.

It is suggested that the functional maturational disturbance hypothesis clarifies the multideterminate etiology of the HK syndrome by presenting a model which shows the far-reaching and varied effects of a localized immaturity in the total adaptive functioning of the organism. If such is the case, then Luria's concept of the brain as a hierarchically structured entity, having control over all behaviors, provides a useful framework for investigating the HK syndrome from etiological and behavioral perspectives.

#### Summary

The HK syndrome, its definition, characteristic dysfunctions, and etiology, were discussed. The psychophysiological perspective was endorsed as a framework for the present study. That perspective postulated a dysmaturation in the central nervous system. The concept of dysmaturation was explored on a twofold basis: (a) minimal brain dysfunction, and (b) functional maturational disturbance. The latter was accepted as the theoretical rationale for the present research.

## CHAPTER II

### Functional Maturational Orientation of Hyperkinesis

Two possible physiological explanations for the behavior of HK children were advanced in the discussion of the etiology of the HK syndrome. Both explanations postulate that the HK syndrome is due to a maturational disturbance in the central nervous system. Minimal brain dysfunction was rejected as an explanation of the etiology of hyperkinesis because it appeared to be confusing and non-specific. The second explanation, functional maturational disturbance, was accepted for the present research. It postulates that the brain is a hierarchically structured entity, highly differentiated, and intrinsically dependent on developmental and environmental interaction. Luria's position is more fully explored within the present chapter.

The objectives of the present chapter are as follows: (a) to review the neurobiochemical and neurophysiological research orientations to the functional maturational dysfunction interpretation of hyperkinesis; (b) to discuss Luria's model and to show that Luria's position provides a valid approach to the understanding of hyperkinesis; (c) to assess sensorial processing and stimulus integration; (d) and to state the hypotheses and

objectives of the current study.

### The Neurobiochemical Research on Hyperkinesia

The neurobiochemical approach postulates a relationship among the brain, behavior, and chemical substances in the brain. The earliest neurobiochemical research reported was that of Laufer et al. (1957) who attempted to test the thesis that dysfunction of the diencephalon is related to the HK syndrome. The nature of the diencephalic dysfunction is discussed later in the present chapter. Laufer et al. used the photo-Metrazol procedure of Gastaut (1950) and Gastaut and Hunter (1950). The technique consists of determining the threshold dose of pentyl-enetrazol (Metrazol) per mg/body weight required to obtain an EEG spikewave burst and myoclonic jerking of the forearms when the patient is stimulated visually by a stroboscope. When Laufer and his workers administered amphetamines to HK children and remeasured the photo-Metrazol thresholds, analysis showed that the amphetamines had increased the photo-Metrazol threshold of these children to a level characteristic of a normal group of subjects. According to Laufer et al., the effect of amphetamine in raising the photo-Metrazol threshold may indicate a pharmacological imbalance responsible for the diencephalic dysfunction.

Unfortunately, in the Laufer experiment, the effect of amphetamine on the non-HK children was not determined. Nor was any effort made to correlate changes in photo-Metrazol thresholds with changes in behavior, even for HK children. Thus the findings must remain inconclusive, although they are impressive in that they suggest a possible relationship between pharmacological imbalance, brain dysfunction, and the HK syndrome.

Further experiments on the behavioral effects of amphetamine have been done (Connors, 1966; Connors and Eisenberg, 1963; Connors and Rothschild (1968). However, none of these studies gives an acceptable explanation of why the HK child shows significant improvement in behavior when treated with amphetamines. Connors (1966) and Connors and Rothschild (1968) suggested that the drug action in the HK child is not a pharmacologically true paradoxical effect but merely a direct action of the stimulating effects of the amphetamines. They stated that amphetamines cause an increase in general alertness and excitation with a concomitant increase in focused attention. Responses to interfering stimuli then decrease; as a result the child becomes more amenable to positive reinforcement by parents and teachers.

The effects of experiments using operant conditioning in animals have suggested some apparent paradoxical effects (Kornetski, 1970). Animals trained on a fixed

ratio schedule of reinforcement show a very high rate of responding, often pressing a lever at the rate of two responses or more every second. After an effective dose of dextro-amphetamine, the animal's rate of responding decreases. Likewise, animals trained on a fixed interval schedule of reinforcements have a low rate of responding. But Dextro-amphetamine in a fixed schedule does cause an increase in rate of responding (Thompson and Schuster, 1968).

One possible explanation for such paradoxical results with amphetamine is that in the overaroused organism amphetamine may either inhibit norepinephrine (NE) synthesis or block the release of NE (Kornetski, 1970). Gunne and Lewander (1968) found that brain NE levels are reduced after administration of amphetamine and that urine levels are dramatically increased. However, the increase in urine levels may be entirely due to the release of bound NE that is functionally inactive in the brain except during conditions of stress (Kornetski, 1970). Sympathetic activity resulting from increased stress causes a release of NE in many organs, including the brain (Udenfriend, 1968). Kornetski (1970) and Stein and Wise (1969) assumed that there is an increase in the synthesis or turnover of NE in the HK Child, and that the increase is instrumental in producing the HK syndrome. According to Kornetski and Stein and Wise, amphetamine blocks the NE turnover; that

block in turnover rate is primarily responsible for the therapeutic effects of amphetamine.

Neurobiochemical research has been done on the changes in monoamine (neurotransmitter) levels during the maturation of the brain. Agrawal, Glisson, and Hiwisch (1966) observed changes in the monoamine levels during maturation of the brain of rats in which hyperkinesia had been induced. In addition to those changes, they reported that brain levels of serotonin (5-HT) and norepinephrine increased progressively with age; with adult levels being reached 5 to 6 weeks after birth; dopamine (DA) continued to increase until adulthood.<sup>1</sup>

Amphetamine apparently stimulates neurons within the reticular activating system (RAS) of the adult. Wender hypothesized that if the HK child had only small amounts of DA within his caudate nucleus and none of the (unspecified) neural transmitters which mediate the activity of the RAS, administration of amphetamine would stimulate his caudate nucleus but not his RAS, and would decrease rather than increase his hyperkinesia. The biochemical research on hyperkinesia (Agrawal et al., 1966; Coleman, 1971; Connors, 1966; Kornetski, 1970; Laufer et al., 1957; Wender, 1970) suggests a biochemical abnormality among HK children, and a possible neurophysiological localization of the biochemical lesion.

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<sup>1</sup>Weaning in the rat takes place at about 3 weeks, sexual maturation at 2 to 3 months.

It seems clear that if there are differential rates of maturation in various systems of the brain, and if the HK syndrome is partly caused by deficient monoamines, then increases in age and maturation should affect the diminuation of the syndrome.

The following section will present evidence of a possible neurophysiological basis for the HK syndrome.

### The Neurophysiological Research on Hyperkinesis

The neurophysiological approach to hyperkinesis postulates that hyperkinesis is caused by a dysmaturation of a localized organ and/or function. That is, maturation of the brain has been delayed and is irregular (Abrams, 1968).

The previously mentioned work of L  ufer et al. suggested that hyperkinesis results from a diencephalic dysfunction. The normal functions of the diencephalon, thought to be the rostral component of the RAS, are to sort, route, and pattern impulses coming from sensory receptors before they become amplified at higher levels of the brain. In that capacity the diencephalon functions as an inhibitor of irrelevant stimuli, keeping them from "flooding" the cortex. If the diencephalon is not functioning properly, the cortex, unable to deal adequately with an abundance of stimuli, may be overwhelmed.

There are two possible causes of the presumed diencephalic dysfunction. The first is that there may be a structural impairment of the brain stem or diencephalon so that the cortex is not properly shielded from stimuli which are irrelevant.<sup>2</sup>

The second and more widely accepted explanation of diencephalic dysfunction is that it is caused by a maturational imbalance between the diencephalon and cortex which hinders the relatively underdeveloped cortex from keeping up with the demands of a normally functioning diencephalon. This explanation has been supported by Laufer et al. (1957), and also by Lacey and Lacey (1958) who theorized that easily aroused diencephalic-cortical mechanisms produce high levels of cortical activity which in turn lead to motor agitation resulting in a poor attention span and distractibility. Laufer et al. presumed that the cortex is bombarded by an intense stimulation which in turn leads to HK behavior. This theory was derived from the finding that HK children have lower photo-Metrazol seizure thresholds than do non-HK children. The photo-Metrazol test, previously discussed, has been used in the past to investigate

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<sup>2</sup>It should be noted however, that the concept of the cortex being bombarded by external stimuli is highly speculative. Very few attempts to record cortical activity in HK children while stimuli are being presented to them have been reported in the literature.

sub-cortical structures, especially the diencephalon and thalamus (Gastaut, 1950; Gastaut and Hunter, 1950).

Lytton and Knobel (1958) also support dysmaturation as an explanation of hyperkinesis but they considered the crucial structure in the maturation process to be the prefrontal lobe of the cortex, which, they suggested, shows progressive changes in structure until approximately 10 years of age. They speculated that mild trauma, such as birth complications, would have no effect on older neurological structures but might hamper further development and functioning of the prefrontal cortex. The localization of the dysmaturation factor is supported by a number of researchers, including Rosvold and Teuber (1963) who found that the frontal lobes and the caudate nucleus had virtually identical functions with regard to motor activity. Pontius (1973), in accordance with Rosvold and Mishkin (1961), stated that a relationship may exist between specific signs of dysmaturity of the frontal lobe and/or caudate nucleus dysfunction and some essential but overlooked qualitative aspects of the adaptive processes, that is, how the child learns.

Attempts at localizing the dysmaturation factor are also found in the work of Luria and Homskaya (1963) who pointed out that immaturities of the frontal lobes are related to specific difficulties observed in normal children who cannot reprogram a simple ongoing activity

on verbal command at an earlier age than 24 to 26 months. For more complicated reprogramming tasks it has been shown that the normal child must be at least 4 years of age (Luria, 1966a; Yakovlev, 1967; Yakovlev and Lecours, 1967). More recently, Luria (1966a), Miller (1969), and Pontius (1973) have emphasized that the HK child's difficulty lies not in commencing an activity but in reprogramming an on-going activity. Miller (1969) and Pontius (1973) claim that the symptoms and signs most consistently associated with immaturity of the frontal lobes are the inability to switch from one principle of action to another and the inability to reprogram an ongoing activity upon verbal command.

Consider, for example, a HK child in a store, acting in accordance with his initial guiding principles — "Walk around; handle some toys but don't damage or steal anything." Suddenly the store-keeper yells at the child not to touch the toys. Such a child may be incapable of switching his principles of action and of reprogramming his ongoing activity upon verbal command. He continues to act according to his first formed principles of handling the toys without damaging them, and in his frame of reference, without stealing them. The verbal command has, to some extent, fragmented his plan and principle of action without reordering them in a new and appropriate way. He could conceivably continue to hold

the toy he happens to have in his hand at the moment of the store-keeper's shout, and might leave the store and be accused of stealing. However, that apparent act of theft might well have resulted from the child's loss of mastery over his actions, as a result of his inability to reprogram his ongoing activity.

The foregoing anecdote illustrates the difficulty the HK child experiences in reintegrating the addition of a new stimulus to an ongoing activity. A more effective way of dealing with such a child would have been to touch him gently on the shoulder and allow him sufficient time to receive the message being sent by the store-keeper.

In summary, the HK child is seen as being not unlike all normal but very young children who have no difficulty in starting an activity but who cannot stop or reprogram an ongoing activity. Luria (1966a, 1966b) and Pontius (1973) claim that the inability to stop or reprogram an ongoing activity is caused by a maturational imbalance between the first signalling system and the second signalling system.

The neurobiochemical and neurophysiological data supports the theory that hyperkinesis arises from a functional maturational disturbance. Luria supports that theory by postulating that the functional dysmaturational disturbance may exist either in the vascular system or in the cerebrospinal fluid, causing the normal condition of

organism to be upset. In any case, Luria (1966b) contends that the chief pathological agent of hyperkinesis is not an irreversible disturbance of the cortical cells but rather a "delayed and irregular maturation" of the central nervous system.

Luria's orientation is neither a narrow localization approach (Teuber, 1962) nor a holistic functional approach (Goldstein, 1948; Strauss and Kephart, 1955), but rather one which views a mental function as a complex hierarchically structured system. The operation of such a system will be impaired by the immaturity of any one of its links. And when one or more links in such a functional system is immature, mental functioning will be disrupted relative to the location of the dysmaturity.

#### Luria's Model

The cerebro-asthenic (CA) syndrome described by Luria (1963c) closely resembles the HK syndrome as it is seen in the present study. Luria describes CA children as having weak or immature inhibitory processes which result in an increase in their distractibility and impulsiveness. Luria demonstrated that a CA child will experience no appreciable difficulties when asked to press a rubber bulb in response to red signals and to abstain from pressing in response to green signals. He will immediately understand the instruction, formulate the

corresponding rule of action and easily accomplish the given task. However, if the experimenter complicates the neurodynamic conditions of the experiment by making greater demands on the inhibitory processes, the situation will change radically. That is, as soon as the experimenter switches to relatively shorter signals presented at an accelerated rate, CA children begin to exhibit peculiar characteristic dysfunctions. The CA child has trouble switching immediately to an inhibitory response in a more difficult task. For example, rapidly presented short inhibitory signals often call forth impulsive motor reactions. Luria contends that CA children are aware of their impulsivity when they make a mistake. And they often accompany incorrect responses by the exclamation "wrong", but yet are unable to refrain from pressing the rubber bulb at the wrong time. Luria's observation shed some light on the behavior of CA children who, after approximately 10 minutes of school instruction, begin to exhibit complete incomprehension of the tasks required by the teacher. They either answer the question by guessing or stop participating in the classwork. The excessive excitation of cortical structures which causes the characteristic dysfunctions consequently results in academic underachievement for the CA child.

