UNIVERSITY OF ALBERTA

A Principal Component Analysis of the Pediatric Early Elementary Examination

BY

Graham E. Ross ©

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled A PRINCIPAL COMPONENT ANALYSIS OF THE PEDIATRIC EARLY ELEMENTARY EXAMINATION submitted by GRAHAM E. ROSS in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY.

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DEDICATION

To

Andrew

Jennifer

and

David

my children

who also sacrificed so that this project could be completed

ABSTRACT

Levine (1991), a developmental-behavioral pediatrician, developed a series of assessment instruments to assist the physician, the Pediatric Early Elementary Examination (PEEX) is one. Little has been done to explore the psychometric properties of the PEEX, which is the focus of this study. A review of the literature shows there is little evidence regarding the validity or reliability of the PEEX. As well, the norming process appears to be ill-defined.

The PEEX, designed to be used with children ages seven through nine, measures seven areas of development through thirty-two tasks. This study, with 203 subjects ages seven through nine, uses a principal component analysis to examine the structure of the PEEX. The subjects (146 male 57 female) were referred to one of two hospitals due to school problems.

The results of this study indicate that the thirty-two tasks do not cluster into the seven developmental areas proposed by Levine. A four component solution is deemed most appropriate; however, it only accounts for 38.4 percent of the variance. It is also shown that there are different principal component solutions when only seven year olds and only eight year olds are used as individual sub-populations. This finding suggests that the PEEX yields different information for different age groups. Finally, a principal component analysis was completed using the PEEX variables as well as the scaled scores from eleven subtests of the Wechsler Intelligence Scale for Children - Revised. It was found that there is virtually no overlap between the variables of the two instruments. Further analysis shows that the PEEX does not reflect general intelligence.

The study concludes that pediatrics and the disciplines related to education will benefit the child to the degree that they can articulate. However, given the lack of evidence for validity and reliability of the PEEX, the lack of specificity regarding the norming process, and the findings of this study with respect to the lack of surety regarding the seven developmental areas it purports to measure, the use of the PEEX should be extremely limited until a major revision of the instrument can be completed.

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CHAPTER ONE

Introduction to the Pediatric Early Elementary Examination

Introduction

The development of the Pediatric Early Elementary Examination (PEEX) in the early 1980's, which is the focus of this study, is a product of the evolution of medicine, specifically the pediatric branch, and of Levine himself. The subspecialty of pediatric medicine evolved just before the turn of the century even though, at that time, pediatric medicine was not seen as significantly different from adult medicine. In the early 1970's, a subspecialty of pediatrics, developmental-behavioral pediatrics, emerged with Levine as one of its founders and most vocal proponents. This particular branch of medicine concerns itself, in part, with school aged children and their success, or lack thereof, within the educational environment.

Developmental-behavioral pediatrics has as part of its focus school aged children; inevitably the paths of education and medicine would therefore need to cross, or more accurately, blend, for this subspecialty to be viable. As developmental-behavioral pediatrics' roots are in medicine, not education, medical practitioners were faced with the task of understanding the impact of neurodevelopmental assessment on education from their medical vantage point. Locally, this was evidenced in the early 1980's as some medical institutions (e.g., University of Alberta Hospitals, Glenrose Hospital) and the Edmonton Board of Health began using a family of assessments which were developed by Levine. These assessments were medical in orientation; however, they appeared to have many commonalties with assessment instruments used in psychology. As well, the results of this family of assessments appeared to have implications for children in their learning environments. Of primary interest was that these instruments (e.g., the PEEX) seemed to have educationally related components and content, however, as they were developed in the medical arena, they had not undergone the rigorous scrutiny to which many measures developed within education or psychology have been subjected.

The Problem

It was encouraging in the early 1980's to witness medicine and education beginning to work together, especially in the area of learning difficulties, areas Levine's instruments target. However, the questions regarding issues such as the accuracy, validity, generalizability, and reliability of instruments such as the PEEX needed to be answered. Today an answer is still required.

This study examines the simple structure of the PEEX. Levine's model of neurodevelopmental dysfunction in children (1980), although not explicitly stated, appears to be the basis for the development of the PEEX. Levine (Levine & Rappaport, 1983) hypothesizes that there are seven developmental areas into which the 32 tasks of this instrument sort, thereby providing the physician, and subsequently the educator, with a descriptive profile of a child's strengths and weaknesses. The specific question is whether Levine's seven areas accurately reflect the data generated by the PEEX. If not, the subsequent issue of finding a better way of understanding the PEEX (e.g., fewer clusters or components), must be investigated. In the process of answering this question, an examination of the validity, reliability, and other issues related to test construction was undertaken through a review of the literature.

The results of this study have significant implications with respect to what the PEEX actually contributes to an improved understanding of the area of learning difficulties in education. Questions as to whether or not the PEEX should be used, and if so in what ways, are also addressed. Finally, other worthwhile research questions emerged as a result of this investigation.

Delineation of the Research Problem

The PEEX has 32 tasks, which Levine has grouped into seven areas (Levine & Rappaport, 1983). To date, no rigorous examination of this instrument has been undertaken, even to the extent of reporting clear norming procedures. As well, the PEEX is just one instrument in a family of instruments used to assess learning difficulties of children ages three through eighteen. The delimitation of this study was particularly difficult as there were a plethora of areas ripe for investigation. Given the nature of the data that reasonably could be collected and the importance of investigating the development and the structure of the instrument, it was decided that a principal component analysis of the PEEX was primary and critical.

Focus

This investigation was focused on exploring one key area, specifically, Does the simple structure of the PEEX support the grouping of the 32 variables (tasks) in the manner that Levine purports? Secondly, are there more efficacious or parsimonious ways of understanding the meaning of the outcomes of this instrument? The answers to these questions have implications for the use of the PEEX and how the results are being applied to individuals and groups of students.

CHAPTER TWO

Review Of The Literature

Outline

This chapter begins with a brief history of Levine's perception of his own development as a physician and an examination of some of his thoughts regarding children and their education. A discussion of what Levine calls "neurodevelopmental examinations" follows, with a specific and detailed description of the Pediatric Early Elementary Examination, the instrument that is the focus of this study. Next, an examination of the major areas of dysfunction that Levine believes negatively impact school performance for children of this age group (i.e., ages seven to nine inclusive) is undertaken, followed by a discussion of how Levine conceptualizes the assessment of these areas. Some of the terms unique to developmental-behavioral pediatrics are defined and an attempt is made to outline and develop a model using a number of Levine's writings. The Aggregate Neurobehavioral Student Health and Educational Review (ANSER), a companion to the PEEX, is reviewed briefly in order to understand how broadly Levine sees the scope of assessing children's needs. The PEEX then undergoes a detailed scrutiny, from the available literature, as well as by comparing the instrument to some of the primary standards found in the Standards for Educational and Psychological Testing (1985). The chapter concludes with a summary and a statement regarding some of the important questions raised.

Background

Levine (1987a), has described himself as a developmental-behavioral pediatrician. He has focused his expertise on learning disorders, normal development, and developmental expectations of school aged children. He stated that his distinct point of view is not just a function of his training and experience, but has also grown out of his experiences when he was a student. His interest in outpatient versus inpatient medicine, combined with two years as a school physician and general pediatrician, taught him "an appreciation for the many ways in which collaboration between pediatricians and school could have a powerful impact on the lives of children" (Levine, 1987a, p. x).

Levine became aware of the magnitude of the problems children have in school while he was the director of the outpatient department of The Children's Hospital in Boston. At that time he also became interested in the ethics of diagnosing disorders in children. He stated that each specialty has its own biases and he claimed that the results reported are more dependent upon the training of the specialists than the actual difficulties of the children. He further stated that parents and children were being "victimized" (Levine, 1987a, p. xi) by the assessment process within schools. Consequently, he set up a number of multidisciplinary clinics to perform independent evaluations of children. He stated, "Our need to describe rather than label such children led us to compile a series of neurodevelopmental examinations and standardized questionnaires. Our goal was to identify strengths, styles, and weaknesses unique to each child" (Levine, 1987a, p. xi).

Levine postulated that there are discrepancies in academic and clinical ways of thinking and that:

> The time is right for fresh efforts at integrating what we have learned about normal development in school-aged children and what we are discovering about problematic learning and difficult life adjustment during childhood. I am firmly convinced that we need to regard children with learning problems as functioning along a dynamic continuum of normal developmental variation while struggling to satisfy constantly evolving expectations. (Levine, 1987a, p. xii).

Recently, Levine (1991) listed 12 distinguishing features of the developmental-behavioral pediatrician. He stated that those in this subspecialty have longitudinal and developmental views and are not invested in any disciplinary diagnostic system, set of diagnostic instruments, or therapeutic styles. Developmental-behavioral pediatricians are committed to multidisciplinary collaboration and "deploy multifactorial and differential diagnostic thought processes" (p. 1). He then posed the question as to what upcoming issues this group will face. He began with the need to "deal with our own lack of collective self-esteem and assertiveness. . . . [and to] achieve more unity while preserving our diversity" (p. 2). It would appear that this group, as a function of its desire to be involved and "expert" in all areas and domains of development, has sacrificed to some degree their sense of being, as understood by their medical peers.

<u>Impetus For Neurodevelopmental Examinations</u>

It appears that in the late 1970's and early 1980's there was a growing recognition on the part of pediatricians that they were going to become ever increasingly involved in the assessment and management of children with learning difficulties. In an article discussing the assessment of learning disabled children by pediatricians. Hagerman (1984) stated that when assessing children with learning disabilities the findings of standard physical and neurological examinations are often normal. Sleator and Ullman (1981) supported this contention in that they suggested that 80 percent of hyperactive children appear normal during the course of a pediatric examination. Hagerman (1984) concluded that the neurodevelopmental evaluation, which includes the physical and neurological examinations, is the best way for the physician to detect potential areas of difficulty. During the developmental portion of the examination the areas of auditory perception, expressive language, visual perception, and visual motor integration are examined. Hagerman indicated that:

> Recently, Levine and his colleagues have developed three standardized neurodevelopmental batteries [including the PEEX] for the physician and health care worker to evaluate children from four years into adolescence. These evaluations are thorough, covering the areas of functioning previously discussed, and can be administered within approximately a one-hour time period. . . . These evaluations are useful because of their standardization and organization of learning tasks. (p. 280).

Hagerman (1984) viewed the pediatrician as having several roles in the assessment and management of children with learning disabilities. The neurodevelopmental assessment allows the physician to suggest areas that may require further attention or assessment. The pediatrician is the "integrator" of information from other sources (e.g., teacher, psychologist) and is the "orchestrator" of the treatment program. Finally his or her role is to sort out the possible etiologies of the dysfunction.

Oberklaid, Dworkin, and Levine (1979) stated that physicians were reporting an increase in the number of patients with concerns regarding children's behavior and learning. As well, with the introduction of Public Law 94-142, interdisciplinary evaluation of handicapped children was mandated. Oberklaid, Dworkin, and Levine suggested that this has affected the role of the pediatrician and that pediatric diagnosis has tended to be "experiential and impressionistic" (p.1131). Given that they saw pediatricians as unprepared for this role, they also saw this need for a broad spectrum, well standardized approach to evaluation. They concluded that, "The pediatrician can emerge as an integrator of multiple factors and interpreter of their implications" (p. 1131). Oberklaid, Dworkin, and Levine also stated that standardized instruments need to be developed.