Luria (1966a) based his experimental work on three theoretical assumptions. The first assumption was that the higher mental functions in CA children are complex reflexes,

both afferent and efferent, organized into functional systems that are social in origin. Any attempt to localize them is as difficult as to seek narrow, circumscribed "centers" for the biological systems, such as respiration, thirst, and hunger. To Luria, mental functions have a wide, dynamic representation throughout the cerebral cortex, based on constellations of territorially scattered groups of synchronized ganglion cells, mutually exciting one another. Hence, the higher mental functions such as speech and thought are accommodated in the brain in what Pavlov (1927) called "functional combination centers."

Luria's second assumption is that complex systems of higher mental functions are not preformed; nor do they mature independently. Rather, they are formed in the processes of social contact and objective activity and only gradually acquire increasingly complex connections.

Vygotsky's (1960) influence is clearly seen in Luria's final assumption, namely that higher mental functions are ontogenetic. That is, there exists an observable orderly and sequential number of stages through which the child passes. In each stage is found a characteristic structure of the higher mental functions. The child may perform the same task by means of different, interchaining systems of connections at different stages of his development. This structural variation of the higher mental functions at different stages of ontogenetic development

means that the child's cortical organization likewise does not remain unchanged. That is, at different stages of development, these higher mental functions are carried out by different constellations of the cortical zones.

It is difficult to overestimate the importance of the latter assumption for the correct diagnosis of brain immaturity, as well as for the understanding of the qualitative modifications that the higher mental functions undergo in the course of restoration. For example, in the early stages, relatively simple sensory processes, which are the foundation for the higher mental functions, play a decisive role. During subsequent stages, when the higher mental functions are being formed, the leading role passes to more complex systems of connections that develop as a function of speech. These systems begin to determine the whole structure of the higher mental processes. For those reasons, the relatively elementary processes of sensory analysis and integration, necessary for the further development of speech, are decisively important in early childhood. Disturbance of those processes causes underdevelopment of all the functional formations for which they serve as a foundation (Luria, 1966b).

Luria (1961) suggests that in the normally developing child, the mediating effect of language serves to inhibit the primary or motoric system. However, if there is dysmaturation prior to development of speech, the verbal

intellective functioning may subsequently develop normally, even though while the volitional motor system remains disrupted. His observation that verbal intellective functioning can develop independently of the motoric system has been borne out by clinical evidence which has shown that many HK children possess considerable verbal ability (Weithorn, 1973). The functional deficit of HK children seems to lie in the area of primary sensory input, especially in intrasensory and intersensory integration of sensory stimuli (Birch, 1965a, 1965b; Luria, 1963a, 1963b, 1966a, 1966b). Chalfant and Scheffelin (1969) defined intrasensory integration as "the processing of multiple stimuli which are being received through the same modality," and intersensory integration as "the processing of multiple stimuli which are being transmitted through different modalities (p. 51)." Those definitions are used in the current study.

#### Review of Research on Stimulus Integration

Research conducted on primary sensory information processing, although limited, is potentially significant for the rehabilitation of the HK child into the school and home. In almost all daily activities, particularly in school-related tasks, children must process multiple stimuli. Studies have been done on concept formation (Freiberg, 1965, 1969), problem-solving (Douglas, 1965, 1969), and visual-

motor activity (Burks, 1960), but very little has been done in measuring the visual, auditory, and haptic capacities of the HK child.

Several studies have reported that intrasensory systems develop before intersensory systems. Research by Birch (1964a, 1964b), Deutsch and Schumer (1970), Hasterok (1964), Sherrington (1951), and Reid (1970) suggests that the integration of information arriving through a single sense modality is phylogenetically more primitive and appears earlier than does the capacity to integrate information arriving through two or more sense modalities. Young children, for example, are more likely to perform successfully on test items which make fewer demands on the sensory integrative systems. Belmont, Birch, and Karp (1965) found that the intramodal, that is, visual-visual, demands of the Seguin Form Board Test and of the Three-Hole Form Board ( $2\frac{1}{2}$  year level) subtests of the Stanford-Binet Intelligence Scale are much easier for younger children than are subtests which require multimodal interaction.

A study of intersensory development in children ranging in age from 5 to 11 years with a mean IQ of 115 was conducted by Birch and Lefford (1963). The experiment explored the relationships among visual and haptic (active manual exploration) sense modalities for recognition of geometric shapes. Birch and Lefford showed that the ability to make various intersensory judgments (same-

different) follows a general law of growth and improves with age. Specifically, they found the following:

(a) For judgment of both identical and non-identical forms, the least number of errors was made in visual-haptic judgments. (b) Seventeen percent of the 5 year olds made no errors in judgment using visual and haptic information, while no 5 year olds performed perfectly with haptic-kinesthetic information. (c) At 11 years of age, there were almost no errors under all experimental conditions.

The evidence for normal children strongly confirms the view that the elaboration of intersensory relations represents a set of developmental functions showing age-specific characteristics and markedly regular curves of growth (Birch and Lefford, 1963, p. 51.)

Birch and Belmont (1965a) studied various groups of elementary school children, using the Auditory Visual Pattern Test. They found that the most rapid improvement in auditory-visual integration of temporal and spatial abilities in children seemed to occur between 5 to 7 years of age and reached asymptote by the fifth grade. That finding corroborates the findings of Birch and Lefford. It is interesting to note that significant improvement in integrative abilities occurs at about the same time as the child goes to school. One might wonder whether such rapid improvement is due to "maturation" or to instruction and practice in the school which may make demands on the

integrative processes of normal children.

Meuhl and Kremenak (1966) investigated the ability of first grade children to match information within and between auditory and visual sense modalities. Matching visual pairs was easy for most children. Matching auditory pairs was the most difficult task. Matching visual to auditory and auditory to visual pairs was intermediate in difficulty. Ability to match visual pairs did not contribute to the prediction of reading achievement, while ability to match visual to auditory, auditory to auditory, and auditory to visual pairs made significant contributions to predicting reading success.

Luria (1963a) has also conducted research in intrasensory and intersensory integration in children. He theorized that before the age of four a child's motor responses are not under the control of the verbal signalling system. The studies which he reported show that there is a deficiency in integration of the verbal and motor signalling systems.

There is relatively little information regarding the specific correlates of integrative disorders. Some findings indicate that individuals who function normally when receiving stimuli through a single sensory modality occasionally perform differently when the task involves the simultaneous or successive functioning of several modalities, or when several stimuli are received through

the same modality (Reid, 1970).

Chalfant and Schefflin (1969) claim that factors which may retard the development of integrative abilities or cause breakdowns in integrative functioning are (a) intelligence, (b) brain dysmaturation, and (c) biochemical imbalance. Since the brain dysmaturation and biochemical imbalance factors have already been discussed, only the intelligence factor advanced by Chalfant and Scheffelin (1969) is discussed at this point.

There is evidence from early Russian and English studies that the severely mentally deficient, in addition to being deficient in verbal abilities, also lack flexible connections between words and motor behavior (Hemmelin and O'Connor, 1960; Luria, 1956; Vygotsky, 1934). Except for studies by Holden (1970) and Tulving and Lindsay (1967) on educable mentally retarded subjects, no studies reviewed in the literature have attempted to correlate learning rate (IQ) or amount learned (mental age) with integrative functioning in HK children. However, Birch and Belmont (1964a) found a significant relationship between IQ and auditory-visual integrative ability, as measured by the Auditory Visual Pattern Test. The results indicate that auditory-visual integration may be one of the processes that underlies adaptive behavior and IQ.

### The Present Investigation

The current study considers the behavioral performance of HK children to be the result of interference or difficulties with the processing of input variables. That is, communication and feedback from one channel to another may be faulty or there may be poor integration of signals between and among input information. The present investigation was not concerned with the locus or level of this functional deficit, since the techniques and methods for exploring internal mechanisms such as levels of excitation are currently uncertain. It was accepted however, that the brain has input control functions, and that hyperkinesis upsets or interferes with the normal process of treating information from input channels. It was also accepted that the extent or nature of hyperkinesis could be misunderstood unless an "input-mapping" orientation was adopted.

The abundance of literature on hyperkinesis yields a consensus that hyperkinesis is a nebulous and global entity, only vaguely identified. The present investigation attempted to differentiate the various degrees of hyperkinesis observable in HK children. Chronological age as a factor affecting HK behavior was also explored in order to clarify behavioral developmental differences within a group of HK children. In the current research an attempt was made to "map" behaviorally both intrasensory and intersensory integration at various levels of stimulus complexity,

in order to assess conceptualization of perceptual stimuli.

Consequently, the following research hypotheses were considered:

1. Significant differences in intrasensory processing exist among degrees of hyperkinesis.
2. Significant differences in intrasensory processing exist among age levels.
3. Significant interaction effects in intrasensory processing exist between degree of hyperkinesis and age level.
4. Significant differences in intersensory integration exist among degrees of hyperkinesis.
5. Significant differences between the effects of successive and simultaneous stimuli presentations exist in all children.
6. Significant interaction effects in intersensory integration exist between degree of hyperkinesis and modality presentation.

A completely generalized multivariate analysis of variance model, described in Chapter IV, was used to test hypotheses 1, 2, and 3. Research hypotheses 4, 5 and 6 were tested with a two-way analysis of variance design, and are also described in Chapter IV.

More precisely, the study attempted to answer the following questions: (a) How do degrees of hyperkinesis and age levels differ from each other in intrasensory and intersensory integration of stimuli input? (b) Do those differences have practical educational significance?

### Summary

The present chapter discussed the functional maturational explanation of hyperkinesis from two research orientations: (a) the neurobiochemical, which claims that deficiency of certain monoamines (neural transmitters) may be responsible for the HK syndrome, and (b) the neurophysiological, which claims that immaturity of the activating system may be responsible for the manifestation of hyperkinesis. Luria's theoretical model was used to synthesize the neurobiochemical and neurophysiological orientations to hyperkinesis. The maturational dysfunction of the neurobiochemical and neurophysiological systems is expressed behaviorally through the intrasensory and intersensory integration of stimulus reception and processing which are functions of the primary signalling system. An overview of the present investigation, with hypotheses and objectives, was provided.

## CHAPTER III

### Assessment of Stimulus Integration

The present chapter has two objectives: (a) to discuss the methodology of assessing intrasensory and intersensory stimuli reception and processing, and (b) to discuss the perceptual measures employed in evaluating the intrasensory and the intersensory stimulus integration of HK children.

#### Methodology of Assessment

Luria proposed that hyperkinesis is primarily characterized by functional maturational disturbances in the primary sensory processes. He maintains that analysis of the sensory deficits of the CA (HK) child is of prime importance and must be done in order to ascertain (a) the stage of sensory input at which dysmaturation occurs, and (b) which sensory operations are lacking or poorly developed. He suggests the assessment of those functional deficits by means of certain procedures. The investigation must begin with an administration of preliminary tests which are standardized and which aim to evaluate various aspects of mental activity and processes in general. Those preliminary tests determine functioning of what Luria calls "individual

analyzers," that is, optic, auditory, and tactile modalities. Following the pre-assessment phase Luria proceeds with a variety of tests, all of short duration, enabling the investigator to identify those functions in which impairment does and does not occur. The objective of employing so many tests is to "map" the deficits and assets of the CA child's primary sensory input capabilities.

The pre-assessment phase in the present study consisted of various pretests which determined the functioning of the optic, auditory, and tactile analyzers. Those pretests are described in Chapter IV. The assessment phase of the present investigation consisted of two perceptual measures: (a) the Hôpital Pierre Janet Stimulus Kit (HPJSK), and (b) three subtests of the Illinois Test of Psycholinguistic Ability (ITPA). Complete procedural details of all measures used in the current study are provided in the appendices.

#### Rationale of Perceptual Measures

In many respects the selection of simple perceptual tasks for the present study was guided by the same principles expressed by Gollin (1960) with regard to explorations of developmental aspects of behavior. Gollin states that:

A major difficulty encountered in comparative developmental research is the location of experimental tasks which are within the response limits of widely disparate cross-sectional

samples. The tasks must be easy enough so that fairly young Ss can come to grips with them and difficult enough so that adult Ss have to do some work in order to master the tasks. Correlated with the dimension of workability of tasks are motivational factors which involve aspects such as attention, fatigue, and boredom. These aspects determine to a considerable extent the length of tasks which may be used and the amount of effort which will be expended by Ss, ... It is important to note, in this general context, that the procedural and methodological problems which arise in attempts to investigate ontogenetic behavioral development may represent signposts to essential aspects of psychological functioning. (p. 289).

#### Illinois Test of Psycholinguistic Ability

Since the publication of the latest experimental edition of the Illinois Test of Psycholinguistic Ability, several studies have been done evaluating its validity and usefulness with children who show deficiencies in sensory processing abilities. Examples of its versatility and usefulness are found in the works of Ferrier (1966), Kass, (1962), Kirk and Bateman (1962), Smith (1962), and Olson (1962).

The ITPA was included in the present study for two reasons. First, it permitted the study of the ability of HK children to process linguistic symbols in a non-verbal manner. Secondly, the test was used to map proficient and deficient sensory modalities of the HK child in dimensions set forth by the research of Osgood (1957).

### Hôpital Pierre Janet Stimulus Kit

The literature reports recent research on the information-processing capacities of the various receptor systems (Broadbent, 1962; Jacobson, 1951a, 1951b; Reid, 1970) and on recognition and discrimination of stimuli of various sensory modalities (Holden, 1971; Miller, 1956). Further research has dealt with information-processing of mental retardates and the emotionally disturbed (Birch and Belmont, 1964a, 1964b; Holden, 1969, 1971; Kamlet, 1965; Lindsay, Cuddy, and Tulving, 1965; Spitz, 1966, 1971; Spitz, Hoats, and Holden, 1968; Tulving and Lindsay, 1967; White and Cheatham, 1959; White, Cheatham, and Armington, 1953). However, there are few reports of attempts to evaluate the HK child's performance in reception and processing of stimuli in single modalities or multiple sensory modalities. Undoubtedly that lack is due to the fact that at present there is no standardized set of clinical or experimental procedures for assessing either single sensory modality functioning or multiple modality stimulus integration. Broadbent (1958) has proposed a model which is consistent with much of the empirical findings. His model illustrates the reduction of information between the sensory mechanisms and the perceptual system, as a process of selection. One of Broadbent's (1962) major findings concerns his belief that sensory systems must be allowed adequate time to filter sensory input, and is referred to as Broadbent's

one and two second hypothesis. Considerable data has been amassed on the problem of switching time (Broadbent, 1954, 1958, 1962; Cherry, 1963; Dykman, Walls, Suzuki, Ackerman, and Peters, 1970). Broadbent, for instance, reported that there was an advantage to spatial separation of sources of sound if call signals were presented at a slow rate, but that this advantage diminished or vanished when the rate of presentation was rapid. In that context, a slow rate is one pair of call signs every two seconds, and a fast rate is one pair every second. Broadbent's interpretation of the two sources provided the S system, the selective filter, with some means for discriminating the two information channels, and once the channels were discriminated, the subject could switch from one channel to the other. But when the rate of presentation was speeded up to one pair every second, there was not sufficient time to listen to a call sign on one channel, switch to the other channel, listen to the call sign presented on the other channel, and then switch back in time for the next presentation on the first channel. Since this feat was evidently possible in the two-second condition, but not in the one-second condition, Broadbent (1958) concluded that a complete cycle including two perceptions and two switches of channel requires between one and two seconds. Recently Broadbent's one and two second hypothesis has received support from a study by Dykman et al. (1970). Utilizing a Lurian-type

paradigm, Dykman et al. reported that HK children, on the average, took .10 seconds longer to process information than did non-HK controls. The conclusions reported by Dykman et al. were that if teachers are to communicate successfully with children with learning disabilities, then they must speak slowly. They suggest that teachers speak at half the normal rate of speech, especially when transmitting long messages or complicated instructions. Many previous studies (Dykman et al., 1970; Holden, 1971; Kamlet, 1965; Tulving and Lindsay, 1967; White and Cheatham, 1959) have considered the superiority of information-processing of one modality over the other. Previous studies measured only auditory and visual stimuli input independently and did not evaluate successive or simultaneous multisensory integration in HK children. Accordingly, the HPJSK, based on Broadbent's theoretical rationale and derived from the work of Holden (1969, 1971) and Spitz (1966), was included in the present study.

The HPJSK consists of multisensory stimuli which were presented successively and simultaneously to each child. Monosensory stimuli were presented in bisensory and trisensory form. The combinations of each presentation, for all trials, is shown in Table 1, Chapter 4. The use of the HPJSK permitted the study of three different problems

(a) the exploration of the Broadbent (1962) hypothesis that learning deficits of HK children may often be a consequence of their failure to organize or select incoming stimuli and that those deficits can be diminished by organizing the stimuli for them; (b) the assessment of the ability of HK children to integrate multiple stimuli input; (c) the ability of HK children to reprogram ongoing activity.

#### Summary

Methodology of assessment, as set forth by Luria, was discussed. The rationale for the use of the perceptual measures was explained.

## CHAPTER IV

### Sample, Instruments, and Design

#### Sample

The sample of HK children consisted of 28 boys and 4 girls. Some Ss were referred to the present research project from the Children's Clinic of Hôpital Pierre Janet; others were referred directly to the project by the elementary schools in the Hull-Ottawa area. In order that the sample be as homogeneous as possible, a number of criteria were employed in selection of the HK Ss. The most important criterion was that hyperkinesis be the major observable symptom. Hyperkinesis had to be chronic, that is present since early childhood, sustained, that is, apparent throughout most of the day, and it also had to be the cause of severe difficulty both at home and at school. Additional criteria were that the child be between 5 and 13 years of age, have a Wechsler Intelligence Scale for Children (WISC) IQ of 85 or above, and have no history of brain injury, epilepsy, or psychosis. Children primarily diagnosed as neurotic were excluded. None of the Ss were receiving drugs or therapy when they began their participation in the study.<sup>3</sup> All of the HK children were enrolled in regular classrooms and were living at home with at least one parent.

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3 All children were on a placebo and not on an active drug.

The mean age of the HK sample was 9.10 years, with a range of 6.1 to 13.4 years and a standard deviation of 2.3 years. The mean IQ was 99.0 with a range of 80 to 128 and a standard deviation of 13.4.

A group of 11 normal children were matched with the group of HK children on the basis of age, sex, and WISC Full Scale IQ. Control Ss were obtained from the regular classrooms of four elementary schools in the Hull-Ottawa area and were screened to exclude children with a history of neurological damage or emotional disturbance. The mean age of the control children was 9.5 with a range of 6.2 to 12.6 years and a standard deviation of 1.9 years. The mean IQ was 103.6 with a range of 83 to 118 and a standard deviation of 12.1. Statistical comparison indicated that the groups did not differ significantly with regard to age ( $t=1.32$ ) or IQ ( $t=.13$ ).

At the termination of the pre-assessment phase, three psychiatrists rated and classified all Ss on David's (1970) Scale of Hyperkinesis. The rating scale consisted of the seven parameters of the HK syndrome discussed in Chapter I. Ss were rated on a point continuum from 1 to 6. For example, a child who scored 40 points out of the total 42 was considered to present a high global degree of hyperkinesis. Ss who were rated between 0 and 24 were considered as low HKs, between 25

and 33 as medium, and between 34 and 42 as manifesting a high degree of hyperkinesis.

In addition to being classified according to degree of hyperkinesis, Ss were grouped on the basis of chronological age. The three age levels were (a) Oldest - 12.66 to 10.37 years; (b) Younger - 10.36 to 8.51 years; (c) Youngest - 8.50 to 6.66 years. Appendix 2 shows the classification of Ss according to age level and degree of hyperkinesis.

### Instruments

#### Pretests

Visual. Prior to inclusion in the study, all Ss were assessed on visual, auditory, and tactile perception. Visual assessment was done by an optometrist. The visual examination included the following: (a) All Ss were tested for distance vision (20) feet and near vision (14 inches), with or without glasses. Normal was defined as 20/20 to 20/40; (b) Ocular coordination was examined by the standard convergence test, the Madelox Rod, and Madelox Wing Test; (c) Visual field was tested by the Herrington-Flocks visual screener; (d) Colour vision was tested by the Ishihara pseudochromatic plates. There were no significant differences between experimental and control groups on all optic examinations.

Auditory. A Maico Audiometer with an audiometric decibel range from 125 decibels (db) to 1000 db was used as the auditory screening test. All Ss were tested on left, right, and both ears. No significant difference was demonstrated on auditory performance between HK and normal Ss in all frequencies.

Tactile. The tactile screening test, derived from the work of Holden (1971) was administered to all Ss. Ss were seated inclined in a lazy-boy chair with a Mark III vibrator strapped to their left wrist. Four blocks of stimuli ranging from 4 to 10 tactile vibrations were presented to all Ss. After each block, Ss were asked, "How many tickles (vibrations) have you felt?" No Ss were excluded as a result of the tactile screening test.

Upon completion of the selective pretests Ss were assessed on perceptual measures.

### Perceptual Measures

Illinois Test of Psycholinguistic Ability. Three of the nine subtests of the ITPA were administered to all Ss. Those subtests, fully discussed in the appendices, are described by McCarthy and Kirk (1968) as follows:

- I. Tasks at the Representational Level are those which control the internal or central manipulation of symbols with high meaning content.

- A. The Decoding Tests. Decoding is the ability to comprehend auditory and visual symbols ... that is, the ability to comprehend spoken words, written words, or pictures.

- Test 1. Auditory decoding is the ability to comprehend the spoken word. It is

assessed by a controlled vocabulary test in which the subject is asked to answer yes or no by voice or gesture to a series of graded questions. (Appendix 3)

Test 2. Visual decoding is the ability to comprehend pictures and written words. It is assessed by a picture identification technique in which the subject selects from among a set of pictures the one which is most nearly identical, on a meaningful basis, to a previously exposed stimulus picture. (Appendix 4)

B. The Encoding Tests. Encoding is the ability to put ideas into words or gestures.

Test 6. Motor encoding is the ability to express one's ideas in gestures. The manual language of the deaf is an example of motor encoding. This ability is tested by showing the subject an object and asking him to supply the motion appropriate for manipulating it (e.g., drinking from a cup or strumming a guitar). (Appendix 5)

Hôpital Pierre Janet Stimulus Kit. Stimuli were presented to Ss seated in front of a cubicle 91 cm wide, 91 cm deep, and 60 cm high. The inside of this cubicle was painted a flat black and illuminated by a shielded  $7\frac{1}{2}$  watt lamp mounted directly on top of the cubicle.

1) Visual stimulus was a 2.54 cm diameter white bulb with a brightness of .8 footcandles 45 cm away from the S's eye position. 2) Sound stimuli consisted of 600Hz 80db tones presented to Ss through headphones. 3) Cutaneous stimuli were presented by a Mark III vibrator strapped to the S's left wrist. All stimuli were  $\frac{1}{2}$  second pulses presented at a constant rate of one second. The pulses were presented successively in sequences varying from 1 to 6. Each

sequence was administered via the visual, auditory, and tactile modalities. Within each sequence, bisensory and trisensory modality combinations were presented. Two blocks of stimuli were presented in each sequence. Stimuli were randomized within two blocks of 54 stimuli presentations so that each sequence and modality condition occurred an equal number of times in both blocks. The combination of sequence and modality conditions for all trials is shown in Table 1.

Ss were tested individually in a 20 minute session. After entering the laboratory Ss were seated in front of the cubicle and told that they would be counting lights, sounds, and vibrations. A pretest consisting of two cards, one with 7 dots and the other with 14, was given to determine the S's ability to count under a self-paced condition when stimuli were presented both simultaneously and successively. After the S had a brief relaxation period, the vibrat-tile unit was strapped to the S's left wrist and the head phones were adjusted over the S's ears. Ss were instructed that they would see, hear, and feel various combinations of lights, tones, and vibrations.

Each stimulus was demonstrated individually, and was followed by one practice trial with all stimuli in the same intensity and one practice trial with stimuli in multi-sensory combinations. Ss were instructed to guess if unsure of the correct answers. They were not told whether

Table 1

## Sequences and Combinations of Stimuli of the HPJSK

| Sequences | Combinations                 |                               |
|-----------|------------------------------|-------------------------------|
|           | Bisensory <sup>(a) (b)</sup> | Trisensory <sup>(a) (b)</sup> |
| Block A   | AV AV AV AV                  | TVA TVA TVA TVA               |
|           | TA TA TA                     | VTA VTA VTA VTA VTA           |
|           | AT AT AT AT AT               | ATV ATV ATV ATV               |
|           | TV TV TV TV                  | TAV TAV TAV TAV TVA           |
|           | VT VT VT VT VT VT            | VAT VAT VAT VAT VAT           |
|           | VA VA VA VA VA               | ATA ATA ATA ATA ATA           |
| Block B   | (b) (a)                      | (a) (b)                       |
|           | AT AT AT AT                  | ATV ATV ATV ATV               |
|           | TV TV TV TV                  | TAV TAV TAV TAV TAV           |
|           | AV AV AV AV                  | VAT VAT VAT VAT VAT           |
|           | VT VT VT VT VT VT            | ATA ATA ATA ATA ATA           |
|           | TA TA TA                     | VTA VTA VTA VTA VTA           |
|           | VA VA VA VA VA               | TVA TVA TVA TVA               |

Key: (a) Successive Modality Presentation  
(b) Simultaneous Modality Presentation

or not they answered correctly after each sequence. Ss were told that the ceiling light would go out prior to each sequence and that they could give their answer any time after it came on again. Intertrial interval varied between 35 and 55 seconds. Half of the Ss received the first block of randomized stimuli (A), followed by the second block (B). The remainder of the Ss received the blocks in reverse order.

The total task model is described in Appendix 6.

### Procedure

All Ss were seen individually by one experimenter (E) who tried to maintain a pleasant but businesslike manner throughout each session. In each of the testing sessions each S did the same tests with the same E. The average session was 75 minutes with a range of 65 to 90 minutes.

### Design

As stated in Chapter II, the major purposes of the present research were to determine whether significant differences in the intrasensory and intersensory processing of stimuli existed among the degrees of hyperkinesis and age levels, and to consider the psychological and practical significances of any differences that were found. The first of the major purposes, that of determining whether significant

differences in intrasensory processing existed among degrees of hyperkinesis, was explored by the questions: (a) Do significant differences in intrasensory processing exist among degrees of hyperkinesis? (b) Do significant differences in intrasensory processing exist among age levels? (c) Are there significant interaction effects between degree of hyperkinesis and age level?

Stated empirically, the present research tested the following multivariate null hypotheses:

- 1  $H_0$ . Significant differences in intrasensory processing do not exist among degrees of hyperkinesis.
- 2  $H_0$ . Significant differences in intrasensory processing do not exist among age levels.
- 3  $H_0$ . Significant interaction effects in intrasensory processing do not exist between degree of hyperkinesis and age level.