Levine (1982) indicated that there has been controversy over whether or not a physician should be involved in the diagnosis and management of children whose difficulties appear to be primarily of an educational nature. Levine argued that if a physician provides "more than" traditional services (i.e., medical exams, identification of sensory deficits, hard neurological impairment) there is a place on the team for the doctor. The "more" he suggested, involved two areas, first, the evaluation of family functioning and the assessment of the environmental factors involved in school failure. The second area involves the identification of the neurodevelopmental contributors to school failure. He suggested that it is the administration of stimulant medications to assist with attentional problems that has really drawn the physician into the educational arena. The physician needs to communicate closely with the school to determine the effect of the pharmacological intervention. He also asserted that physicians may be in a better position to advocate for children than the school, as there is no conflict of interest. For example, he suggested that schools may be more concerned about the budget than the needs of an individual child.

Levine would get little argument that there is an important place for the physician on the team bringing its skills to bear on the specific problems of diagnosis, treatment, and management of developmental issues related to school failure. However, it is unlikely that experts in the fields of education or psychology would accept *a priori* that the physician is in the best position, or has the best set of skills, to function as the team leader (or as Hagerman (1984) said to integrate and orchestrate the treatment program).

Levine has called for better training of pediatricians in the area of educational issues since the late 1970's and in a presidential address (Levine, 1991) he said, "we must strengthen and define more clearly the training programs within developmental-behavioral pediatrics" (p. 2).

<u>Definitions and Models</u>

When addressing the areas of developmental focus, Levine (1992d) stated, "Weaknesses in one or more of these areas may be associated with academic underachievement, behavioral difficulties, or problems with social adjustment" (p. 477). Levine has used the phrase "high prevalence, low severity" disorders to refer to these areas. He hypothesized that any given child can suffer from a relatively large number of disabilities. Although any given disability may not, in and of itself, result in a deficit for the child, the cumulative effect of a number of less significant deficits can be severe. Specifically, Levine stated (1992d) that a neurodevelopmental variation which represents a developmental weakness is considered a "dysfunction" (p. 477). If the dysfunction interferes with the acquisition of a specific skill it becomes a "disability" (p. 477). If the skill is important to "reasonable gratification" in our society the disability constitutes a "handicap" (p. 477). He also stated that neurodevelopmental variation can also include the acquisition of skills that could be considered superior. These definitions, which he has indicated are necessary for clarity, are seen as hierarchical in nature and are outlined in Table 2.1.

Levine (1992d) stated that children "who experience academic difficulties harbor *more than one* neurodevelopmental dysfunction" and that the cumulative effect is enough to "impair the innate developmental resiliency of a child, thereby generating academic underachievement" (p. 477). When these neurodevelopmental dysfunctions significantly disrupt learning they are referred to as learning disabilities.

Levine (1984a) stated, that if the child has more than one affected area, the cumulative deficit is overwhelming. Second, he has suggested that the child may not have the compensatory strengths

Table 2.1
A Hierarchy of Neurodevelopmental Status

Variation	An unusual pattern of neurodevelopmental function (e.g., a higher divergent mind)
Dysfunction	A distinct weakness within a neurodevelopmental function (e.g., weak retrieval memory)
Disability	A performance deficiency caused (at least in part) by a neurodevelopmental dysfunction (e.g., trouble throwing a ball)
Handicap	A disability occurring in a much-needed or critical performance area (e.g., a significant reading problem)

From Levine (1992d, p.478)

(bypass strategies) to overcome some of the deficits. This impairs resiliency. Third, there are a number of environmental factors that will have an impact on the outcome (e.g., quality of education, level of remediation available). Fourth, the degree to which the input and output functions are synchronized has an impact. That is, there can be "affective interference" if the child's input skills are average or better but the output skills are impaired. This child can even be considered by others to be morally flawed (e.g., lazy). Fifth, the existence of a productive sibling, especially younger, can have a negative impact on the child.

With respect to labeling, Levine (1992d) indicated that although labels may be useful for obtaining services or money, they can also be dangerous in using labels. Consequently he "shuns labels and offers an empirical approach to the neurodevelopmental dysfunctions that cluster to generate discrete disabilities and significant handicaps" (p. 477). With respect to etiology he has suggested that a low-severity neurodevelopmental dysfunction is most noticeable when it occurs in a "context of environmental turmoils or deprivation" (Levine et al 1985), contrariwise the effects can be minimized in optimal conditions.

Oberklaid, Dworkin, and Levine (1979) presented a model regarding developmental concerns with children. They suggested that the "old" or traditional model of organic versus emotional (i.e., mind/body) is being challenged. They see the result of this model being the presentation of a single theme of causality explaining a child's development. They suggested the "new" model is transactional, that is, outcomes are a function of an "ongoing reciprocal interaction between a child and his environment" (p. 1126). Therefore assessment must examine a child's endogenous characteristics as well as the "transaction" among the environmental factors (e.g., parenting styles, values, critical events).

Oberklaid (1985) expanded on the model described above by suggesting that there are really three models with respect to the approach to assessment. The first is the medical model or the disease model, where the problem is resident within the patient. The goal of this model is to diagnose and treat the disorder within the patient (child). He suggests this model is appropriate in instances of organic disease. The second model he calls the "individual differences" model. The symptoms here are specific to the patient rather than to the disease. The goal in this model is to diagnose the strengths and weaknesses within the patient (child) and then to generate an accurate description (rather than to diagnose). This leads to the development of an individualized management plan, including intervention(s). The third model, "transactional", is a combination of the first two and implies that the dysfunction is a function of intrinsic (within) and environmental (without) factors. Therefore assessment must examine both domains. He said this is best done through history taking, physical examination, neurological and sensory exams, and a neurodevelopmental assessment.

Levine (1987a) stated that, "An implicit conceptual model governed the selection and division of the subject matter" (p. 8). This subject matter consists of the seven developmental functions that Levine postulates have a profound effect on the lives of school aged children. These functions are associated with disordered learning, reduced productivity, and hence to lack of success in school. He listed the seven functions as: attention and intention; simultaneous and sequential processing and production; memory; language; higher-order cognition; motor implementation; and social ability.

The reader may have noted that Levine (1992d) lists eight functions. Table 2.2 summarizes the shift from 1987 to 1992. It is only speculation as to which categories match. Some are apparent (e.g., memory); however, it is somewhat more difficult to determine how those placed later on the list match.

One of the dimensions to the PEEX which tends to make it attractive to potential users, also relates to Levine's (1992d) eight constructs. These constructs have been well documented in the literature as areas which have a significant impact on children's learning and performance in the educational environment. Any

Table 2.2
Comparison of Levine's Functions
Important To School Success
(1987 cf. 1992)

Levine (1987a)	Levine (1992d)
Attention and Inattention	Selective Attention
Memory	Memory
Language	Language
Higher Order Cognition	Higher Order Cognition
Social Ability	Social Cognition
Motor Implementation	Neuro-Motor Function
Simultaneous and Sequential	Temporal Sequential Organization
	Visual Spatial Ordering

instrument which can assess and document difficulties in these areas would contribute significantly to the field of assessment of children with learning difficulties. It is not the intent at this time to review these constructs in detail; however, it can be demonstrated that the constructs that Levine attempts to measure with the PEEX are constructs which others view as significant.

D'Amato, Lassiter, and Dean (1993) explored the factor structure of a number of psychoeducational and neuropsychological instruments used with learning disabled children and found seven factors (i.e., verbal reasoning, academic achievement, visual-perceptual organization, developmental, visual-motor speed, spatial memory, and attention and concentration) which they stated should be considered in identifying and placing learning disabled children.

The similarities between their seven factors and a number of Levine's constructs (1993c) is apparent.

Higher order cognition is a broad construct which includes areas such as concept development. Medin (1989) indicated that concepts were the building blocks of thinking. As concept development in children is explored, it is clear that language becomes paramount in the expression, if not the development, of concepts. The Linguistic area of the PEEX attempts to assess children's language skills. Syntax (Hormann, 1986) governs the structure of language (reflected in the Complex Sentences task). Howard (1983), as part of his work, explored syntactic competence through linguistic intuitions. Higher order cognition and language (linguistics) are seen as important constructs. If however, language is, in part, a subset of higher order cognition, it is possible that Levine is making distinctions which may not be able to be assessed (i.e., assessing higher order cognition independent from language). This might lead to speculation that the PEEX will not discriminate well between some of the constructs.

Children with attentional difficulties evoke concerns in adults (teachers and parents). Children with these difficulties tend to comprise one of the largest groups referred for assistance (Barkley, 1990). Kataria, Hall, Wong, and Keys (1992) found that children with attention deficit hyperactivity disorder (ADHD), who were also learning disabled, had significantly more difficulty with memory tasks, especially ordered recall, than did the non-learning disabled ADHD group. Memory itself is a global construct, as some theorists believe that memory is more than a simplified unified process

(Watkins, 1990) and there appear to be different types of memories (Tulving, 1985). Short term memory is also referred to by Baddeley (1982) as working memory, or as Levine (1992d) called it, active working memory. This type of memory keeps information in storage for only a few seconds and is measured on the PEEX by tasks such as Object Span or Digit Span. Long term memory refers to the child's ability to remember and recall information after considerable time has passed (e.g., minutes or years). Information needs to be elaborated upon to get into long term memory (Craik & Lockhart, 1972). Recall Objects and Recall Words are long term memory tasks on the PEEX. The subject is asked to remember (for later) specific words and objects used in short term memory tasks. The re-presentation can occur twenty minutes or more later. However, as the rest of the PEEX is then given, it is unlikely that many children are able to elaborate as the test itself serves to interfere with that process. This may result in generally poor performance on these tasks.

Levine's social cognition (1992d) construct, the perception and evaluation of oneself and others in social situations, is an area investigated by Osman (1987). She suggested that learning disabled children lack social competence and that the social problem seemed to be intrinsic to the learning disability itself. She stated that the difficulty occurred on different levels: at the social cognition and skill deficit level, the performance level, or at the self-monitoring level. This is an area which has implications that go beyond the learning environment. Levine recognized this when he included the Gross Motor area on the PEEX, he indicated that children who have poor gross motor skills are at risk for worse than average peer relationships.

Perception and visual motor skills are frequently clustered when discussed. Mantzicopoulos & Morrison (1990) found that kindergarten children who were retained had higher incidences of perceptual and visual motor problems. Mattison, McIntyre, Brown, and Murray (1986) found that, with learning disabled children, the motor coordination component and the integration of the motor coordination and visual perceptual components were impaired. Sommers (1988) found a strong relationship between linguistic abilities and fine motor skills.

From this brief review of literature related to Levine's (1992d) eight areas, it has been demonstrated that the constructs that Levine is attempting to measure have continuing importance in the area of children with learning disabilities. As well, it was noted that some of these constructs were quite global, having a number of inter-related components. Further, it was shown that there is considerable overlap among the constructs, suggesting that assessing each of these constructs as discrete areas may be extremely difficult.

Levine (1987a) stated that to understand the developmental functions, there are seven critical points. These may be considered to form the basis of his implicit theory upon which the PEEX rests. Following are the points:

1) Each function consists of discrete but related elements, and that there can be variation both within and between functions.
2) The functions are not a closed system, that is, they are affected by forces external to the child and forces within the child.

3) The child does not progress through the seven functions in a lock-step method, nor is the progression always forward. Therefore, this is not a stage model in the technical sense.

4) The functions overlap and interact.

5) Because functions can be identified and described does not mean that there is a rigid model of information processing or production.

6) Variations in function can be documented without understanding why they exist. Therefore description rather than etiology becomes important.