The experimental design is illustrated in Figure 1.

The second of the major objectives of the current study was to determine whether significant differences in intersensory integration existed among degrees of hyperkinesis. The objective was considered by first exploring the questions: (a) Do significant differences in intersensory integration exist among degrees of hyperkinesis? (b) Do significant differences in intersensory integration exist between successive and simultaneous modality presentations? (c) Are there

|           |                            | Degree of Hyperkinesis                       |                          |                       |                           |
|-----------|----------------------------|----------------------------------------------|--------------------------|-----------------------|---------------------------|
|           |                            | High<br>H <sub>1</sub>                       | Medium<br>H <sub>2</sub> | Low<br>H <sub>3</sub> | Normals<br>H <sub>4</sub> |
| Age Level | Oldest<br>A <sub>1</sub>   | X <sub>1</sub> X <sub>2</sub> X <sub>3</sub> |                          |                       |                           |
|           | Younger<br>A <sub>2</sub>  |                                              |                          |                       |                           |
|           | Youngest<br>A <sub>3</sub> |                                              |                          |                       |                           |
| n 43      |                            |                                              |                          |                       |                           |

Figure 1

Experimental Design for Intrasensory  
Evaluation

The independent variables were degree of hyperkinesis and age level. The dependent variables were:

- X<sub>1</sub> auditory reception ITPA Score
- X<sub>2</sub> visual reception ITPA Score
- X<sub>3</sub> tactile reception ITPA Score

significant interaction effects between degrees of hyperkinesis and modality presentations?

Stated empirically, the present investigation tested the following univariate null hypotheses:

- 4  $H_0$ . Significant differences in intersensory integration do not exist among degrees of hyperkinesis.
- 5  $H_0$ . Significant differences between successive and simultaneous stimuli presentations do not exist for all children.
- 6  $H_0$ . Significant interaction effects in intersensory integration do not exist between degrees of hyperkinesis and modality stimuli presentation.

The experimental design is illustrated in Figure 2.

#### Statistical Treatment of Data

A multivariate analysis of variance model prepared by Finn (1967) was used to test null hypotheses 1, 2, and 3. Finn's program performs univariate and multivariate linear estimations and tests of hypotheses for crossed and/or nested designs, with or without concomitant variables. The number of observations in the individual cells need not be equal or proportional. The program, performing an exact least-square analysis (Bock, 1963), yielded univariate F ratios for each of the dependent variables and their interactions with each other. The program also computed the probability levels associated with each of the F ratios reported.

|                        |                           | Modality Presentation |                |                |                |                |  |
|------------------------|---------------------------|-----------------------|----------------|----------------|----------------|----------------|--|
| Degree of Hyperkinesis | S                         | Successive            |                |                |                | Simultaneous   |  |
|                        | H <sub>1</sub><br>high    | 1                     | X <sub>4</sub> | X <sub>5</sub> | X <sub>6</sub> | X <sub>7</sub> |  |
|                        | H <sub>2</sub><br>medium  |                       |                |                |                |                |  |
|                        | H <sub>3</sub><br>low     |                       |                |                |                |                |  |
|                        | H <sub>4</sub><br>normals |                       |                |                |                |                |  |
|                        | n                         |                       |                |                |                |                |  |

n = 43

Figure 2

## Experimental Design for Intersensory Evaluation

The independent variables were degree of hyperkinesis and modality presentation. The dependent variables were all the possible combinations of:

- X<sub>4</sub> visual and auditory stimuli
- X<sub>5</sub> auditory and tactile stimuli
- X<sub>6</sub> visual and tactile stimuli
- X<sub>7</sub> visual, auditory and tactile stimuli

If significant main effects were reported on degrees of hyperkinesis, age levels, and/or on the interactions of age levels and degrees of hyperkinesis, the E would apply the post hoc procedures outlined by Timm (1970, pp. 54-56).

A two-way analysis of variance model with repeated measures, prepared by Bay (1971), was used to test null hypotheses 4, 5, and 6. Bay's program performs univariate analysis and tests the hypotheses for crossed and/or nested design, with or without concomitant variables. The number of observations in the individual cells need not be equal or proportional. The program yielded univariate F ratios for each of the dependent variables and also computed the probability levels associated with each of the F ratios reported.

Scheffé's (1962, pp. 362-364) method was used to locate the possible significant main effects among degrees of hyperkinesis and modality presentations.

### Summary

The perceptual performance of 32 HK children and 11 normal children was pre-assessed. Each HK child was classified in one of three degrees of hyperkinesis and one of three age levels. A completely generalized multivariate analysis of variance design was used. The purpose of the design was to determine whether significant intrasensory

differences, as measured by 3 ITPA age-scores, existed among degrees of hyperkinesis and age levels. Contingent on the results of the multivariate analysis design, and with the same sample, a two-way analysis of variance design was used to determine whether intersensory differences existed among degrees of hyperkinesis and modality presentation as measured by the HPJSK.

## CHAPTER V

### Statistical Analysis and Results

The present chapter reports, in two parts, the statistical analysis of intrasensory and intersensory differences among degrees of hyperkinesis and age levels.

Part I reports and interprets the statistical analysis of intrasensory differences among degrees of hyperkinesis and age levels.

Part II reports and interprets the statistical analysis of intersensory differences between degrees of hyperkinesis and modality presentations.

#### Analysis of Data - Part I

The present research explored the questions:

(a) Do significant differences in intrasensory processing exist among degrees of hyperkinesis? (b) Do significant differences in intrasensory processing exist among age levels? (c) Do significant interaction effects in intrasensory processing exist between degree of hyperkinesis and age level?

Stated empirically, the current study tested the following multivariate null hypotheses:

- 1  $H_0$ . Significant differences in intrasensory processing do not exist among degrees of hyperkinesis.
- 2  $H_0$ . Significant differences in intrasensory processing do not exist among age levels.
- 3  $H_0$ . Significant interaction effects in intrasensory processing do not exist between degree of hyperkinesis and age level.

Finn's (1967) multivariate analysis of variance program described in Chapter IV, was used to test these null hypotheses.

#### Results of the Multivariate Analysis of Variance

Illinois Test of Psycholinguistic Ability. Table 2 presents the results of the two-way multivariate analysis of variance, in which the three ITPA subtest scores were used as the dependent variables.

The F ratio of 3.44 for the differences among degrees of hyperkinesis was significant at the 0.05 probability level. Multivariate null hypothesis 1, that significant differences in intrasensory processing do not exist among the degrees of hyperkinesis, was therefore rejected. It was concluded that the four degrees of hyperkinesis did not have similar reception and processing of visual, auditory, and tactile stimuli as measured by the ITPA.

The F. ratio of 3.62 for the difference among children at the three age levels was significant at the 0.05 probability level. Consequently null hypothesis 2, that significant differences in intrasensory processing patterns do

Table 2

Multivariate Results of Analysis of Variance with  
the Three ITPA Scores as Dependent Variables

| Sources of Variation                                   | ndf   | F     | p     |
|--------------------------------------------------------|-------|-------|-------|
| Degree of Hyperkinesis                                 | 9,71  | 3.44* | 0.001 |
| Age Level                                              | 6,58  | 3.62* | 0.004 |
| Interaction of Degree of<br>Hyperkinesis and Age Level | 18,83 | 0.69  | 0.813 |

\* Significant at 0.05 level

not exist among age levels was rejected. Therefore, it was concluded that significant differences existed in intrasensory processing patterns among children at the three different age levels.

The interaction between age level and degree of hyperkinesis did not reach significance at the 0.05 level. Hence null hypothesis 3, that significant interaction effects in intrasensory processing patterns do not exist between degree of hyperkinesis and age level, was not rejected. Thus it was concluded that there were no demonstrable interaction effects between degree of hyperkinesis and age level. While there were significant ITPA score differences between degree of hyperkinesis and age level, they appeared to be the same kind of difference over both main factors. More precisely, the probability of interaction effect between age level and degree of hyperkinesis was computed at the .812 probability level. That is, the probability of an interaction effect of that size arising by chance between age level and degree of hyperkinesis, as presented by an F ratio of .629, was 812 in 1,000.

With those results, the researcher continued with the study, disregarding the age levels of the children.

#### Results of Post Hoc Procedures

Given that differences existed among the four degrees of hyperkinesis, the next question involved locating these differences. (a) To what extent do degrees of hyperkinesis

differ from one another on measures of the ITPA? (b) Do additional hyperkinetic-normal differences exist, as suggested in the review of the literature?

In univariate analysis of variance models, techniques similar to Scheffé's (1960) multiple contrast method can be utilized to determine the extent and nature of the differences. Similar techniques for use with multivariate analysis of variance models are described by Timm (1970) and were used as post hoc procedures in the present study.

Table 3 contains the summary of 95% confidence limits for simple contrasts between means of each level of factor A (Hyperkinesis).

The contrast of the tactile encoding means for  $H_1$  and  $H_4$  was significant on the .05 level, indicating that high HK children received a significantly lower score on the tactile decoding task of the ITPA than normal children. Also the contrast between  $H_3$  and  $H_4$  was significant on the 0.05 level, indicating that children with a low degree of hyperkinesis also scored a lower ITPA score than normal children. Although some of the other contrasts came close to the significant confidence limits, they failed to reach significance at the 0.05 level.

### Summary

Significantly different intrasensory processing patterns of four degrees of hyperkinesis had been shown

Table 3

95% Simultaneous Confidence Limits for Simple Contrasts  
Between Means of Degrees of Hyperkinesis

| Contrast (a)<br>Estimate | Variable (b) | Confidence Limits |              |
|--------------------------|--------------|-------------------|--------------|
|                          |              | Lower Limits      | Upper Limits |
| $M_1 - M_2$              | 1            | -2.94             | 2.45         |
|                          | 2            | -3.11             | 1.80         |
|                          | 3            | -3.68             | 0.07         |
| $M_1 - M_3$              | 1            | -3.95             | 1.84         |
|                          | 2            | -3.70             | 1.58         |
|                          | 3            | -3.14             | 0.88         |
| $M_1 - M_4$              | 1            | -.457             | 0.82         |
|                          | 2            | -3.66             | 1.25         |
|                          | 3            | -5.14             | -1.38*       |
| $M_2 - M_3$              | 1            | -3.79             | 2.17         |
|                          | 2            | -3.12             | 2.31         |
|                          | 3            | -1.40             | 2.74         |
| $M_2 - M_4$              | 1            | -4.40             | 1.14         |
|                          | 2            | -3.08             | 1.94         |
|                          | 3            | -3.39             | 0.46         |
| $M_3 - M_4$              | 1            | -3.807            | 2.16         |
|                          | 2            | -2.86             | 2.77         |
|                          | 3            | -4.21             | -0.06*       |

\* Significant at the 0.05 level

Key: (a)  $M_1$  - Mean for High Hyperkinesis  
 $M_2$  - Mean for Medium Hyperkinesis  
 $M_3$  - Mean for Low Hyperkinesis  
 $M_4$  - Mean for Normals

(b) Variable 1 - Auditory Decoding  
Variable 2 - Visual Decoding  
Variable 3 - Tactile Encoding

to exist. Those differences appeared to be of the same kind among three age levels.

The present investigation, employing post hoc procedures, found that the reception and processing of tactile stimuli was significantly more difficult for HK than for normal children. HK and normal children were not significantly different in the reception and processing of auditory and visual stimuli.

### Analysis of Data - Part II

Part I reported and interpreted results of the multivariate techniques used to determine the significance, extent, and nature of the differences in intrasensory processing patterns of four degrees of hyperkinesis. The present section reports the statistical results of the two-way analysis of variance with repeated measures of the differences in intersensory processing of stimuli between degree of hyperkinesis and modality presentation.

The research explored the questions: (a) Do significant differences in intersensory processing patterns exist among degrees of hyperkinesis? (b) Do significant differences in intersensory integration exist between successive and simultaneous stimuli presentations? (c) Are there significant interaction effects between degree of hyperkinesis and modality presentation?

Stated empirically, the current study tested the following univariate null hypotheses:

- 4  $H_0$ . Significant differences in intersensory integration do not exist among degrees of hyperkinesis.
- 5  $H_0$ . Significant differences between successive and simultaneous stimuli presentations do not exist for all children.
- 6  $H_0$ . Significant interaction effects in intersensory integration do not exist between degree of hyperkinesis and modality presentation.

Bay's univariate analysis of variance design (Chapter IV) was used to test the null hypotheses.

#### Results of the Analyses of Variance

Visual and Auditory Stimuli Combinations. Table 4 shows the statistical results of the two-way analysis of variance between degree of hyperkinesis (A) and modality presentation (B), within visual and auditory stimuli combinations.

The F ratio of 1.35 for the differences among degrees of hyperkinesis, when auditory and visual stimuli were presented, was not significant at the 0.05 probability level. Thus, the investigator was not able to reject null hypothesis 4. It was concluded that significant differences in visual-auditory intersensory patterns do not exist among degrees of hyperkinesis.

Table 4

Results of Analysis of Variance of HPJSK Scores  
for Visual and Auditory Stimuli Combinations

| Sources <sup>a</sup>    | ndf | MS   | F     | P     |
|-------------------------|-----|------|-------|-------|
| <u>Between Subjects</u> |     |      |       |       |
| 'A' Main Effects        | 3   | 0.98 | 1.35  | 0.270 |
| Subj.w.groups           | 39  | 0.72 |       |       |
| <u>Within Subjects</u>  |     |      |       |       |
| 'B' Main Effects        | 1   | 1.68 | 4.06* | 0.050 |
| 'A x B' Interaction     | 3   | 1.63 | 3.93* | 0.015 |
| 'B' x subj.w.groups     | 39  | 0.41 |       |       |

\* Significant at 0.05 level

a Main Effect A - Degree of Hyperkinesis  
Main Effect B - Modality of Presentation  
Measures repeated across B

The F ratio of 4.06 for the difference between successive and simultaneous modality presentation in auditory and visual combinations was significant at the 0.05 level. The probability of arriving at modality presentation differences of that size by random selection of four samples from a two-dimensional univariate was less than 5 in 100. The univariate null hypothesis 5, that significant differences in successive and simultaneous presentations do not exist among all children, was therefore rejected. With 0.05 level of significance, it was concluded that the four degrees of hyperkinesis did not have similar integration sensory patterns, as measured by successive and simultaneous auditory-visual stimuli presentations.

Auditory and Tactile Stimuli Combinations. Table 5, contains the results of the two-way analysis of variance with degrees of hyperkinesis and modality presentation.

The F ratio of 3.02 for the differences among the four degrees of hyperkinesis, when stimuli were presented in an auditory and tactile combination, was significant at the 0.05 level, indicating that significant intersensory differences do exist among degrees of hyperkinesis when auditory and tactile stimuli were combined. Thus the investigator did not reject null hypothesis 4. On the contrary, it was concluded that the four degrees of hyperkinesis did not have similar intersensory integration patterns within an auditory and tactile stimuli combination.

Table 5

Results of Analysis of Variance of HPJSK Scores  
for Auditory and Tactile Stimuli Combinations

| Sources <sup>a</sup>    | ndf | MS   | F     | p     |
|-------------------------|-----|------|-------|-------|
| <u>Between Subjects</u> |     |      |       |       |
| 'A' Main Effects        | 3   | 1.94 | 3.02* | 0.040 |
| Subj. w. groups         | 39  | 0.64 |       |       |
| <u>Within Subjects</u>  |     |      |       |       |
| 'B' Main Effects        | 1   | 2.34 | 5.59* | 0.023 |
| 'A x B' Interaction     | 3   | 2.66 | 6.36* | 0.001 |
| 'B' x subj.w.groups     | 39  | 0.41 |       |       |

\* Significant at 0.05 level

a Main Effect A - Degree of Hyperkinesis  
Main Effect B - Modality of Presentation  
Measures repeated across B

The F ratio of 5.59 for the differences of auditory and tactile stimuli combinations in successive and simultaneous form was significant at the 0.05 level. Null hypothesis 5 was therefore rejected. With confidence, it was concluded that the four degrees of hyperkinesis did not have a similar intersensory integration pattern when auditory and tactile stimuli were presented in successive and simultaneous forms.

Visual and Tactile Combination. Table 6 presents the results of the two-way analysis of variance between degrees of hyperkinesis and successive and simultaneous modality presentations within visual and tactile stimuli combinations.

The F ratio of 5.46 for the differences among degree of hyperkinesis, when stimuli were presented in a visual and tactile combination, was significant at the 0.05 level of probability. Univariate null hypothesis 4, that significant differences in intersensory integration patterns do not exist among degrees of hyperkinesis, was therefore rejected. It was concluded that the four degrees of hyperkinesis did not have similar intersensory integration patterns when stimuli were presented in a visual-tactile combination.

The F ratio of 23.21 for the differences between successive and simultaneous modality presentations for all children was also significant at the 0.05 level. The

Table 6

Results of Analysis of Variance of HPJSK Scores  
for Visual and Tactile Stimuli Combinations

| Sources <sup>a</sup>    | ndf | MS   | F      | P     |
|-------------------------|-----|------|--------|-------|
| <u>Between Subjects</u> |     |      |        |       |
| 'A' Main Effects        | 3   | 3.33 | 5.46*  | 0.003 |
| Subj.w.groups           | 39  | 0.61 |        |       |
| <u>Within Subjects</u>  |     |      |        |       |
| 'B' Main Effects        | 1   | 5.36 | 23.21* | 0.000 |
| 'A x B' Interaction     | 3   | 1.68 | 7.28*  | 0.000 |
| 'B' x subj.w.groups     | 39  | 0.23 |        |       |

\* Significant at 0.05 level

a Main Effect A - Degree of Hyperkinesis  
Main Effect B - Modality of Presentation  
Measures repeated across B

probability of arriving at modality presentation differences of that size by random selection of four degrees of hyperkinesis from a two dimensional univariate was less than 2 in 100,000. Null hypothesis 5, that significant differences in successive and simultaneous modality presentations do not exist among all children, was therefore rejected when stimuli were of visual-tactile nature. With a high degree of confidence, it was concluded that the four degrees of hyperkinesis did not have similar intersensory integration patterns, as measured by the modality presentation.

Trisensory Stimuli Combinations. Shown in Table 7 are the results of the two way analysis of variance with degrees of hyperkinesis (factor A) and modality presentations (factor B) within trisensory stimuli combinations.

The F ratio of 7.06 for the differences among degrees of hyperkinesis, when stimuli were presented in a trisensory combination, was significant at the 0.05 level of probability. As was the case with the bisensory stimuli combinations the univariate null hypothesis 4 was again rejected with a trisensory stimuli form presentation. The analysis of variance revealed that the four degrees of hyperkinesis did not have a homogenous intersensory integration pattern when stimuli were presented in a trisensory combination.

Table 7

Results of Analysis of Variance of HPJSK Scores  
or Visual-Auditory-Tactile Stimuli  
Combinations

| Sources <sup>a</sup>    | ndf | MS     | F      | p     |
|-------------------------|-----|--------|--------|-------|
| <u>Between Subjects</u> |     |        |        |       |
| 'A' Main Effects        | 3   | 32.01  | 7.06*  | 0.000 |
| Subj.w.groups           | 39  | 4.53   |        |       |
| <u>Within Subjects</u>  |     |        |        |       |
| 'B' Main Effects        | 1   | 126.26 | 59.59* | 0.000 |
| 'A' x B' Interaction    | 3   | 8.15   | 3.84*  | 0.010 |
| 'B' x subj.w.groups     | 39  | 2.11   |        |       |

\* Significant at 0.05 level

a Main Effect A - Degree of Hyperkinesis  
Main Effect B - Modality of Presentation  
Measures repeated across B

The F ratio of 59.29 for the differences between successive and simultaneous modality presentations for all children was significant at the 0.05 level. Null hypothesis 5, that significant differences between successive and simultaneous modality presentations do not exist among all degrees of hyperkinesis, was rejected. It was concluded that trisensory successive and simultaneous modality presentation were not similar for all children within the four degrees of hyperkinesis.

Because neither null hypothesis 4 nor 5 was able to be rejected at the 0.05 probability when the four degrees of hyperkinesis were assessed on bisensory and trisensory stimuli combinations in successive or simultaneous form, the next procedure was to apply tests for simple effects to locate the differences.

#### Testing for Simple Effects

Given that differences in intersensory integration patterns existed among degrees of hyperkinesis and modality presentation, Scheffé's method (Chapter 4) was used in an attempt to answer the questions: (a) To what extent do individual degrees of hyperkinesis differ from one another in the various bisensory and trisensory stimuli combinations? (b) Are there successive and simultaneous differences between HK and normal children?

The F ratios associated with Scheffé's method of contrast of means between each of the four degrees of

hyperkinesis were computed and examined (Table 8).

The twenty-three F ratios reported were not significant beyond the 0.05 probability level. The F ratio of 3.25 between the mean of high HK children and the mean for normal children on the trisensory stimuli presentation task was significant at the 0.05 level. The F ratios of variables 4, 5, and 6 derived through Scheffé's method of contrasts among degrees of hyperkinesis and stimuli combinations neared significance; however they did not attain the critical F value of 2.92, significant at the 0.05 level of probability.

With regard to the conservative nature of Scheffé's method, it was concluded from the results of the F ratios (Table 8) that more than bipolar differences were possible among the degrees of hyperkinesis, and that all degrees of hyperkinesis probably contributed to the overall significance of degree differences on bisensory and trisensory stimuli combinations.

Contrast of Means Between Successive and Simultaneous  
Modality Presentation for Each Degree of Hyperkinesis

Using the results of Scheffé's method of contrasts between degrees of hyperkinesis within bisensory and trisensory stimuli presentations, the researcher explored the nature of successive and simultaneous modality differences within each degree of hyperkinesis (Table 9).

Table 8

Scheffé's Contrast of Successive and Simultaneous  
Modality Means Within Each Level of Hyperkinesis

| Variable | Contrast                        | Estimate | Variance<br>of<br>Estimate | F     |
|----------|---------------------------------|----------|----------------------------|-------|
| 4        | M <sub>1</sub> - M <sub>2</sub> | -0.16    | 0.12                       | -0.46 |
|          | M <sub>1</sub> - M <sub>3</sub> | 0.16     | 0.14                       | 0.44  |
|          | M <sub>1</sub> - M <sub>4</sub> | 0.16     | 0.12                       | 0.93  |
|          | M <sub>2</sub> - M <sub>3</sub> | 0.33     | 0.14                       | 0.86  |
|          | M <sub>2</sub> - M <sub>4</sub> | 0.50     | 0.13                       | 1.37  |
|          | M <sub>3</sub> - M <sub>4</sub> | 0.16     | 0.14                       | 0.46  |
| 5        | M <sub>1</sub> - M <sub>2</sub> | 0.84     | 0.11                       | 0.25  |
|          | M <sub>1</sub> - M <sub>3</sub> | 0.47     | 0.12                       | 1.33  |
|          | M <sub>1</sub> - M <sub>4</sub> | 0.62     | 0.11                       | 1.87  |
|          | M <sub>2</sub> - M <sub>3</sub> | 0.38     | 0.12                       | 1.07  |
|          | M <sub>2</sub> - M <sub>4</sub> | 0.54     | 0.11                       | 1.59  |
|          | M <sub>3</sub> - M <sub>4</sub> | 0.15     | 0.12                       | 0.43  |
| 6        | M <sub>1</sub> - M <sub>2</sub> | 0.31     | 0.10                       | 0.09  |
|          | M <sub>1</sub> - M <sub>3</sub> | 0.38     | 0.11                       | 1.12  |
|          | M <sub>1</sub> - M <sub>4</sub> | 0.84     | 0.10                       | 2.60  |
|          | M <sub>2</sub> - M <sub>3</sub> | 0.35     | 0.12                       | 1.01  |
|          | M <sub>2</sub> - M <sub>4</sub> | 0.81     | 0.11                       | 2.45  |
|          | M <sub>3</sub> - M <sub>4</sub> | 0.45     | 0.12                       | 1.30  |
| 7        | M <sub>1</sub> - M <sub>2</sub> | 0.80     | 0.78                       | 0.90  |
|          | M <sub>1</sub> - M <sub>3</sub> | 0.88     | 0.14                       | 0.59  |
|          | M <sub>1</sub> - M <sub>4</sub> | 2.89     | 0.78                       | 3.25* |
|          | M <sub>2</sub> - M <sub>4</sub> | 2.09     | 0.82                       | 2.30  |
|          | M <sub>3</sub> - M <sub>4</sub> | 1.39     | 0.91                       | 1.45  |

\* Significant at 0.05 level

Key: M<sub>1</sub>- Mean for High Hyperkinesis  
M<sub>2</sub>- Mean for Medium Hyperkinesis  
M<sub>3</sub>- Mean for Low Hyperkinesis  
M<sub>4</sub>- Mean for Normals

Variable 4 - Visual-Auditory Stimuli Combination  
5 - Auditory-Tactile Stimuli Combination  
6 - Visual-Tactile Stimuli Combination  
7 - Trisensory Stimuli Combination

Table 9

Scheffé's Contrast of Means for Successive and  
Simultaneous Modality Stimuli Presentation

| Variable | Contrast        | Degree of<br>Hyperkinesis | Estimate | Variance<br>of<br>Estimate | F     |
|----------|-----------------|---------------------------|----------|----------------------------|-------|
| 4        | $M_1 - M_2$     | $H_1$                     | 0.16     | 0.06                       | -0.63 |
|          | $M_1^1 - M_2^2$ | $H_1^1$                   | 0.09     | 0.07                       | 0.32  |
|          | $M_1^1 - M_2^2$ | $H_2^2$                   | 0.11     | 0.09                       | 0.36  |
|          | $M_1^1 - M_2^2$ | $H_3^3$                   | 1.09     | 0.07                       | 3.96* |
| 5        | $M_1 - M_2$     | $H_1$                     | -0.16    | 0.00                       | -0.63 |
|          | $M_1^1 - M_2^2$ | $H_1^1$                   | 0.09     | 0.07                       | 0.32  |
|          | $M_1^1 - M_2^2$ | $H_2^2$                   | 0.22     | 0.09                       | 0.72  |
|          | $M_1^1 - M_2^2$ | $H_3^3$                   | 1.36     | 0.07                       | 4.93* |
| 6        | $M_1 - M_2$     | $H_1$                     | 0.00     | 0.03                       | 0.00  |
|          | $M_1^1 - M_2^2$ | $H_1^1$                   | 0.01     | 0.04                       | 0.88  |
|          | $M_1^1 - M_2^2$ | $H_2^2$                   | 0.55     | 0.00                       | 2.45* |
|          | $M_1^1 - M_2^2$ | $H_3^3$                   | 1.27     | 0.04                       | 6.21* |
| 7        | $M_1 - M_2$     | $H_1$                     | 1.66     | 0.35                       | 2.80* |
|          | $M_1^1 - M_2^2$ | $H_1^1$                   | 1.45     | 0.38                       | 2.34* |
|          | $M_1^1 - M_2^2$ | $H_2^2$                   | 2.44     | 0.47                       | 3.56* |
|          | $M_1^1 - M_2^2$ | $H_3^3$                   | 4.18     | 0.38                       | 6.73* |

\* Significant at 0.05 level

Key:  $M_1$  - Mean for Successive Presentation  
 $M_2$  - Mean for Simultaneous Presentation

$H_1$  - Degree of High Hyperkinesis  
 $H_2$  - Degree of Medium Hyperkinesis  
 $H_3$  - Degree of Low Hyperkinesis  
 $H_4$  - Degree of Non-Hyperkinesis

Variable 4 - Visual-Auditory Stimuli Combination  
Variable 5 - Auditory-Visual Stimuli Combination  
Variable 6 - Visual and Tactile Stimuli Combination  
Variable 7 - Trisensory Stimuli Combination

Eight of the 16 F ratios were significant beyond the 0.05 probability level. The F ratios associated with Scheffé's method of contrasts between high and medium and low degrees of hyperkinesis on variables 4 and 5 did not reach the critical value of 2.02 for significance on the 0.05 level. Four of the eight significant F ratios were the contrasts of means between successive and simultaneous modality presentation for normal children on both the bisensory and trisensory stimuli combinations. Normal children performed better than HK when stimuli were presented in a simultaneous manner rather than in a successive modality presentation, regardless of the sensory stimuli combination. Children diagnosed as low HK on a visual and tactile stimuli combination task, demonstrated a significantly lower mean error rate with a simultaneous modality presentation rather than with a successive modality presentation. Perceptual integration of HK and normal children was significantly better with a trisensory simultaneous modality presentation.