7) There are antecedents to these functions that exist within the pre-school child.

Levine and Jordan (1987) addressed the outcomes in a child regarding the "transaction between environmental conditions and events and evolving endogenous capacities" (p. 141). Although they specifically referred to 11 to 14 year olds, defined by them as children in "middle-childhood", their postulates underlie Levine's work, and can be considered applicable to the seven to nine year old age group covered by the PEEX. They stated that the elements for dysfunction and failure are present in younger children and that they manifest themselves in middle childhood. They suggested that the neurodevelopmental dysfunction provides a unique lens through which to view the child interacting with his/her life experience and with adult expectations. Specifically their work viewed neurodevelopmental dysfunctions as endogenous to the child, combined with evolving risk factors, resulting in poor school performance.

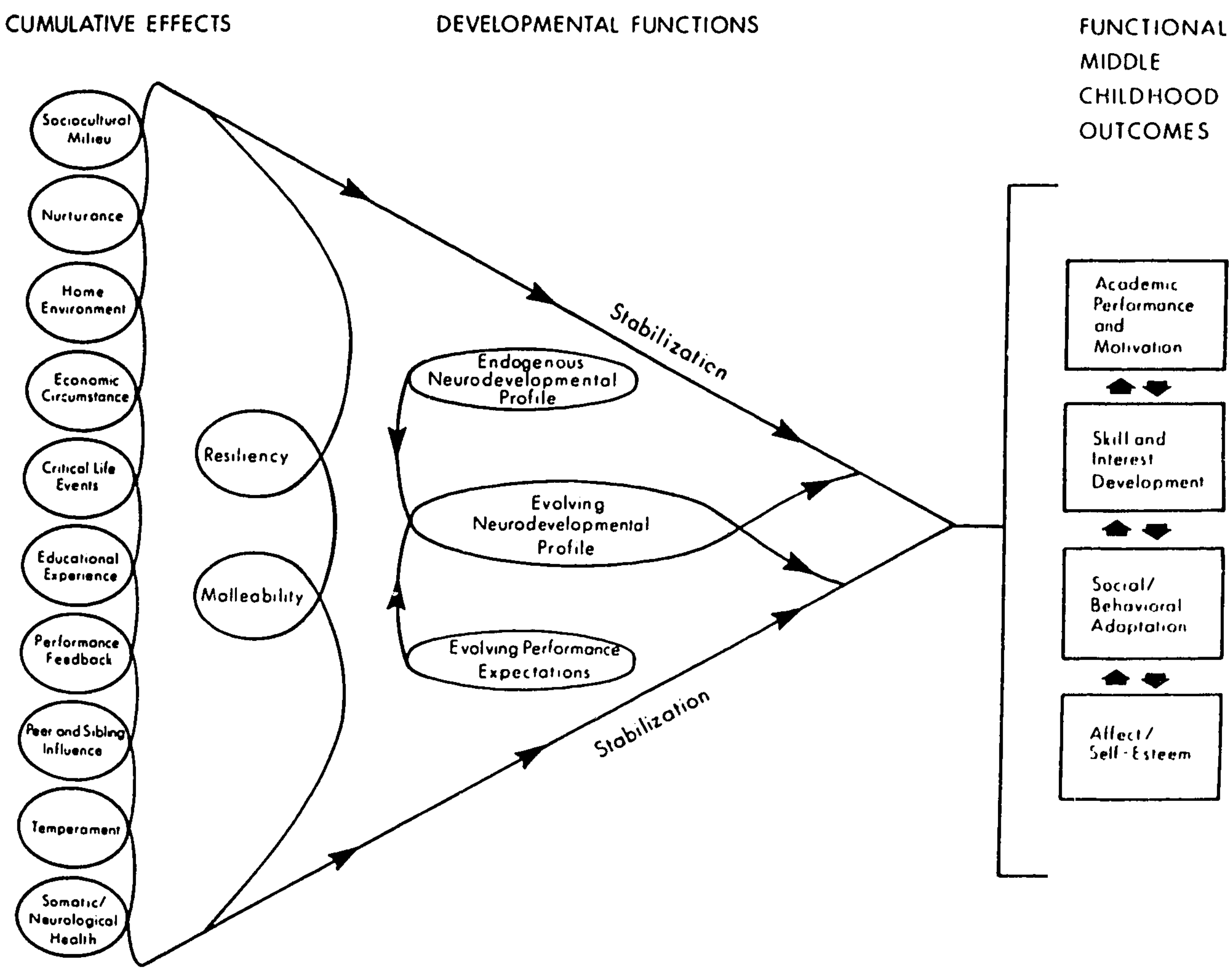
Levine and Jordan (1987) indicated that neurodevelopmental progression is situated within the context of increasing demands being placed upon children as they proceed through elementary school. These demands are a function of people (e.g., parents, teachers) and the curriculum itself. Single neurodevelopmental dysfunctions are common among children who succeed academically, as those children are able to compensate for the deficit. Levine and Jordan (1987) hypothesized that twenty percent of students show dysfunction in three or more areas. The success or failure of these children was viewed as a function of the combination of the dysfunctions, the severity of any given dysfunction, and any additional stressors to which they may be exposed. The interaction of these factors makes it extremely difficult, if not impossible, to define specific criteria for normalcy or delay for any single area of dysfunction. Basically, it was seen as the interaction of the internal resilience of the child and the perceived environmental stressor that determines the outcome, rather than any absolute value. They suggested that some children have more deficit resistance, defined as the capacity to mitigate the impacts of dysfunction(s). They suggested that just as there are children who are vulnerable, but basically unaffected, there are "lethal clusters" of neurodevelopmental dysfunction from which very few, if any children can escape. Levine and Jordan (1987) stated that dysfunctions in expressive language, attention, and memory are most predictive of delinquency in middle childhood, although they did not hypothesize as to why. When external factors such as economic, health, or family problems are entered in to the equation there is "simply too much adversity to bypass and perhaps too much damage to repair" (p. 149), creating a "risk factor complex".

Finally, the child's neurodevelopmental profile is present, although latent, at birth. This profile interacts over time with other factors; environmental, historical, and physiological. The neurodevelopmental profile can be influenced to change (e.g., improving verbal expression through language instruction). Three other factors have an impact (modulating effect) on the outcome. The first, "stabilization" refers to the tendency of the child's neurodevelopmental profile to be constant and predictable over time. The second, "resiliency", is the capacity for the child to recover spontaneously from setbacks, that is stress resistance, and/or to compensate for personal deficiencies (i.e., deficit resistance). Third, is "malleability", the extent to which various interventions can modify the neurodevelopmental profile. Healthy children are characterized as those who will stabilize positive attributes, recover spontaneously from setbacks, compensate for weaknesses and strengthen their profile over time. Figure 2.1 pictorially represents what the Levine and Jordan are stating.

Description of The Pediatric Early Elementary Examination

The PEEX (Levine & Rappaport, 1983) is a neurodevelopmental, behavioral, and health assessment for children ages seven to nine. Levine & Rappaport stated that it is a "middle level evaluation tool" (p. 1) which means that it is more comprehensive than a screen but does not yield an in-depth evaluation of any specific area. As it is not a screen it is intended to be used with a clinically referred population. The administration time suggested by the authors is 40 to 50 minutes excluding the physical examination. The results can be used to highlight areas that may require further evaluation. They also stated that it does not yield a specific score or diagnosis, but rather generates a "functional profile". They define this profile as "a description of strengths, weaknesses, and stylistic preferences" (p. 1). This is consistent with Levine's (1987b) statement that the goal is to "generate a 'functional profile', an account of a child's

Figure 2.1
Multifactorial Processes Shaping
Functional Middle Childhood Outcomes



Levine & Jordan (1987) p. 150

strengths and deficits in those developmental areas most germane to academic success and productivity" (p. 319).

There are several recommended guidelines for using the PEEX. First, Levine and Rappaport (1983) indicated that it should never be used in isolation, but should be part of a multidimensional assessment. They suggested that the easiest way to do this, is to use it in conjunction with the Aggregate Neurobehavioral Student Health and Educational Review (ANSER) system. Specifically, forms 2P (parent) and 2S (school) would be used with the PEEX. It was also recommended that achievement and/or psychoeducational test results be used in conjunction with the PEEX. Second, they also suggested that the parent watch the administration of the PEEX and be queried as to whether or not the child's performance is typical of the child. However, they failed to state what steps the examiner should take if the parent(s) suggest that the performance is atypical. Third, they suggested that the examiner be aware of the need for local standards of performance, that "locally applicable norms are essential" (p. 31). This task is more onerous than it first appears, the reasons as to why will become clearer when the "norming" of the original instrument is examined. They also suggested that verbal feedback be given to the child and a report be written.

The thirty-two individual tasks on the PEEX were divided into seven specific areas of development (Levine & Rappaport, 1983). The first area of development is Fine Motor. This area contains five tasks used to measure a child's finger dexterity (efficiency and accuracy). Tasks include finger localization, quick and accurate movements, motor planning, and eye-hand coordination. The second area is Visual-Fine Motor, which contains four tasks. The tasks require the interpretation of complex visual patterns and the planning and implementation of a motor response. Three of the four tasks require a pencil and paper response, while the fourth is a visual tracking task. The third area, containing five tasks, is Visual Processing. The items in this section require the monitoring of visual patterns without a significant motor response. Three areas are stressed, visual attention to detail, visual perception (discrimination), and visual memory. Levine and Rappaport (1983) suggested that the relation of these tasks to reading is still controversial; however, they suggested that they are related to spelling, writing, and mathematics.

At this point, Checkpoint A is completed addressing the issue of attention. The fourth area is Temporal-Sequential Organization, which has seven tasks. These tasks measure a child's ability to apprehend, store, and retrieve sequences of information in which the order is significant to the meaning. Different modalities are assessed in this area. The fifth area, Linguistic, has four tasks that are designed to reflect language processing and production. The first three tasks measure receptive language function while the fourth requires the child to name pictures.

At this point Checkpoint B is competed addressing the associated observations, including attentional issues. The sixth area is Gross Motor that includes five tasks that assess gross motor function. Tests of balance, motor rhythm, and eye-upper limb coordination are included. Levine and Rappaport (1983) acknowledged that gross motor functioning has little to do with academic performance; however, it is included as they hypothesize that it is related to self-esteem and feelings of effectiveness. The seventh and final area, which has two tasks, is Recall. At this time the child is ask to recall visual and auditory information that was presented during the temporal-sequential organization area. This area taps long-term memory. Appendix A briefly outlines what Levine and Rappaport stated each task measures.

Levine and Rappaport (1983) stated that the PEEX consists of five major sections. The first section, and the only section this study is concerned with, is Developmental Attainment. This is basically the "scoring" system for the instrument. There are four levels: Level One, which reflects a performance that is clearly below expectations for all age groups; Level Two, a performance appropriate for younger children in this age group (i.e., 7-8 years old); Level Three, performance appropriate for older children in this age group (i.e., 8-9 years old); and Level Four, a performance that should be considered strong for anyone in any age group. Each subject is assigned a developmental attainment level for each task. Subjects who are consistently above or below the appropriate level in a specific area can be considered stronger or weaker respectively. Levine and Rappaport also suggested that the total number of tasks at each level can be computed for the whole instrument. When the protocol is examined it can be seen that each attainment level has an associated range or a cut score. For example, on the first task, imitative finger movement, the score can range from 0 to 8 (i.e., number of correct imitations - 8 items), scores of 0 through 4 produce a level one result; a score of 5, level two; scores of 6 or 7, level three; and a score of 8, level 4. Quantifiable responses are available for all tasks and these determine the developmental level. The developmental scores are not totaled by area or for the whole instrument. Rather the examiner determines how many 1's, 2's, 3's, and 4's the child obtained. Then depending on the age group the examiner is able to indicate in how many areas the child is below, average, or above expectation.