Interaction between Degrees of Hyperkinesis and Modality Presentations within Bisensory and Trisensory Stimuli Combinations

The F ratios for the interaction between degree of hyperkinesis and modality presentation were all significant at the 0.05 level of probability. Hence, null hypothesis 6, that significant interaction effects in intersensory

integration patterns do not exist between successive and simultaneous modality presentation and degree of hyperkinesis, was rejected.

Visual and auditory stimuli. Figure 3 shows the interaction between degree of hyperkinesis and modality presentation within visual and auditory stimuli combinations.

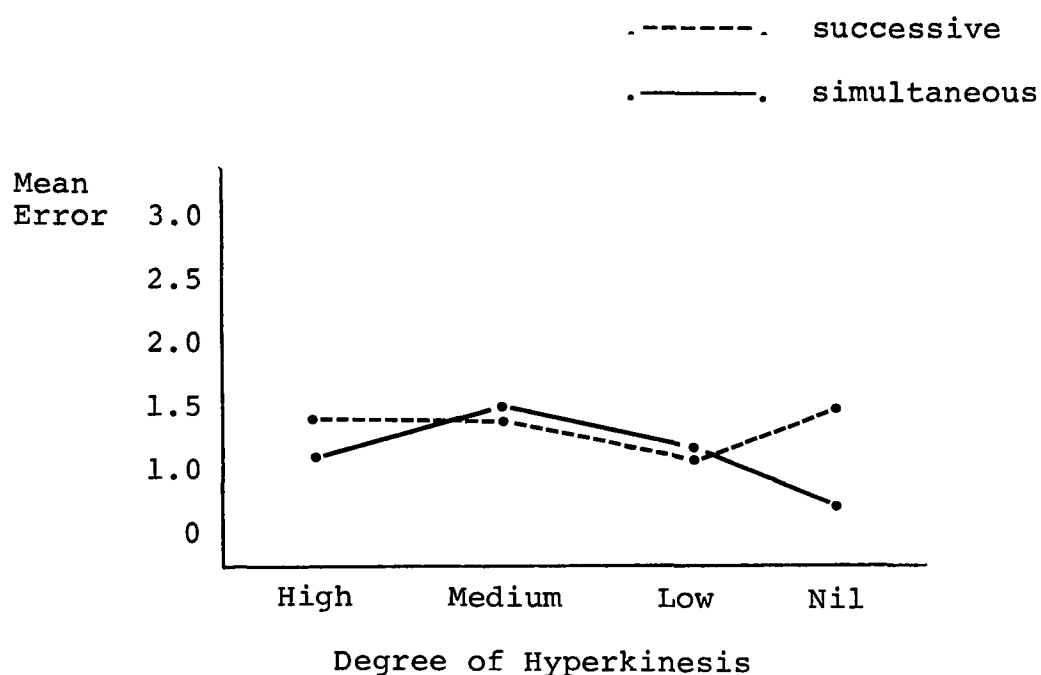


Figure 3

Illustration of Interaction Between Degrees of Hyperkinesis and Modality Presentation Within Visual and Auditory Stimuli Combinations

Figure 3 shows a disordinal interaction between high and medium HK children presented with visual and auditory stimuli in successive and simultaneous modalities. The mean error results of the visual and auditory successive and simultaneous stimuli presentations were not significant

for high, medium and low degrees of hyperkinesis. The interaction was significant between successive and simultaneous modality presentations to children who manifested no HK behavior. Those children had a significantly lower mean error rate when auditory and visual stimuli were presented simultaneously.

Auditory and tactile stimuli. Figure 4 presents the disordinal interaction between degree of hyperkinesis and modality presentation within an auditory and tactile stimuli combination.

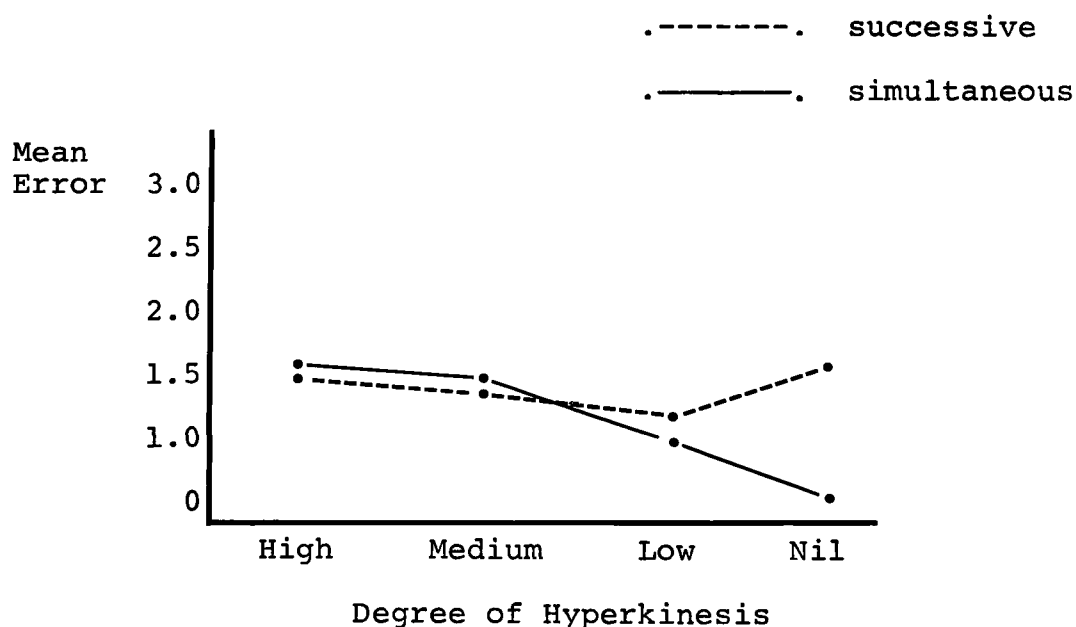


Figure 4

Illustration of Interaction Between Degrees of  
of Hyperkinesis and Modality Presentation  
Within Auditory and Tactile Stimuli Combinations

The perceptual performance of low, medium and high HK children was non-significant when auditory and tactile stimuli were presented in either successive or simultaneous modalities. Normal children committed a mean error rate of 1.6 when auditory and tactile stimuli were presented successively. However, the same group of children, with the same stimuli combination presented in a simultaneous modality, reduced their mean error rate to a 0.27 error. That 1.33 error reduction was significant at the 0.05 level of probability, indicating that non-HK children experienced significantly less difficulty than normal children in counting stimuli in a simultaneous modality presentation.

Visual and tactile stimuli. The ordinal interaction between degree of hyperkinesis and modality presentation within visual and tactile stimuli combinations is shown in Figure 5.

The less marked the degree of hyperkinesis, the smaller the mean error rate differences between degree of hyperkinesis and modality presentation. For example, the mean error rate of children who manifested a high degree of hyperkinesis was 1.6 for both the simultaneous and successive modality presentations. Children with a lesser degree of HK behavior reduced their mean error rate significantly when visual and tactile stimuli were presented in a simultaneous modality.

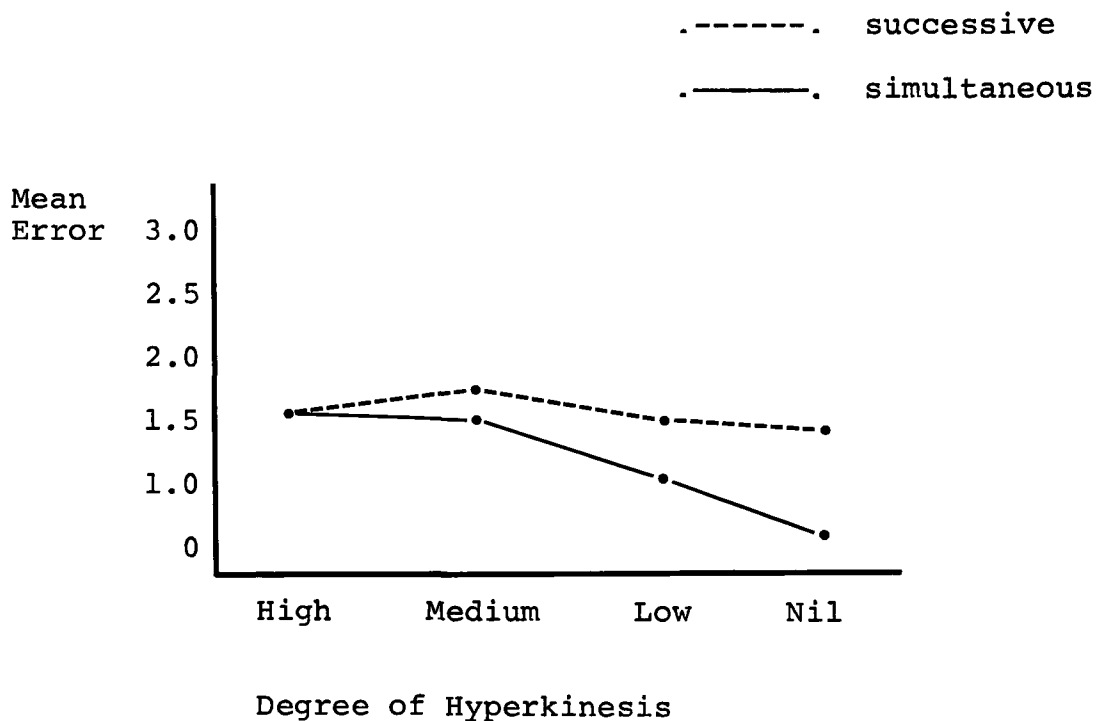


Figure 5

Illustration of Interaction Between Degrees of Hyperkinesis and Modality Presentation Within Visual and Tactile Stimuli Combinations

Trisensory stimuli combinations. An ordinal interaction occurred when auditory, visual and tactile stimuli were presented in a trisensory form in either successive or simultaneous modality to all four degrees of hyperkinesis (Figure 6).

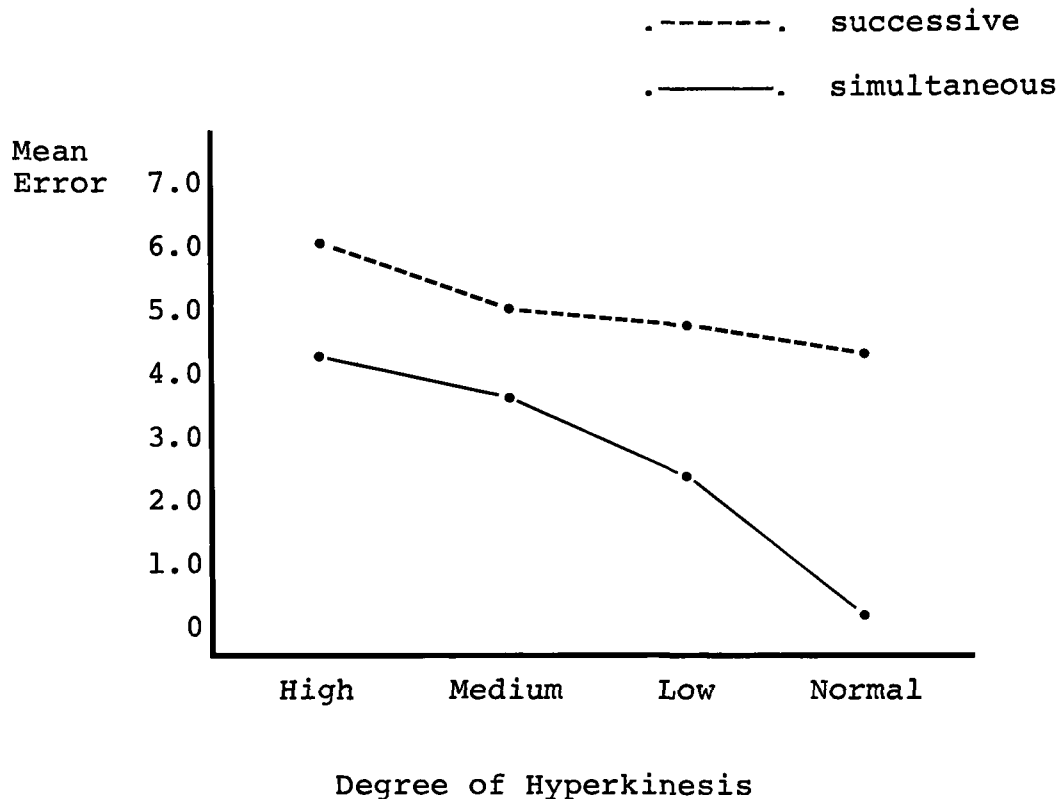


Figure 6

Illustration of Interaction Between Degrees of Hyperkinesis and Modality Presentation Within Trisensory Stimuli Combinations

Hyperkinetic children performed significantly better when auditory, tactile, and visual stimuli were presented simultaneously. A successive modality presentation with a combination of trisensory stimuli proved difficult for all HK children.