The second major section is Neuromaturation. In this section the examiner is looking for specific indicators of dysfunction in neuromaturation. The authors equated these to soft neurological signs. There are 12 items that can evoke synkinesias (associated mirror motor movements) or extraneous motor movement about the mouth. They are scored as 0 (active), 1 (suggestive), or 2 (absent). A total score on the 12 items is used with a maximum score of 24. Simultaneously, other minor neurological indicators are observed on 8 items, 6 of which are the same as the 12 above. These indicators include; motor impersistence, choreiform movements, dysdiodochokinesis (problems with rapid alternating movements), dystonic posture, dyskinesia, and poorly established hand preference. Although a total score is derived, no cut scores or ranges for "normal" are available in the manual.

The third major section is Cognitive Tempo. This section exists to give the examiner information as to the subject's learning style, problems with processing or producing information, and specific areas of weakness. This area selects for subjects whose style is either slow and labored, or impulsive. Scoring is on a continuum with belabored responses marked on the left (score 0), impulsive responses marked on the right (score 2), and appropriate responses marked in the middle (score 1). As this is a continuum, intervals can also be marked. Levine and Rappaport also state that the scoring of this section is "fairly subjective" (p. 3). Perhaps this is why a continuum rather than a discrete score is used. This allows the examiner some latitude by not forcing him or her to make a specific determination.

The fourth section, Task Analysis, attempts to determine the child's performance in specific developmental functions. The section is divided into 10 elements grouped under three headings: information intake or input through various modalities; memory and experience; and output, through different modalities. The score in the first section, developmental attainment, is transferred to the appropriate columns (as determined by the authors) in this section. Total scores for each of the 10 elements are then determined. The rationale for this section is that a specific task, such as copying a sentence, has several components. On the PEEX three task analysis elements would be scored for Copy Sentence; visual input, experiential, and fine motor output. However, although a total score for each of the ten elements can be obtained, the manual provides neither cut scores nor normal ranges for this section.

The fifth major section is Associated Observations. There are three components that are examined at two checkpoints during the administration of the PEEX. At Checkpoint A, the examiner rates the subject's selective attention on seven dimensions. These dimensions are re-rated at Checkpoint B. Scoring is accomplished by placing an "A" (Checkpoint A) or a "B" (Checkpoint B) on the continuum for each of the seven dimensions. Although a continuum is used, discrete scores (1 being overactive, 5 being appropriate) can be derived. This section is used to detect and describe subject's with attention deficits. When the examiner reaches Checkpoint B, an attempt is made to differentiate five types of distractibility (e.g., impulsivity, fatigability) with respect to the modality involved (e.g., fatigability predominately with visual input or with verbal input or with both). Scoring is the same as in Checkpoint A, only each item is scored only once. Also at Checkpoint B the examiner attempts to evaluate the subject's adaptation to the examination (e.g., compliance, self-confidence; four items) and the subject's affective state (e.g., reality orientation, affective range; five items). Again, each of these is rated on a five point continuum.

The last major section is the General Health Assessment where the examiner conducts a routine physical examination as well as neurological and sensory assessments.

For the purposes of this study, each of the 32 tasks are examined using as data input the level of developmental attainment (i.e., 1, 2, 3, or 4) for each variable. The other major sections of the PEEX provides data which could be used as a focus for subsequent study.

Areas of Dysfunction

The PEEX was first published in 1983 (Levine & Rappaport). Prior to that time however, Levine in conjunction with several others, had begun to develop the processes and procedures that would emerge as the PEEX. Levine, Brooks and Shonkoff (1980) make reference to the neurodevelopmental examination as part of the pediatric examination. This predates the existence of the PEEX but illustrates the concept of including a neurodevelopmental exam in the process. This neurodevelopmental examination is "a systematic screening of the elements of development, including age-appropriate tasks of gross motor function, fine motor output, Gestalt and visual-spatial orientation, temporal-sequential organization, memory, and language." (p.141). In 1980 they were still compiling a list of neurodevelopmental screening instruments. Levine and Rappaport (1983), also stated at that time that a "pediatric neurodevelopmental battery should adhere to a descriptive rather than psychometric model." (p.141). An overall score was deemed inappropriate and misleading, therefore a narrative description of an individual's strengths and weaknesses was generated.

The specific areas that, according to Levine, should be sampled in a neurodevelopmental screening also evolved over time. In 1980 Levine, Brooks, and Shonkoff describe "clinical phenomenology *likely* to be encountered in children with specific functional deficiencies." (p.46). They go on to list the areas that should be sampled as: 1) selective attention; 2) visual-spatial and gestalt processing; 3) temporal-sequential organization and segmental processing; 4) receptive language function; 5) expressive language function; 6) memory; 7) voluntary motor function, including gross and fine motor functioning; and 8) developmental function, including, higher order integration and conceptualization, cognitive strategy formation, working capacity, and social cognition and adaptation. Four years later, Levine (1984a) spoke about developmental output failure in school aged children and discussed five related areas of dysfunction starting with 1) Fine motor dysfunction, including eye-hand coordination, proprioreceptive-kinethestic feedback, motor praxis and motor memory; 2) rapid retrieval memory; 3) expressive language; 4) organization; and finally 5) selective attention.

In 1992, 12 years later, Levine (1992d) stated that there *are* eight key areas of neurodevelopmental function: selective attention; memory; language; visual-spatial ordering; temporal sequential ordering; neuro-motor function; higher order cognition; and social cognition. Two observations can be made at this time. First, Levine's language in 1980 is more tentative "it is likely", whereas in 1992 he states unequivocally the eight areas. Second, over time the number of areas to be examined changes; however, there appears to be a number of central themes that permeate his work through the intervening decade. Levine (1992d) stated that although there is wide variability with respect to each specific neurodevelopmental function, these eight areas reflect common pathways through which the dysfunctions converge and cluster. He also said that the specific outcome for an individual child is dependent upon both the strengths and weaknesses within each area. Therefore, each of the eight areas will be examined in more detail with respect to deficits and strengths.

Attention

Levine (1992d) indicated that dysfunctions of attention are the most common neurodevelopmental problems affecting children and are most likely to have a broad, although subtle, impact on day-to-day performance. He stated that they are very common and pervasive. Levine (1992d) has indicated that "Attention plays a leading role in virtually all cognitive, academic, behavioral, and social activities. It is not surprising, therefore, that disturbances of attention commonly have a deleterious effect over a broad range of contexts and pursuits" (p. 468).

He continued by saying the assessment of attentional difficulties should occur at five levels: documentation of the degree and pervasiveness; identification of associated or complicating factors; identification of actual or potential facilitators and strengths; formulation of service needs; and determination of advocacy needs. He refers physicians to the teacher and the parent questionnaires of the ANSER system to assess the degree and pervasiveness. He stated the advantage is that the ANSER system includes questions on behavioral cognitive factors. He indicated that complicating factors be explored through a psychoeducational assessment and a neuropsychological or a neurodevelopmental assessment.

Memory

Levine (1992c) postulated four levels of memory. The first level is registration. This involves registering information, and is a skill, in short-term memory. Students who experience difficulty in this area have trouble attending to information being presented, and demonstrate a generalized deficiency. Some children have difficulty registering specific types of memory, such as visual, spatial, or sequential. In this case, the deficiencies would be specific to the area of difficulty. The final group of children who have difficulty in this area are those who can register the information, however, cannot do so quickly enough to keep up with the presentation of the material.

The second level is active working memory. This involves the student keeping information in memory temporarily while they are utilizing it to solve a problem or synthesize it with other information. Children who have difficulty in this area often demonstrate it through problem solving weaknesses in mathematics, where they have forgotten the process while attempting to carry out the activity, or when required to remember what they have read. These children are the ones who forget what they have read at the beginning of the paragraph by the time they get to the end of the paragraph.

The third level is the consolidation of information into long-term memory. Levine stated that consolidation of information into long-term memory happens in one or more of four ways. The first, is pairing two pieces of information; the second, is classifying information into categories; the third, is linking new information to known rules; and the fourth, is arranging information into logical chains.

The fourth level of memory is retrieval. He stated (1992c) that although some children are able to register and consolidate information, they cannot retrieve it. He stated that many children with simultaneous recall deficits, (i.e., recalling several pieces of information at the same time) have significant difficulty with written output as it requires the concurrent recall of a number of pieces of information. They also may exhibit difficulties in mathematics where simultaneous recall is also important. Compensatory strategies such as mnemonic strategies and meta-cognitive strategies can serve to reduce the impact of these difficulties.

Language

Good language functioning is paramount to school success. Levine (1992c) has divided language dysfunction into four common forms. The first of these he identified as poor phonological awareness. He also talked about semantic deficiency as another area of dysfunction. The third area is a syntactic problem, which affects comprehension. The last area is weak meta-linguistics, which affects the child's ability to understand how language works. Levine also discussed the differences between expressive and receptive language deficits, and the impact that they can have on school success.

Visual Spatial Ordering

Levine (1992c) stated that most spatial data enter the nervous system through visual pathways but can be mediated through non-verbal conceptualization or propriokinesthetic pathways. He included shape, position, relative size, foreground, background, relations, and form constancy under visual spatial ordering. Children with difficulties in this area have problems with letter recognition, and subsequently spelling. They also may have difficulty with left-right discrimination and exhibit fine or gross-motor clumsiness.

Temporal Sequential Ordering

These skills involve the understanding of time and the ability to use appropriate sequences. Spelling, story-telling, and problem solving in mathematics all require sequential, as well as temporal skills. Children with deficits in this area have difficulty telling time, following multi-step instructions, and, ultimately, develop difficulties in the area of organization.

Neuromotor Function

Levine (1992c) described students with this difficulty as sometimes being referred to as having "developmental output failure" (p. 481). This area, including fine-motor dysfunction, affects the writing process. Neuromotor functioning can be divided into eight sub-types: 1) finger agnosia (trouble localizing fingers in space while writing, breakdown in the propriokinesthetic feedback); 2) production deficits (coordinating motor movements for writing - many of these students also display oromotor production weaknesses resulting in speech articulation deficits as well as writing problems); 3) pre-visualization dyspraxia (difficulty visualizing, therefore planning the configurations of letters or words); 4) procedural memory dyspraxis (unable to recall, therefore plan the precise frequency of motor movements required to form letters); 5) visual-motor dyspraxia (difficulty using visual information or programming a motor response - copying); 6) verbal motor dyspraxia (found in students who have difficulty listening and writing at the same time, in this case, the integrated function is at fault, not either of the individual isolated functions); 7) pseudomotor dysfunction (the graphomotor output cannot keep pace with the ideation); and 8) functional undermining (the non-motor components of writing take so much effort that motor precision is compromised). Also under this section are gross-motor dysfunctions which may show up in physical education activities. At a more complex level, gross-motor dyspraxia prevents the child from implementing complex motor procedures. He stated that most children with dysfunctions in these areas also suffer from self-esteem problems.

High Order Cognition

Levine (1992c) included concept acquisition, problem solving skills, critical thinking, brainstorming (including creativity), metacognition, and rule recognition and application in this category.

Conceptual development involves the child being able to categorize. Fluidity is a hallmark of this particular skill. Problem solving skills are required in mathematics as well as other curricular areas. Lack of development of problem solving leads to random solutions, impulsivity, and poor planning. Brainstorming weaknesses are demonstrated in children who have difficulty generating original ideas. Levine defined critical thinking skills as involving the ability to evaluate situations and determine their own biases. These are most often seen in compare and contrast type activities in school. Analyses of situations are also compromised. Children who lack metacognitive skills are unable to monitor their own behavior as they proceed through cognitive tasks. Therefore, they may not use the most efficient strategies to obtain goals. In the area of rule development application, students are insensitive to regularity and irregularity of particular subject content. They have difficulty with "if/then" concepts. Students who demonstrate strengths in any of the six higher cognitive functioning areas are in a better position to compensate for lower level weaknesses.

Social Cognition

This is a concept Levine (1992c) has equated with social skills and identified as a critical component of a complete description of a child's neurodevelopmental profile. In fact, Levine included the Gross Motor section in the PEEX even though it did not have much to do with school failure. He included it as he believes that gross motor functioning has a lot to do with a child's self-esteem and being accepted socially.

Assessment

"The immediate goal of assessment should be the collaborative description of a child's life struggle, a therapeutically relevant set of empiric observations instead of a numerical caricature or a simplistic label" (Levine, 1985, p. 792).

With respect to learning disabilities, Levine (1987a) has indicated that these problems are also referred to as low-severity, high-prevalence disabilities. He has identified these as high prevalence, as he stated that 15 to 20 percent of the school population is affected; and low severity, when compared to mental retardation or sensory impairments. He has also stated (1987b) that learning disabilities describe a broad range of subtle dysfunctions of the central nervous system, and that the better definitions reflect this. He further suggested that a child's emotional functioning should be included in any definition of learning disabilities. Levine (1987a) indicates that a lack of standard definitions further confounds the discussion of these disorders. Therefore, he supplies hierarchical definitions for variation, dysfunction, disability, and handicap. These will be detailed in the next section.

Levine (1987b) suggested that definitions of learning disabilities that focus on the discrepancies between cognitive abilities and achievement are inadequate, as the traditional multiple choice format of the achievement test may give an overestimate of a child's ability and further, if a child has a disability in an area directly tapped by the intelligence measure the intelligence score may be artificially lowered. He stated that "the most justifiable practice is one in which children are identified as having learning disabilities by proving the existence and relevance of specific handicaps that impede information processing and/or academic productivity" (p. 318). Although he does not overtly state how this should be done, his later reference to "developmental dysfunctions" would lead one to believe that the use of instruments like the PEEX would be preferable to him.

Developmental output failure is the primary difficulty of middle childhood (Levine 1984a). The child is able to learn but has difficulty translating this knowledge into an adequate product. This child can learn but cannot produce. He concluded that "Much of the suffering by victims of 'developmental output failure' is likely to be preventable" (p. 242). He suggested that the antecedents of this impaired productivity can be identified in early middle childhood (the age range covered by the PEEX) or in preschool. He continued by stating that the educational system needs to consider putting more emphasis on encoding as well as a greater emphasis on strengthening the working and learning capacities of children in middle childhood.

It remains to be seen whether Levine is able to arrive at diagnostic conclusions predicated on these areas of stated dysfunction. Levine's view of the role of the health care professional and his or her interaction with child leads to a further understanding of neurodevelopmental assessment, specifically the PEEX, and areas sampled by the instrument. Levine views the health care professional as having "a profound influence on the outcomes of the various missions of middle childhood" (1992c, p. 59). The neurodevelopmental examination is embedded in a larger process that emphasizes the importance of well-child examinations and the periodic attendance of both parents during examinations of the child. Time alone with the parent(s) is viewed as critical to the process, as is time alone with the child, which allows for education and counselling. Levine sees this as best achieved during the physical exam. The final step in the process is a debriefing with parents and the child.

Specifically, an examination, of how the areas that Levine sees as critical can be assessed in a meaningful way, is paramount. The assessment of children with neurodevelopmental dysfunction requires, according to Levine (1992d), "meticulous multi-disciplinary evaluations based on differential diagnoses appropriate for chronological age and grade level. It is unlikely that any single professional can assess adequately the diverse sources and broad effects of academic under achievement" (p. 488).

Levine (1985) purports that all children in contemporary North American society grow up being evaluated and judged. He gives several examples of how children are measured in schools (i.e., intelligence, achievement, and/or projective assessment). He states that these test scores are seductive in that they imply a measure of exactitude that is not there, and that there are many factors that confound the results so badly, as to render them meaningless (e.g., test taking ability, examiner bias, confusing correlation with causality, test formats which introject bias). However, he declares there is still a place for standardized observation. He has identified this as still the best way to diagnose and treat children's difficulties. The outcomes however must depict functional profiles and descriptive accounts. Ideally these profiles are developed by a number of individuals from different disciplines. Levine (1985) further stated that the PEEX meets these criteria and can be found to be extremely helpful in this process. Therefore the physician plays "a more meaningful role as a politically informed child advocate to help counter-balance conflicts of interest that may exist in school systems, to temper any strong diagnostic disciplinary biases, and to provide longitudinal functional monitoring" (p. 792). It would appear that Levine ignored many of the arenas of psychometrics which address some of these issues (e.g., standard error of measure, confidence intervals, norming procedures) and chose not to recognize that the appropriate use of these "other tests" also requires that the results (numerical or otherwise) be placed in the context of the whole child and his or her world.

Meltzer (1984) also argued that traditional norm referenced assessment is inadequate with respect to the diagnosis and remediation of learning disabilities. She has suggested the approaches developed by Binet and Wechsler are inadequate as they come to represent the notion of "fixed, immutable intelligence" (1984, p. 132). She suggested that intellect is multifaceted and prefers the broader term "cognition". She also suggested that Piaget's approach to cognition, despite the criticism of his work, is more useful and appropriate in that it recognizes a developmental component of cognition. She also cites the work of Feuerstein with its concepts of "learning potential" and "cognitive modifiability" as more accurately reflecting the construct of intelligence. She also stated that his linking of assessment and remediation as inter-related processes is a better paradigm to use with respect to learning disabled students.

Meltzer (1984) also believes that the specific language used by the professional (e.g., minimal brain dysfunction versus learning disability) belies the theoretical orientation as well as the approach to resolving any difficulties. She suggested that the "developmental difference perspective" (p. 141) assumes a non-deficit approach and that the cognitive learning styles of the child are unique and require an individualized response. This view also implies an interactive approach to amelioration.

Meltzer (1984) concluded by proposing a cognitive model for the assessment of "learning style". This model involves the administration of educational and neurodevelopmental batteries (e.g., PEEX). She stated that an instrument like the PEEX is a "cognitive inventory [that] has been developed on conceptual and empirical suggestions that children who have difficulty shifting and selecting from a corpus of problem-solving strategies will experience problems with reading comprehension, written language, and math conceptualization" (p. 144). She suggested that these weaknesses cause more difficulty as the student moves through the school system where the demands for higher order integration increase.

Levine (1992d) also saw the assessment of intelligence alone as inadequate. He stated that "certain clusters of neurodevelopmental dysfunction may fail to create a sufficient disparity between IQ result and achievement test score" (p. 488). He sees evaluation including a complete physical, neurological, and sensory examination. Standardized questionnaires are useful in obtaining historical data from the school, the parents, and the child. He indicated that several levels of pediatric neurodevelopmental examinations exist which can sample behavior from children ages three to approximately sixteen years of age. Included in this range of instruments is the PEEX, suitable for ages seven through nine inclusive. These examinations allow pediatricians to:

> observe or sample directly key neurodevelopmental functions such as attention, memory, language, and motor skills. Examinations of this type also permit direct behavioral observations as well as assessments of minor neurological indicators (sometimes called "soft signs") frequently associated with neurodevelopmental dysfunctions." (p. 488).

Although not sufficient in themselves, Levine has identified intelligence testing and psychoeducational testing as beneficial. Finally, he has suggested that a mental health professional could be used in identifying the family-based issues that complicate or confound any assessment of neurodevelopmental dysfunction.

With respect to neurodevelopmental assessments, Busch (1992) indicated that they permit the pediatrician to observe a child's developmental attainment directly, and assist the physician in explaining the developmental processes which are responsible for academic difficulties. She stated that this perspective can assist the school in selecting developmentally appropriate teaching adaptations or remediation strategies. Neurodevelopmental assessments also assist the pediatrician to determine more precisely what further diagnostic assessments might be needed. They also may allow the pediatrician to translate observations of brain function into practical relevant suggestions for parents and teachers. This results in a constructive collaboration between educators and physicians, which ultimately helps children with developmental disorders.

The ANSER System

Although not central to this study, an understanding of the Aggregate Neurobehavioral Student Health and Educational Review (ANSER) system will assist the reader in understanding how comprehensive, from Levine's perspective, the assessment of children needs to be. Levine stated that the PEEX alone would not be considered sufficient to describe a child's strengths and needs (Levine, Meltzer, Busch, Palfrey, & Sullivan, 1983). Additionally, the philosophy behind the construction of the ANSER system is the same as that which underlies the construction of the PEEX. A detailed description of the ANSER system is found in Appendix B.

The PEEX

Levine, Meltzer, Busch, Palfrey, and Sullivan (1983) reported the results of the first, and apparently only published study focusing on the development and standardization of the PEEX. Levine, Meltzer, Busch, Palfrey, and Sullivan opened by suggesting that reliable and valid systems used to study this age group have not been available to physicians. The objective was to "help validate the PEEX by comparing the performance of children of varying levels of academic competence" (p. 894). They continued by stating that the PEEX was designed to accomplish four objectives: One, to provide a set of age appropriate tasks in order to screen for low-severity disorders in this age group. Two, to assist physicians to identify areas that will require further evaluation. Three, to highlight developmental areas of concern instead of an overall score. Four, to enhance the overall contribution made by the pediatrician. Further, they stated that the PEEX was not meant to be administered alone, rather it is to be used with other data gathering systems (i.e., ANSER). As well, information from other disciplines is to be integrated with the PEEX results, although there was no specific suggestion as to how that is to be done. The aim is to discover recurring themes that explain a child's underachievement. They suggested that administration time is 45 minutes.

The PEEX was piloted in the summers of 1978 and 1979 in Brookline, Massachusetts, near Boston with a sample of 148 children. No indication was given as to how these children were selected. Each child was administered the PEEX, the Weschler Intelligence Scale for Children - Revised (WISC-R), and the California Achievement Test (CAT). A team of pediatricians, psychologists, and educators reviewed the PEEX and developed a "tentative scoring criteria based on clinical knowledge and a review of relevant published studies" (p. 896). At that point, the data were analyzed comparing the PEEX areas, achievement results, and use of special services in schools. Scoring criteria were adjusted when the developmental areas were over- or under- represented in the community population. Finally, a list of criteria was developed for each area (minor neurologic indicators; temporal-sequential organization; visual-spatial organization; auditory-language function; fine motor function; gross motor function; and memory). The present version of the PEEX also assesses seven areas, however, some have been renamed. When the 1983 version is compared to the current version, it can be seen that a few specific tasks have been dropped or added, and many have been moved from one major area to another. Unfortunately, there is no documentation to explain the rationale for making the changes.