### Summary

Part II of the present chapter reported the existence of significant intersensory integration patterns between degree of hyperkinesis and modality presentation.

The testing of simple effects revealed significant perceptual differences between HK and normal children when stimuli were presented in a successive or simultaneous modality. For example, the mean error rate was significantly lower for normal children than HK children on a bisensory simultaneous modality presentation. However, both HK and normal children reduced their mean error rates significantly when trisensory stimuli were presented in a simultaneous modality.

## CHAPTER VI

### Conclusions and Implications

#### Conclusions

The primary purpose of the present investigation was to explore Luria's concept of a functional maturational disturbance (Chapter I) as being an explanation of hyperkinesis. The present study represented the first reported attempt to clarify intrasensory and intersensory processing patterns of HK and normal children within a Lurian paradigm. It was the first study to use degrees of hyperkinesis and chronological age levels as independent variables. The present investigation was also a first in that it attempted to assess the inability of HK children to adapt to ongoing activity with successive and/or simultaneous stimuli presentations.

Despite the limitations of samples and difficulties of available psychometric instruments to evaluate intrasensory and intersensory integrational abilities of HK children the present investigation succeeded in making the following conclusions:

Intrasensory. It was postulated that difficulties in intrasensory and intersensory integration would exist among children who exhibited varying degrees of hyperkinesis.

The comparison between HK and normal children on the reception and processing of visual, auditory, and tactile stimuli showed that Ss with a more marked degree of HK behavior experienced significantly more difficulty in the use of the tactile modality. But no significant differences were found in the visual and auditory modalities.

Intersensory. Hyperkinetic and normal children were assessed on intersensory integration with successive and simultaneous stimuli presentations. The results of a successive stimuli presentation, showed that HK and normal children did not differ significantly in their rate of recognizing bisensory or trisensory stimuli presentations. However, in a simultaneous bisensory stimuli presentation significant differences were found between HK and normal children. In simultaneous trisensory stimuli presentation both HK and normal children committed significantly fewer errors than in a successive trisensory stimuli presentation.

#### Theoretical and Educational Implications

An important finding of the current study was that significant differences in the ability to receive and process intrasensory stimuli, found between degrees of hyperkinesis, were also found in the three age levels. However, the lack of significant interaction effects

between degrees of hyperkinesis and age levels appears to indicate that anomalous intrasensory development may have taken place by the time HK children reached the age of six. Those findings suggest that current methods of teaching exceptional children should take into account the possibility that sensory reception capacities might not have matured in harmony with the chronological age of the child. Since no significant interaction effects were found between age levels and degrees of hyperkinesis, it was concluded that the intrasensory processing patterns of HK children were more closely related to the etiology of hyperkinesis than to a critical age period.

It will be recalled that the post hoc procedures indicated that the tactile sensory reception capacities of HK children were significantly inferior to those of the normal controls. A similar discrepancy between auditory, visual, and tactile modalities of brain-damaged children was reported by Deutsch and Schumer (1970). It has been claimed that tactual training procedures based on an understanding of the role of relevance, irrelevance, or absence of visual cues would be especially helpful for children who demonstrated deficiencies in tactile perception. Similarly, in a number of his training and diagnostic procedures, Luria (1963a) commented on the primacy of the visual systems in all children. He suggested that, for a

child underdeveloped in the tactile modality, tactile training without the use of visual cues might develop the tactile modality to the same level as the visual and auditory modalities.

It was concluded from the results of the successive and simultaneous stimuli presentations that HK children's intersensory reception difficulties were a function of modality switching rather than of the number of modalities stimulated. The results support the contention that the major difficulty of HK children lies in their inability to reprogram ongoing activity. In practical terms, a teacher could simultaneously use all three of the sensory modalities causing undue difficulty for the HK child, if the stimuli are organized and spaced in keeping with Broadbent's one-two second hypothesis. That approach would allow HK children to integrate incoming stimuli adequately. Much of the inability to reprogram ongoing activity may be reduced if the learning situation is tailored to the HK child's own particular disabilities and impairments, defined in terms of modality, age, degree of hyperkinesis, and complexity of stimulus.

Since correct diagnosis carries the potential for ultimate treatment, it is suggested that the HK's incapacity to reprogram ongoing activities might be overcome by specific remedial developmental assistance. The diagnosis

having been established, teachers could make use of tests or games which emphasize and develop the ability to switch between principles of action. Examples of such tests are the Trail Matching Test B, the Wisconsin Card Sorting Test, and the Porteus Maze Test in its qualitative form. Such tests or games could be employed in a way similar to that used by Palkes, Stewart, and Kahana (1968) who trained children in self-directed commands by means of the Trail Matching Test and Porteus Maze Test. Care should be taken that the adaptation focuses primarily upon tactile reception and processing of stimuli.

In the past, the HK child's quantitative activity patterns have been used to categorize him as HK. The current study viewed hyperkinesis as a qualitative expression of a functional maturational disturbance rather than as a mere quantification of behavioral characteristics. That viewpoint makes it possible for one to regard the HK syndrome as being on a continuum of behavior, and as being amenable to treatment which could take the form of educational rehabilitation. It is clear that time and maturation must also be seen as being significant factors in the re-education process of the HK child.

### Further Research Implications

The current study found that delayed and irregular maturation of sensory reception and processing is evident by the time HK children enter elementary school. That finding, coupled with the insignificant interaction between degrees of hyperkinesis and age levels on the experimental tasks, caused the investigator to propose that anomalous intrasensory-intersensory development may be detected at the pre-school level. Such a study would determine the approximate age at which reception and processing of stimuli differs between HK and normal children.

It is obvious that regardless of the advances made in perfecting methods of identification and treatment of HK children, research must be conducted on a longitudinal basis, in order to clarify the extent and nature of the functional maturational disturbance among all age levels and degrees of hyperkinesis.

It is further suggested that cross validation studies be conducted using independent and random samples from various populations. Such studies would improve the ability to understand, predict, and generalize the intra-sensory and intersensory integration processes of HK children to a larger population.

The intrasensory-intersensory results of the present study suggest a thorough review of present methods

of teaching HK children. The review would elaborate on what modality is used and how stimuli are organized in classroom learning.

Another method of investigation is the assessment of the effect of pharmacotherapy on degrees of hyperkinesis and age levels. Fortunately, the pharmacotherapeutic trend in education (Grinspoon and Silver, 1973) and in psychiatry (Metcalf and Jordan, 1972; Connors, 1972) favour a specific drug rationale for HK children. Butter and Lapierre (1973a, 1973b)<sup>4</sup> have attempted to specify the drug action of methylphenidate, through the use of perceptual, attentional, and autonomic measures to isolate modality specific reactions. Further studies, using both behavioral and physiological measures, could assess the effects of such drugs as dextroamphetamine and pemoline (Cyclert) on intrasensory-intersensory integration processing patterns, and/or the ability to reprogram ongoing activity.

#### Summary

The present research determined that significant differences in intrasensory and intersensory integration processing patterns exist among degrees of hyperkinesis as

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Abstracts of the results of those studies appear in Appendices 10, 11, and 12.

classified by independent raters. It dismissed the effects of age levels by showing that intrasensory-intersensory degree of differences were the same among three age levels.

Finally, the results of the current study were discussed. Theoretical, practical, and future implications for educational rehabilitation of the HK child were suggested.

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APPENDIX 1  
DAVID'S RATING SCALE

TABLE 1. Rating scales for hyperkinesis.

Child's Name \_\_\_\_\_ Birth Date \_\_\_\_\_

Rater's Name \_\_\_\_\_ Date of Rating \_\_\_\_\_

Please rate the child on each of the characteristics (or behavior) listed on the following scales. Place a check mark at the point on the scale indicative of your estimate of the degree to which the child possesses the particular characteristic.

As you make each rating, judge the child in comparison with other children of the same sex and age. That is, the ratings should indicate your estimate of the child's behavior in comparison with the behavior displayed by other "normal children."

For each of the characteristics, which are defined below, place a check mark at one of the six points on the scales running from "much less than most children" to "much more than most children." Do not mark the midpoint on any of the scales. Even though it may sometimes be difficult to make a judgment, please make a rating on one or the other side of the scale.

- 1 *Hyperactivity* – Involuntary and constant overactivity, advanced motor development (throwing things, walking, running, etc.), always on the move, rather run than walk, rarely sits still.

|                              |      |               |               |      |                              |
|------------------------------|------|---------------|---------------|------|------------------------------|
| Much Less Than Most Children | Less | Slightly Less | Slightly More | More | Much More Than Most Children |
|------------------------------|------|---------------|---------------|------|------------------------------|

- 2 *Short Attention Span and Poor Powers of Concentration* – Concentration on a single activity is usually short, with frequent shifting from one activity to another, rarely sticks to a single task very long.

|                              |      |               |               |      |                              |
|------------------------------|------|---------------|---------------|------|------------------------------|
| Much Less Than Most Children | Less | Slightly Less | Slightly More | More | Much More Than Most Children |
|------------------------------|------|---------------|---------------|------|------------------------------|

- 3 *Variability* – Behavior is unpredictable, with wide fluctuations in performance, "sometimes he (or she) is good and sometimes bad."

|                              |      |               |               |      |                              |
|------------------------------|------|---------------|---------------|------|------------------------------|
| Much Less Than Most Children | Less | Slightly Less | Slightly More | More | Much More Than Most Children |
|------------------------------|------|---------------|---------------|------|------------------------------|

- 4 *Impulsiveness and Inability to Delay Gratification* – Does things on the spur of the moment without thinking, seems unable to tolerate any delay in gratification of his (her) needs and demands; when wants anything, he (she) wants it immediately; does not look ahead or work toward future goals, thinks only of immediate present situation.

|                              |      |               |               |      |                              |
|------------------------------|------|---------------|---------------|------|------------------------------|
| Much Less Than Most Children | Less | Slightly Less | Slightly More | More | Much More Than Most Children |
|------------------------------|------|---------------|---------------|------|------------------------------|

- 5 *Irritability* – Frustration tolerance is low, frequently in an ugly mood, often unprovoked, easily upset if everything does not work out just the way he (she) desires.

|                              |      |               |               |      |                              |
|------------------------------|------|---------------|---------------|------|------------------------------|
| Much Less Than Most Children | Less | Slightly Less | Slightly More | More | Much More Than Most Children |
|------------------------------|------|---------------|---------------|------|------------------------------|

- 6 *Explosiveness* – Fits of anger are easily provoked, reactions are often almost volcanic in their intensity, shows explosive, temper-tantrum type of emotional outbursts.

|                              |      |               |               |      |                              |
|------------------------------|------|---------------|---------------|------|------------------------------|
| Much Less Than Most Children | Less | Slightly Less | Slightly More | More | Much More Than Most Children |
|------------------------------|------|---------------|---------------|------|------------------------------|

- 7 *Poor School Work* – Has difficulty participating successfully in school work, cannot concentrate on school work, has some specific learning difficulties or blocks (e.g., poor in arithmetic, poor in reading, etc.), poor visual-motor coordination (e.g., awkward gestures, irregular handwriting, poor in drawing, etc.).

|                              |      |               |               |      |                              |
|------------------------------|------|---------------|---------------|------|------------------------------|
| Much Less Than Most Children | Less | Slightly Less | Slightly More | More | Much More Than Most Children |
|------------------------------|------|---------------|---------------|------|------------------------------|



## APPENDIX 2

### CLASSIFICATION OF CHILDREN ACCORDING TO AGE LEVEL AND DEGREE OF HYPERKINESIS

## APPENDIX 2

CLASSIFICATION OF CHILDREN ACCORDING TO  
AGE LEVEL AND DEGREE OF HYPERKINESISDegree of Hyperkinesis

|        |    |
|--------|----|
| High   | 11 |
| Medium | 12 |
| Low    | 9  |
| Normal | 11 |

| <u>Age Group</u> | <u>Hyperkinetic</u> | <u>Normal</u> |
|------------------|---------------------|---------------|
| Old              | 14                  | 4             |
| Medium           | 12                  | 4             |
| Young            | 10                  | 3             |

n - 43

APPENDIX 3  
AUDITORY DECODING

## APPENDIX 3

Basal: 5 succès consécutifs

Ceiling: 3 faillites dans 7 items

RECEPTION AUDITIVE

Démonstration A

Ss sous 6-0 commence avec Demo I:

E: Est-ce que les garçons jouent?

Après la réponse de S, E dit:

Oui, les garçons jouent.  
Est-ce que les chaises jouent?

Après la réponse de S, E dit:

Non, les chaises ne jouent pas.  
Est-ce que les chaises mangent?

Après la réponse de S, E dit:

Non, les chaises ne mangent pas.

TEST

Ss sous 6-0 commence avec item I

Demo I

- a) Est-ce que les garçons jouent?
- b) Est-ce que les chaises jouent?
- c) Est-ce que les chaises mangent?