The study, which was the focus of the Levine, Meltzer, Bush, Palfrey, and Sullivan (1983) article, was conducted one year later (1980/1981). A total of 246 children from the ages of 6-11 years to 9-1 years, with a mean age of 8-0 years participated. One hundred eighty-seven of these children (103 male; 84 female) were chosen randomly from grade two classes in two schools. These schools were located in suburban middle-class communities. The remaining 59 children (46 male; 13 female) comprised a referred group with delays exceeding six months in one or more major academic subject area. The 59 children were matched for age and grade level with the random group. No cognitively delayed children were included in the sample. The PEEX, WISC-R, and CAT were administered to each child. If a child was receiving remedial assistance or counselling this was used as an indicator of dysfunction. Interobserver reliability on the PEEX ranged from 90 to 98 percent with the exception of rating the minor neurologic indicators (87%).

The results of the PEEX were obtained by using the criteria developed during the pilot study. The criteria were apparently adjusted to "take into account under- or oversensitivity in several areas" (p. 898). These adjustments were made using the results of the 187 randomly chosen children. These children's developmental attainment score showed concerns ranging from 9 percent to 13 percent in each of the areas, see Table 2.3.

Table 2.3
Frequency Distribution (%) of Areas of Concern in
Community Sample (n=187)

	No Concern	Concern
Minor neurologic indicators	87	13
Temporal-sequential organization	89	11
Visual-spatial orientation	91	9
Auditory-language function	90	10
Fine motor function	90	10
Gross motor function	89	11
Memory	91	9

From Levine, Meltzer, Bush, Palfrey, and Sullivan (1983, p. 898)

Globally, 58 percent of the 187 children showed no concerns; 24 percent concern in one area; 11 percent concern in two areas; 4 percent concern in three areas; and 3 percent concerns in four or more areas. The authors stated that children having one or two areas of delay were common; however, only infrequently were these delays associated with generalized delays.

The results for the 187 children on the CAT yielded scores in the high range with a mean grade equivalent of 3.24 +/- 0.65 (SD). Only 3.4 percent were over six months delayed on reading and 6.3 percent in math. However, when CAT scores were compared to areas of concern on the PEEX statistically significant differences (i.e., inverse relationships) were noted between the CAT scores of children with no concerns (PEEX) and those with three or more areas of concern (PEEX) for all subtests of the CAT. This suggested that children who had three or more areas of concern, also had poorer achievement test results. Levine, Meltzer, Busch, Palfrey, and Sullivan (1983) then attempted to determine which areas of the PEEX accounted for the variance of the CAT scores. A stepwise regression analysis was conducted and the temporal-sequential score accounted for 20 percent of the variance while the auditory-language score accounted for 9 percent; interestingly minor neurologic indicators accounted for none of the variance on the CAT.

The mean full scale score for the 187 children on the WISC-R was 115 (mean verbal score 115; performance 113). Full scale scores ranged from 59 to 153 (1 child cognitively delayed and 64% with scores over 110). The number of areas of concern on the PEEX were compared to the verbal, performance, and full scale scores. The results showed that children with one versus two areas of concern, as measured by the PEEX, demonstrated little difference; however their WISC-R scores were significantly weaker than the group with no concerns and significantly stronger than the group with three or more concerns. A stepwise regression revealed that auditory-language explained 38 percent of the WISC-R variance while minor neurologic indicators explained 6 percent. The other areas contributed little (less than 1.3% each).

The PEEX was then used with children who were known to be having school problems. Two groups were used. One group (community sample) consisted of second grade students receiving special services (20% of the n=187) and the second group was the referred population (n=59) coming from a larger geographic area. Of the community group receiving service (20% of the n=187), 55 percent had one or two areas of concern; and 18 percent had three or more areas of concern on the PEEX. Levine, Meltzer, Busch, Palfrey, and Sullivan (1983) stated that the PEEX could not identify all children receiving service. When those individuals receiving reading assistance were identified, 70 percent of this group had at least one area of concern while 50 percent had multiple areas. The PEEX did less well at identifying those receiving counselling or speech therapy services.

When the 187 community subjects were compared to the referred population there were significant marked differences between the two groups in all areas. Eighty-two percent of the Brookline group (n=187) had one or less area of concern, while this was true for only 27 percent of the referred population. When those receiving assistance were removed from the community group and the remaining individual's results compared to the referred population results, 23 of the 30 individual tasks were found to discriminate between the two groups.

In summary, Levine, Meltzer, Busch, Palfrey, and Sullivan (1983) found that one area of concern on the PEEX did not often affect the success of a child in school; however, multiple areas of concern correlated significantly with lower CAT and WISC-R results. They suggested that children can overcome a single area of weakness but are unable to do so when faced with multiple concerns. Also, referred populations tended to experience multiple areas of concern rather than a single deficit area. They also suggested that low-severity disorders may be "widely prevalent" among those who score within the average range on intelligence tests.

Critique of the PEEX

Landman and Carpenter (1988) conducted a study to determine the usefulness of the PEEX in evaluating hyperactive inner city boys. The sample consisted of 39 black males (mean age 8.5

years, SD 0.99; mean IQ 98, SD 10). The PEEX along with two measures of achievement, one of intelligence, checklists for attention, and an assessment of personal functioning were administered. The results suggested no relationship between the soft neurological signs on the PEEX (e.g., motor overflow) and any of the other parameters. Performance on laterality tasks was positively related to reading. The copying forms task was related to functioning in math (r=.45) while the copying sentences related to both math (r=.44) and reading (r=.35). Connecting dots was related to math functioning (r=.50) as was performance on the picture naming (r=.42) and complex sentence (r=.32) subtests. The ability to follow instructions was related to math (r=.35).

Landman and Carpenter (1988) also said that the verbal instruction task items were most related to social and academic functioning reflected a microcosm of the child's world. That is, many behaviors displayed during this task reflected the child's behavior in the real world. They concluded that the PEEX may be helpful to the physician in that a child referred for attentional difficulties, who has no difficulties on the PEEX, may be suitable for a trial of stimulant medication, while a child who does poorly on some of these tasks may first require a referral for further assessment as factors other than attention may be contributing to school difficulties. However, until the other areas are explored, it is not possible to determine the degree to which attention may be having an impact on performance.

Levine (1991) stated that within developmental-behavioral pediatrics, "there must exist diagnostic tools that provide for the rigorous and valid assessment of problems . . . . during childhood"

(p. 2). He further stated, "There is an ongoing need to refine our instrumentation" (p. 2). It is most unfortunate that, with respect to the PEEX, he has not published (in either the manual or journal articles) any statements of reliability or validity, yet calls for the need to develop such measures. With respect to refinements, it appears that the present version of the PEEX is different from the one used to conduct the original study; however, in what specific ways it differs remains unpublished. It is unknown, except perhaps to the author of the PEEX, how many times it has been refined and what specific changes, if any, have been made to the scoring criteria.

Kenny, Gaes, Saylor, Grossman, Kappelman, Chernoff, Toler, and Majer (1990) conducted a study with 299 "disadvantaged" seven to nine year olds using the PEEX. They stated that a number of questions regarding the PEEX still exist: How effective is the instrument in identifying children with learning problems?, What is the impact of developing an instrument on a population with a mean IQ of plus one standard deviation and above average achievement test scores?, How much preparation is required to administer the PEEX?, and Is this a diagnostic or a screening instrument?

Kenny et al. examined the effectiveness, efficiency and generalizability of the PEEX by using an urban low SES population. Their sample consisted of a random sample of 250 disadvantaged 7 to 9 year old children from six urban public schools and 49 children from the same population having been previously identified by teachers or administrators as having school problems. The age range (n=299) was from 6.5 to 10.1 years (Mean 7.8 years; Standard Deviation 1.6). It should be noted that the upper age and lower age ranges of the subjects included in this sample are beyond the stated maximum/minimum ages for which the PEEX was developed. The number of children included outside the stated age limits is unknown, therefore the effect on the results is also unknown. This problem is mitigated somewhat by the fact that the age ranges of the PEEX are only suggested and it can be used with older children should the examiner deem it appropriate.

The group in this study consisted of 177 males and 122 females. The sample contained 67.9 percent black individuals; 31.8 percent white; while less than one percent of the sample was Asian-American. Students were in the first (15), second (263), third (18), and fourth grades (3). The PEEX was administered to all subjects by three pediatricians with extensive experience and training with the PEEX. The WISC-R was administered by trained psychometricians. School records were used to define those children as having an "identified problem" (n=78; 25%).

The efficiency of the PEEX was determined by comparing the number of "areas of concern" with whether the child had an "identified problem" (i.e., receiving special services). This approach yielded a sensitivity of 76.9 percent (i.e., number of correct referrals/number receiving service) and a specificity of 59.9 percent (i.e., number of correct non-referrals/number not receiving service). The percentages were determined at the point of optimal balance (sensitivity vs. specificity) which was between two or fewer areas of concern and three or more areas of concern. Kenny et al. (1990) stated that the sensitivity is moderately acceptable while the specificity is unacceptable. The PEEX had an identification rate of

64.3 percent which they stated is unacceptable. The false positive rate was 29.7 percent while the false negative was 6.0 percent (i.e., subjects who needed to be referred who would not have been). They also found the average administration time to be 72 minutes compared with the time stated in the manual of 45 minutes. They concluded, "the test is not cost-effective as a screening tool [it has] limited generalizability, its weak sensitivity and specificity further diminish its use as a diagnostic tool" (p. 25).

Grill (1987) reviewed the PEEX and indicated that the PEEX is not a screening nor a diagnostic instrument, nor did he see it as a normed or criterion referenced test. Further, Grill stated that the child's performance is rated with "varying degrees of subjectivity" (p. 603). The strength of the PEEX is that a child's performance on a task can be recorded in addition to the child's proficiency while performing the task. Grill (1987) identified several problems: First, there were no norms presented nor is the demographic data presented in the manual. The second area of concern was the lack of reliability or validity data. He stated this lack of information "renders the PEEX useless except to record observations" (p. 604). The third area of concern was that there was no description of the implications of specific types of performance on the various tasks. He recommended the inclusion of the suggested data at which point the instrument can would be very useful.

Schwartz (1987) also reviewed the PEEX. Schwartz stated that the PEEX succeeds in assisting to infer the child's level of neurodevelopmental functioning and in assisting to determine what further assessment is required. Schwartz also expressed concerns about the lack of norms. Specifically, he noted it is not possible to know how the cut scores for each of the four levels were determined. He went on to question why a standardized administration is required in the absence of norms, as it is often only central in determining norms. His final concern was the lack of a statement of validity or reliability. He concluded that "if its use is restricted to screening where descriptive statements are solicited" (p. 606), then the PEEX still has some value.

Another way to evaluate the PEEX is against an accepted standard designed for that purpose. Although this is an instrument designed by a physician, its stated purpose is to detect high-prevalence, low-severity disorders (learning disabilities) which impact negatively on school performance. As well, many of the items and tasks are the same as, or similar to, items seen on psychological tests. It is reasonable then to use the Standards for Educational and Psychological Testing (1985) (*Standards*) as evaluation criteria. In general, this document advocates that the necessary technical information about a test be made available. The *Standards* were developed, "to provide criteria for the evaluation of tests, testing practices, and the effects of test use. . . . the *Standards* can provide a frame of reference to assure that relevant issues are addressed" (p. 2). With reference to applying the standards, it is suggested that the acceptability of a test is not dependent on the satisfaction of each of the primary standards and that individual standards should not be considered in isolation.