Items

- 1) Est-ce que les chiens mangent?
- 2) Est-ce que les chiens volent?
- 3) Est-ce que les arbres volent?
- 4) Est-ce que les bébés boivent?
- 5) Est-ce que les bébés pleurent?
- 6) Est-ce que les bicyclettes mangent?
- 7) Est-ce que les robes chantent?
- 8) Est-ce que les enfants grimpent?
- 9) Est-ce que les chats jappent?
- 10) Est-ce que les abeilles piquent?

## APPENDIX 3

Demonstration B

Ss 6-0 et au-dessus commence avec Demo II

E: Est-ce que les avions volent?

Après la réponse de S, E dit:

Oui, les avions volent.

Est-ce que les poulins se rasent?

Après la réponse de S, E dit:

Non, les poulins ne se rasent pas.

TEST

Ss 6-0 et au-dessus commence avec Item II.

Demo II

a) Est-ce que les avions volent?

b) Est-ce que les poulins se rasent?

Items

- 11) Est-ce que les gens se marient?
- 12) Est-ce que les bananes téléphonent?
- 13) Est-ce que les fourmis rampent?
- 14) Est-ce que les aigles peignent?
- 15) Est-ce que les briques flottent?
- 16) Est-ce que les hachettes coupent en morceaux?
- 17) Est-ce que les cadrans baillent?
- 18) Est-ce que les bûches brûlent?
- 19) Est-ce que les trottoirs arrosent?
- 20) Est-ce que les pingouins se balancent?
- 21) Est-ce que les pelotes acclament?
- 22) Est-ce que les saucisses froncent les sourcils?
- 23) Est-ce que les fleurs s'épanouissent?
- 24) Est-ce que les parachutes rament?
- 25) Est-ce que les scouts font des signes?
- 26) Est-ce que les bouffons culbutent?
- 27) Est-ce que les clairons camouflent?
- 28) Est-ce que les cheminées se détendent?
- 29) Est-ce que les magiciens divertissent?
- 30) Est-ce que les baromètres félicitent?

## APPENDIX 3

- 31) Est-ce que les dentistes percent?
- 32) Est-ce que les microscopes magnifient?
- 33) Est-ce que les zèbres se cachent?
- 34) Est-ce que les mariés rêvent?
- 35) Est-ce que les cosmétiques célèbrent?
  
- 36) Est-ce que les feuilles s'agitent?
- 37) Est-ce que les portails se précipitent?
- 38) Est-ce que les charpentiers s'agenouillent?
- 39) Est-ce que les sphinxes galopent?
- 40) Est-ce que les météorites se heurtent?
  
- 41) Est-ce que les dictionnaires définissent?
- 42) Est-ce que les belettes tricotent?
- 43) Est-ce que les combustibles allument?
- 44) Est-ce que les canines manufacturent?
- 45) Est-ce que les breuvages désaltèrent?
  
- 46) Est-ce que les pigeons roucoulent?
- 47) Est-ce que les compas efficaces renseignent mal?
- 48) Est-ce que les oiseaux sans ailes s'élèvent?
- 49) Est-ce que les oiseaux migrateurs traversent?
- 50) Est-ce que les musiciens muets vocalisent?

APPENDIX 4  
VISUAL DECODING

## APPENDIX 4

BASAL : 3 succès consécutifs.

CEILING : 3 faillites consécutives.

RECEPTION VISUELLE:

DEMONSTRATION:

Ss sous 6-0 commence avec Demo Ia et Ib.

Ss 6-0 et au-dessus commence avec Demo IIa et IIb.

E expose page-stimulus pour 3 secondes et dit:

Vois-tu ceci?

Après 3 secondes, E expose la page-réponse et dit:

Trouves-en un ici.

Après la réponse de S, E expose de nouveau la page-stimulus et dit:

Pour Demo Ia : Oui, (non) nous devrions trouver un autre chien.

Pour Demo Ib : Oui, (non) nous devrions trouver une autre paire de pantalon.

Pour Demo IIa : Oui, (non) nous devrions trouver quelque chose qui contient les rebuts.

Pour Demo IIb : Oui, (non) nous devrions trouver un autre enfant qui court.

E expose la page-stimulus, indique la bonne réponse et dit:

La voici.

TEST:

Ss sous 6-0 commence avec Item I

Ss 6-0 et au-dessus commence avec Item II.

E présente la page-stimulus en disant:

Vois-tu ceci?

E présente la page-réponse en disant:

Trouves-en un ici.

APPENDIX 5  
MOTOR ENCODING

## APPENDIX 5

BASAL : Aucun  
CEILING : Aucun

EXPRESSION MANUELLE:

E donne le marteau (jouet) à S.

Montres-moi ce que l'on fait avec un marteau.

Si pas bonne réponse, E fait la démonstration et repose la même question.

E enlève le marteau, montre un portrait d'un marteau.

Maintenant, montres-le moi encore. Imagines que tu en as un vrai.

TEST:

Même processus, aucune verbalisation.

## APPENDIX 6

### HOPITAL PIERRE JANET STIMULUS KIT

## APPENDIX 6

## Instructions

After the pre-test, and relaxation period Ss were told:

VISUAL

"Maintenant quand la lumière blanche s'éteint il va y avoir une lumière rouge qui va s'allumer et ensuite quand la lumière blanche va se rallumer tu diras les nombres de lumières rouge que tu as vu."

AUDITORY

"Maintenant écoute bien dans les oreilles, tu vas entendre un son, quand la lumière blanche s'éteint, et ensuite quand la lumière blanche va se rallumer tu diras combien de sons tu as entendu."

TACTILE

"Sur la main droite, tu as un vibreur. Tu sens que ça chatouille. Quand la lumière blanche s'éteint et ensuite quand la lumière blanche va se rallumer tu diras les nombres des vibrations tu as reçu."

TWO MODALITIES

Essai pour les deux:

"Maintenant, il va y avoir deux fois: une lumière et un chatouillement, ou bien un son et un chatouillement. La lumière blanche va s'éteindre il va y en avoir deux comme ça une fois ... et ensuite une autre fois. Quand la lumière blanche se rallume il faut que tu dises: combien en nombre, de lumières, sons et vibrations."

THREE MODALITIES

Essai pour les trois:

Maintenant, il va y en avoir trois à la fois: une lumière, un son et un chatouillement.

La lumière blanche va s'éteindre et il va y en avoir trois comme ça une fois et ensuite une autre et une autre fois. Quand la lumière blanche se rallume, il faut que tu

## APPENDIX 6

dises combien de nombres de lumières, sons-et vibrations.

All responses were recorded on sheets during each phase of the experiment. (Appendix 7)

APPENDIX 7

SCORE SHEET FOR THE HPJSK TASK

[illegible]

[illegible]

APPENDIX 8  
EXPERIMENTAL INFORMATION SHEET

APPENDIX 8  
INFORMATION SHEET

NOM DU PROJET:

RESPONSABLE PRINCIPAL:

NOM DU MALADE:

SEXE:                      AGE:                      DATE DE NAISSANCE:

No. DE DOSSIER:                      No. DE CODE:

POIDS:                      SERVICE DR:

DIAGNOSTIC:

AUTRES DIAGNOSTICS:

DATE D'ADMISSION DANS L'EXPERIENCE:

DATE DE LA FIN DE L'EXPERIENCE:

SI RETIRE(E) DE L'EXPERIENCE, DONNEZ LES RAISONS:

## APPENDIX 9

### EXPERIMENTAL PROGRESS SHEET

APPENDIX 9

DATE:

NOM:

NO:

MEDECIN TRAITANT

\_\_\_\_\_ Subject has passed  
Inclusion and Exclusion Criteria

\_\_\_\_\_ Pretest Measures

\_\_\_\_\_ Familiarization Run

\_\_\_\_\_ Depart (Drying out phase if necessary)

\_\_\_\_\_ Measures Done:

- Rating Scales
- Auditory Decoding
- Visual Decoding
- Motor Encoding
- HPJSK

## APPENDIX 10

THE EFFECT OF METHYLPHENIDATE ON SENSORY  
PERCEPTION AND INTEGRATION IN HYPER-  
ACTIVE CHILDREN

## APPENDIX 10

THE EFFECT OF METHYLPHENIDATE ON SENSORY PERCEPTION AND  
INTEGRATION IN HYPERACTIVE CHILDREN

H.J. Butter, M.Ed., Y.D. Lapierre, M.D., F.R.C.P. (C)

Abstract

An attempt has been made to elucidate the perceptual deficiencies of hyperactive children and the improvement of these deficiencies during treatment with methylphenidate. Using the Illinois Psycholinguistic Ability Scale, hyperactive children were found to be 18 to 24 months immature compared with the normal group. The effect was particularly evident in the tactile and auditory modalities. The recognition of sensory stimuli was also impaired in the auditory and tactile modalities. The auditory modality alone was improved with methylphenidate. The recognition of successive stimuli was not improved with methylphenidate, but the recognition of simultaneous stimuli of several modalities was improved by the drug.

Hyperactive children indicated a maturational lag which can be partly corrected by the administration of methylphenidate.

## APPENDIX 11

A MULTIVARIATE STUDY OF THE EFFECT OF METHYL-  
PHENIDATE ON SENSORY PERCEPTION AND INTE-  
GRATION AMONG VARIABLE DEGREES OF  
HYPERKINESIS

## APPENDIX 11

A MULTIVARIATE STUDY OF METHYLPHENIDATE EFFECT ON SENSORY PERCEPTION IN VARIABLE DEGREES OF HYPERKINESIS

H.J. Butter, M.Ed., A. Côté, M.D., Y.D. Lapierre, M.D.

Abstract

Thirty-two hyperkinetic children were treated with methylphenidate and placebo in a 6 week double-blind cross-over study. They were assessed on psycho-educational, psychometric, activity and perceptual parameters by means of a clinical assessment, the Illinois Psycholinguistic Ability Scale, the WISC, as well as with a battery of tests specifically directed to attention and perception. The results obtained were compared to a group of eleven normal children of equivalent chronological and mental age.

Degree of hyperkinesis was determined by David's Rating Scale to subdivide the group into high, medium and low severity. There was a negative correlation between chronological age and the severity of hyperkinesis. Therapeutic drug effect correlated positively with the degree of hyperkinesis and negatively with chronological age.

Differences with varying degrees of hyperkinesis and normals were demonstrated on the Illinois Psycholinguistic Ability Scale. These were more pronounced in auditory and visual perception than in tactile. Errors on tactile stimulation, however, were inversely related to the degree of hyperkinesis. Attention span differed significantly in

## APPENDIX 11

the hyperkinetic children.

Treatment with methylphenidate modified these deficiencies selectively. On some parameters, improvement was present or absent for all degrees of hyperkinesis. On others, however, improvement was limited only to the higher degrees of hyperkinetic impairment.

## APPENDIX 12

THE EFFECT OF METHYLPHENIDATE ON CARDIOVASCULAR  
SENSORY DIFFERENTIATION AMONG VARYING  
DEGREES OF HYPERKINESIS

## APPENDIX 12

AbstractTHE EFFECT OF METHYLPHENIDATE ON CARDIOVASCULAR SENSORY  
DIFFERENTIATION AMONG VARYING DEGREES OF HYPERKINESIS

H.J. Butter, M.Ed., Y.D. Lapierre, M.D.

There is increasing experimental evidence that abnormalities of the autonomic nervous system components to the orienting response can be found in subjects who exhibit attentional problems and difficulties with impulse controls. Since the most clearcut psychological deficiencies in hyperkinetic children appear in attention and control of impulses, the present drug study used the heart rate as a correlate for a better understanding of these deficiencies with and without treatment with methylphenidate.

In this study, the action of methylphenidate on heart rate was studied while hyperkinetic children were submitted to intrasensory and intersensory stimuli presentations. Neither children receiving methylphenidate nor those receiving placebo exhibited a significant shift in tonic heart as a result of monosensory stimuli presentation. Heart rates were higher for subjects receiving placebo than those receiving methylphenidate in all experimental conditions for the high and moderate degrees of hyperkinesis. A drug reversal effect was demonstrated in mildly hyperkinetic children. The moderately hyperkinetic children yielded a significant deceleration of heart rate on bisensory and trisensory successive and simultaneous stimuli presentations.

These heart rate and treatment results support the explanation of Luria that hyperkinesis is a functional maturational disturbance of the primary signalling system which is modified by methylphenidate.

APPENDIX 13

VITA

## VITA

Name: Hendrik James Butter

Date of Birth: March 24, 1938

Educational Background:

|           |                        |                   |
|-----------|------------------------|-------------------|
| 1959-1963 | University of Montreal | B.A. June 1963    |
| 1968-1970 | Boston College         | M.Ed. August 1970 |

Communications:

The Effect of Methylphenidate on Sensory Perception and Integration in Hyperactive Children.

23rd Annual Meeting of the Canadian Psychiatric Association, Vancouver, June 1973.

Study on Sensory Perception and the Effect of Methylphenidate in Varying Degrees of Hyperactivity.

18th International Congress of Applied Psychology, Montreal, July 1974.

A Multivariate Study of Methylphenidate Effect on Sensory Perception in Variable Degrees of Hyperkinesis.

24th Annual Meeting of Canadian Psychiatric Association, Ottawa, September 1974.

The Effect of Methylphenidate on Cardiovascular Sensory Differentiation among Varying Degrees of Hyperkinesis.

Canadian Pharmacological and Chemotherapy Association, Montreal, October 1974.

Publication:

The Effect of Methylphenidate on Sensory Perception and Integration in Hyperactive Children. International Journal of Pharmacology, 1974 (in press).