Standards (1985) is divided into four parts. Each part is further subdivided and for each subdivision there are a number of standards listed. The standards are classified as primary, secondary, or conditional. Primary standards should be met by all tests before they are used. If they are not met it is expected that an explanation as to why, is to be given. Secondary standards are desirable, but go beyond what is usually considered reasonable. If secondary standards are not met, no explanation is required. Conditional standards can be primary or secondary. The importance of these standards is determined by the use of the test. The importance of the conditional standards increases as larger numbers of individuals are exposed to the test or as the significance of the impact of the results increases. For the purposes of this study only the primary standards will be examined.

Part I of *Standards* gives a framework to evaluate the technical standards of a test. This section is very important as it speaks to the aspects of good test construction, hence the aspects to be evaluated. Part I is divided into five areas, each of which will be briefly addressed in turn. For a more detailed analysis specifically of the first three areas refer to Appendix C.

Validity

The first area is validity, which, "is the most important consideration in test evaluation validity always refers to the degree to which [the] evidence supports the inferences that are made from the scores" (p. 9). Validity has 17 primary standards requiring that evidence of validity be presented and if that evidence is not presented an explanation as to why is required. As well, evidence is required as to the interpretation of profiles or a subsequent caution with respect to interpretation of the results must be made. Other requirements are made with respect to construct and criterion related validity. When a detailed examination of this area is conducted, it is clear that the PEEX fails to meet the vast majority of the validity standards; therefore validity of this instrument is not substantiated.

Reliability and Errors of Measurement

The second area is reliability and errors of measurement. "Reliability refers to the degree to which test scores are free from errors of measurement" (p. 19). There are eight primary standards. First, for each score, reported estimates of reliabilities and standard errors of measurement must be provided. As well, the nature of the population and relevant procedures for data collection must be provided. Internal coefficients of reliability must be supplemented with stability over time figures. Interrater reliabilities must also be reported. Since none of these statistics are presented, except for some interrater reliability figures, the majority of the reliability standards have not been met.

Test Development and Revision

Section three details issues of concern to the test developer. It is stated that "Test developers have a responsibility to provide evidence regarding reliability and validity, as well as manuals and norms" (p. 25). This section presents eight primary and relevant standards. Conditions such as the instrument having its roots in scientific principles and research as well as delineating the items to various domains is required. This area is also concerned with clear test directions and protocols that support accurate use and interpretation. Concern with timely revisions is also in this section.

The PEEX meets more some standards in this area as tasks are assigned to specific domains, the directions for administration are clear, and the protocol is adequate; however, it still fails to meet a number of standards.

Scaling, Norming, Score Comparability, and Equating

In this section it is stated that there are ways to enhance the interpretation of scores by linking the scores to theory or empirical evidence. These areas have not been addressed in the development of the PEEX.

Test Publication: Technical Manuals and User's Guides

The fifth section indicates that enough information should be provided for the test to be evaluated. This is clearly not the case with the PEEX. No technical manuals, user's guides, or other supplementary materials are available.

Summary

Levine's personal development as a physician has influenced developmental behavioral pediatrics. The development of neurodevelopmental examinations including the PEEX has influenced pediatrics and, to some extent, education. Levine stated that there are eight areas of dysfunction which negatively impact school performance for children, ages seven to nine inclusive. These areas are attention, memory, language function, visual spatial ordering, temporal sequential ordering, neuromotor function, higher order cognition, and social cognition. It was shown that these constructs are not unique to Levine. Literature was reviewed that demonstrated that these constructs are widely accepted as central to learning, especially with respect to children who have learning disabilities.

Assessment, from Levine's perspective, is to be reported descriptively, as opposed to numerically. Specifically, Levine believes that numerical scores imply a precision that does not exist, whereas a description of a child's functional abilities accurately reflects reality. Therefore, when he developed the PEEX it was with the intent to describe a profile of abilities; however, the instrument is "scored", and he speaks to the issue of developing local norms. The result is a quasi-normed instrument that both gives and does not give a score.

A number of Levine's articles were examined in an attempt to crystallize his views and present a model of learning difficulties and their assessment in order to put the PEEX in an appropriate context. To that end the ANSER is also reviewed in order to apprehend more fully Levine's perceptions. The assessment of dysfunction, from his perspective, must examine both the intrinsic and environmental factors which influence outcomes. He believes this can substantively be done within the domain of medicine. His model focused on developmental functions referred to as low severity, high prevalence disabilities, the cumulative effects of which serve to increase a child's inability to cope in the educational environment, eventually leading to school failure. These developmental functions are influenced by a child's malleability and resiliency, and are acted upon by a number of cumulative factors in the child's environment such as economic circumstance and critical life events.

The PEEX was then presented within the context of Levine's implicit model, and was scrutinized from the perspective of the available literature as well as the Standards for Educational and Psychological Testing. From the literature it was seen that while studies conducted by Levine and his colleagues showed definite promise with respect to the PEEX, they lacked the rigor expected of these types of projects. For example, the descriptions of the norming populations and procedures was inadequate, the specificity was unacceptable, and issues of reliability, validity, and utility are still in question. Even though Levine at times stated that the PEEX is not a "test", it has the look of an assessment instrument and could be used as one. Even the "scores" could also be used in ways that Levine would not have intended. Therefore, it was decided to compare the instrument to a widely accepted criteria for test development published in *Standards*. With respect to validity the PEEX failed to meet the majority of the standards. When reliability and error of measurement were examined, again the majority of standards were not met. In the section dealing with test development and revision approximately half of the standards examined could be considered to have been met. The last two sections in *Standards* were only given a brief survey as sufficient data was not available from which to draw any conclusions.

Overall, as an assessment instrument, the PEEX was seen to be inadequate. Levine's contention that its function is to provide a descriptive profile is mitigated by the fact that norms, scoring criteria, and cut scores are used to obtain this profile. Therefore it can be argued that the PEEX can, and should, be subjected to the same scrutiny as other educational and psychological tests. In the literature review it would appear that the PEEX fails to meet acceptable standards. However, just because the instrument is inadequate does not suggest that the concepts, theories, or the "model" developed by Levine should be discarded or ignored. Rather, it appears that there are many valuable concepts presented. Given the contrast between heuristically useful concepts and an apparently inadequate measure of those concepts, it would be useful to ascertain how accurately the instrument reflects the model. This direction is the focus of this study; the study will explore whether data generated from the PEEX can be considered reflective of the model presented which led to the development of the PEEX. In the next chapter, this process will be developed and described.

CHAPTER THREE

Research Design and Methodology

Overview

This chapter presents a description of how the subjects for this study were selected and describes the sample population. Then a description of how the archival data was collected, including the process and the instrumentation involved, is undertaken. The next section entails a description of the methodology, including the statistical procedures that will be invoked. The chapter concludes with a discussion of the methodological assumptions and limitations.

Selection of Subjects

The data from two hundred and three (203) subjects were collected for this study. The sample population consisted of 146 males (72%) and 57 (28%) females. Eighty-five individuals were seven years of age; 99 children were eight years of age; and 19 children were nine years of age. All subjects were referred to the School Function Clinic at either the University of Alberta Hospitals or the Glenrose Hospital for a Pediatric Early Elementary Examination. One of the conditions of being accepted by the School Function Clinic was that prior to being given the PEEX, all subjects had to have been administered an individual intelligence test (e.g., Wechsler Intelligence Scale for Children - Revised (WISC-R)). Of the 203 subjects, 130 had been given the WISC-R. The balance were administered some other measure of intelligence (e.g., Stanford-Binet Forth Edition).

Data Collection and Instrumentation

The referrals were made directly to the School Function Clinic at either hospital, by school personnel, or by the family physician. Due to the limited numbers of children seen in the clinics, data was collected from subjects seen from March 1985 through August 1992 inclusive. The PEEX was administered by either a physician trained by Levine, or by other physicians under direct supervision. The WISC-R's were administered by clinicians who were trained in the administration of the instrument. The mean Full Scale Score on the WISC-R (n=130) was 100.10 (range 54 to 132); the mean Verbal Score was 98.25 (range 65 to 131); and the mean Performance Score was 102.33 (range 51 to 142).

The sample population for this study, therefore, was a clinically referred group of students who were likely experiencing difficulties at school. The precise reason for the referral did not form part of the selection process. The subjects were brought to the hospital by one or both parents/guardians. On the first visit a physical examination was conducted, as Levine recommends. The second visit consisted of the administration of the PEEX. The third and final visit allowed the physician to present the results to the parents/guardians.

It should be noted that the initial data was originally collected for purposes other than this study, and was already held by the University of Alberta and Glenrose Hospitals. Therefore, the analysis of this archival data was undertaken in such a way as to ensure the anonymity of each of the subjects involved. In addition there was no need to identify from which hospital the various subject's data were obtained.

Review of the PEEX Tasks

As was outlined in more detail in Chapter Two, the 32 individual tasks on the PEEX are divided into seven specific areas of development. Each task is composed of various items, with the specific number of items varying from task to task. The first area, Fine Motor, contains five tasks which are used to measure a child's finger dexterity (efficiency and accuracy). The tasks (i.e., Imitative Finger Movement; Motor Speed Dominant; Motor Speed Non-Dominant; Finger Opposition; and Eye Hand Board) reflect finger localization, quick and accurate movements, motor planning and eye-hand coordination.

The second area is Visual-Fine Motor, which contains four tasks (i.e., Copy Forms; Copy a Sentence; Connect Dots; Visual Tracking). The tasks require the subject to interpret complex visual patterns and then to plan and implement a motor response. The first three of the four tasks require a pencil and paper response, while the fourth, visual tracking, does not.

The third area, containing five tasks, is Visual Processing (i.e., Vigilance Matching; Direct Matching; Visual Recognition; Visual Retrieval; and Left-Right Discrimination). These tasks require the monitoring of visual patterns without significant motor response. Three areas are stressed: visual attention to detail, visual perception (discrimination), and visual memory.

The fourth area is Temporal-Sequential Organization, which has seven tasks (i.e., Object Span; Word Span; Tap Blocks; Count Aloud; Name Days of the Week; Tell Time; Digit Span). These tasks measure the subject's ability to apprehend, store, and retrieve sequences of information in which the order is significant to the meaning.

Linguistic, the fifth area, has four tasks which are designed to reflect language processing and production (i.e., Verbal Instructions; Complex Sentences; Serial Commands; Name Pictures). The first three tasks measure receptive language function, while the fourth involves expressive language as the subject is required to name pictures.

The sixth area, Gross Motor, includes five tasks that assess gross motor function (i.e., Motor Stance, Rapid Probation-Supination; Hop in Place; Stressed Gait; Catch Ball). Tests of balance, motor rhythm, and eye-upper limb coordination are included.

The seventh and final area, which has two tasks, is Recall (i.e., Recall Objects; Recall Words). At this point the subject is asked to recall visual and auditory information that was presented during the temporal-sequential organization area.

The "scoring" system, or Developmental Attainment, for the instrument, has four levels: Level One, a performance that is clearly below expectations for this entire age group (i.e., ages 7, 8 or 9); Level Two, a performance appropriate for younger children in this age group (i.e., 7-8 years old); Level Three, performance appropriate for older children in this age group (i.e., 8-9 years old); and Level Four, a performance that should be considered strong for anyone in this age group.

The PEEX record form was used to obtain the data. For each of the 32 variables (tasks) a developmental attainment level "score" was obtained. This score ranged from "1" to "4" inclusive for 29 of the subtests and from "1" to "3" for three subtests (i.e., Finger

Opposition, Visual Tracking, Visual Recognition). Level scores were selected as the raw data for a number of reasons. First, for four subtests it was the only score available. Second, the protocol section "examiner's cues and notes", where the raw data is recorded, did not always require that the specific number correct, or time taken for specific items, be recorded. Third, were specific item scores used for each task in the principal component analysis, a much larger sample size than was available would have been required. Other than demographic data, no other information was used from the PEEX. The WISC-R results were obtained from the psychological reports contained in each file. The individual subtest scaled scores, as well as the verbal, performance, and full scale scores, were recorded.

Methodology

The PEEX consists of 32 tasks (variables) grouped into seven developmental areas (components). An exploration of the underlying structure of the PEEX was undertaken by determining whether the 32 variables cluster to form the seven components. This exploration was conducted using a number of principal components analyses, inputting the developmental attainment level scores for each variable. A principal component analysis is a technique that "linearly transforms an original set of variables into a substantially smaller set of uncorrelated variables that represents most of the information in the original data set." (Dunteman, 1989, p. 7).

The raw data on which the principal component analysis was conducted were the level of developmental attainment "score" (i.e., 1, 2, 3, or 4) on each of the 32 variables, for each subject. Table D.1

(Appendix D) displays the frequency, in percent, of developmental attainment scores for each of the variables.

After each principal components analysis was completed, a varimax rotation was conducted in order to explore the simple structure solution of the PEEX. Varimax was selected, in part as it is one of the most popular orthogonal rotations. This orthogonal rotation allows for a shifting to a new set of axes, in the same plane. The rotation is undertaken to allow for a simpler interpretation of the rotated components. Varimax maximizes the sum of the squared loadings within each column of the loading matrix (i.e., makes the loadings as large or as small as they can be), yielding a unique solution.

Once the varimax rotation was completed, an oblique rotation followed. The oblique rotation allows for the axes to be rotated in the same plane; however, there is no requirement that they remain orthogonal, allowing each axis to better fit the existing data. This often will increase the ease of interpretation of the components. However; in this study, the results of the oblique rotations will not be reported as they did not improve the interpretability of the data relative to the varimax rotation.

For principal component analyses in which the number of components to be retained was not pre-determined, the root curve method was chosen to estimate the optimal number of components to retain. The root curve criterion method determines the eigenvalue associated with the point of inflection of a plot of the eigenvalues for each component (from largest to smallest). The rank value of the eigenvalue associated with the point of inflection is considered to be an estimate of the number of components. In this particular study, this method of retaining components allowed for more interpretable solutions, as well as ones that were more parsimonious.

As Levine had proposed seven areas, the initial analysis was set to generate seven components. The specific tasks which load onto each component were then examined in order to see how well the structure of the PEEX is replicated.

As well, a principal component analysis was used to determine the number of components generated by using a default setting, which maximized the variance accounted for, based upon the data. This procedure allowed for the results to be generated independent of Levine's model.

Using the total sample (n=203) a principal component analysis was conducted using the root curve method to determine the number of components to retain. This was followed by a varimax rotation. The objective was to further examine the simple structure, independent of attempting to maximize accounted for variance.

Another principal component analysis was run using the root curve method on the seven year old population (n=85) and then on the eight year old population (n=99). These analyses were conducted to determine whether or not major differences between the two age groups existed and would be reflected in the component structure of the PEEX for these two subsets of the population.

A final principal components analysis was run using the 32 tasks from the PEEX and 11 scaled scores from the WISC-R (i.e., Information, Similarities, Arithmetic, Vocabulary, Comprehension, Digit Span, Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Coding). These WISC-R subtest scores were used as marker variables. By determining where they clustered, and with which tasks from the PEEX, it was hoped that the interpretability of the PEEX tasks, or areas, would be increased.

Methodological Assumptions and Limitations

There are several assumptions that underlie the analysis section of this study. First, that the sample size is sufficiently large to produce results that are representative of a particular population. It is commonly accepted in principal component analyses that the ratio of subjects to variables should be at least 5:1. In this study, the ratio of subjects to variables was approximately 6.6:1. When the principal component analysis was run on subsets of the total group there were 2.7 subjects per variable for the seven year olds (2.7:1), and 3.1 subjects per variable for the eight year olds (3.1:1). On the combined PEEX/WISC-R analysis there were approximately 3.0 subjects per variable.

Second, the sample is normally distributed. As this particular sample is a referred group, there is no guarantee of this. The mean (101.1) and standard deviation (14.25) of the Full Scale Score of the WISC-R results are similar to what would be expected. The kurtosis (.113) suggested a mesokurtic curve (similar to expectations), and the skewness (-.076) indicated a slight shift right.

The third assumption is that the investigator has accurately expanded on Levine's model. That is, the hypotheses regarding which factors are correlated is an accurate reflection of the model.

There are also several limitations. First, as the sample was drawn from a clinically referred population the generalizability of the results is limited to similar populations. It is apparent however that little exploration of the PEEX has been done with random samples, and that the application of the results of the PEEX to referred subjects who are not cognitively delayed, and are experiencing school difficulties, is common practice. A second limitation is reflected in the area of examiner interrater error. Not all of the physicians who administered the PEEX had as much training as the supervising physician; therefore, some error was likely introduced at that point. Another possible limitation is the effect of gender on the results. It would appear that many more males than females were included in the referred population. Although Levine does not suggest that there are significant differences between the performance of males and females, the actual effect of gender bias with this sample cannot be determined, and may affect the generalizability of the results.

CHAPTER FOUR

Results

Overview

This chapter outlines the findings of this study as well as the interpretation and discussion of the findings. First, there will be a presentation of the seven component solution of the PEEX, comparing it to the structure of the PEEX as given by Levine (Levine & Rappaport, 1983). A summary of the 16 component solution will also be presented. This solution reflects the number of components to be retained to maximize the accounted for variance. This will be followed by the root curve solution for the total population, where an extensive and detailed discussion of the interpretation of the various components and the specific tasks will occur. There will then be a discussion of the results for the seven year old and eight year old subsets of the population. Finally, a presentation of the combined PEEX and WISC-R data for the total group will be presented and discussed.

During the interpretation and the analysis of the various results in this chapter, if the loading of any individual variable is 0.4 or greater, it will be considered to have practical importance with respect to the interpretability of the component(s) on which it loads. The same abbreviations within each table are used throughout this chapter to represent each of the variables. Table 4.1 shows the abbreviation used, the area to which it relates, and the name of the task in full. For more detailed information, a complete listing of the full name for each variable (task), as well as Levine's description of the task can be found in Appendix A.

Table 4.1
Description of Abbreviation - Area and Task

Abbreviation	Area	Task
FM-IFM	Fine Motor	Imitative Finger Movement
FM-MS	Fine Motor	Motor Speed (Dominant)
FM-MSN	Fine Motor	Motor Speed (Nondominant)
FM-FO	Fine Motor	Finger Opposition
FM-EHB	Fine Motor	Eye-Hand Board
VFM-CF	Visual-Fine Motor	Copy Forms
VFM-CS	Visual-Fine Motor	Copy a Sentence
VFM-CD	Visual-Fine Motor	Connect Dots
VFM-VT	Visual-Fine Motor	Visual Tracking
VP-VM	Visual Processing	Vigilance Matching
VP-DM	Visual Processing	Direct Matching
VP-VR	Visual Processing	Visual Recognition
VP-VRET	Visual Processing	Visual Retrieval
VP-LRD	Visual Processing	Left-Right Discrimination
TSO-0S	Temporal-Sequential Organiz.	Object Span
TSO-WS	Temporal-Sequential Organiz.	Word Span
TSO-TB	Temporal-Sequential Organiz.	Tap Blocks
TSO-CA	Temporal-Sequential Organiz.	Count Aloud
TSO-NDW	Temporal-Sequential Organiz.	Name Days of the Week
TSO-TT	Temporal-Sequential Organiz.	Tell Time
TSO-DS	Temporal-Sequential Organiz.	Digit Span
L-VI	Linguistic	Verbal Instructions
L-CS	Linguistic	Complex Sentences
L-SC	Linguistic	Serial Commands
L-NP	Linguistic	Name Pictures
GM-MS	Gross Motor	Motor Stance
GM-RPS	Gross Motor	Rapid Probation-Supination
GM-HP	Gross Motor	Hop in Place
GM-SG	Gross Motor	Stressed Gait
GM-CB	Gross Motor	Catch Ball
R-RO	Recall	Recall Objects
R-RW	Recall	Recall Words

Means, Standard Deviations, and Frequencies

Prior to the detailed description of these analyses three tables are presented. Table 4.2 presents the means and standard deviations for each of the seven areas of the PEEX, as well as for the Total PEEX Score. The data are presented in this way to assist the reader to better understand the results of the various principal component analyses. Levine (Levine & Rappaport, 1983) did not intend that any type of numerical combination of the scores (i.e., totals, means, standard deviations) be calculated for the instrument. Therefore, it is understood that no attempt is being made to used the scores in this way. These results are not part of the interpretation of the PEEX. The second table, Table 4.3 gives the means and standard deviations for each of the 32 variables. The correlation matrix is presented in Table 4.4.

Table 4.2
Means and Standard Deviations by Area and Total

Area	Mean	S.D.
Fine Motor	14.635	2.974
Visual Fine Motor	10.384	2.761
Visual Processing	11.897	3.037
Temporal Sequential Organization	15.872	3.742
Linguistic	9.379	2.310
Gross Motor	14.207	2.844
Recall	5.227	1.479
Total PEEX	81.601	12.399

Table 4.3
Means and Standard Deviations by Variable

Variable	Mean	S.D.
FM-IFM	3.281	.887
FM-MS	2.887	1.091
FM-MSN	3.143	1.101
FM-FO	2.261	.824
FM-EHB	3.064	.955
VFM-CF	2.202	1.002
VFM-CS	2.685	.969
VFM-CD	3.039	1.206
VFM-VT	2.458	.654
VP-VM	1.911	1.068
VP-DM	2.818	1.104
VP-VR	1.916	.807
VP-VRET	2.192	.794
VP-LRD	3.059	1.065
TSO-0S	1.734	.825
TSO-WS	2.335	1.003
TSO-TB	1.626	.776
TSO-CA	2.847	.784
TSO-NDW	3.084	1.047
TSO-TT	2.291	.820
TSO-DS	1.956	1.036
L-VI	1.759	.793
L-CS	2.084	.795
L-SC	3.108	.932
L-NP	2.429	.884
GM-MS	2.862	1.108
GM-RPS	2.926	.689
GM-HP	2.483	.835
GM-SG	2.956	.72
GM-CB	2.980	.890
R-RO	3.300	.864
R-RW	1.926	1.039

Table 4.4
Correlation Matrix

	FM-IFM	FM-MS	FM-MSN	FM-FO	FM-EHB	VFM-CF
FM-IFM	1					
FM-MS	.159	1				
FM-MSN	.252	.735	1			
FM-FO	.192	.061	.119	1		
FM-EHB	.107	.176	.288	.033	1	
VFM-CF	.086	.076	.137	.141	.338	1
VFM-CS	.122	.0001	.031	.07	.18	.46
VFM-CD	.198	.216	.268	.082	.451	.495
VFM-VT	.055	-.01	.083	-.01	.205	.27
VP-VM	.005	.143	.117	-.044	.271	.393
VP-DM	.186	.126	.144	.059	.298	.315
VP-VR	.113	.167	.209	.028	.179	.28
VP-VRET	.22	.054	.093	.176	.169	.388
VP-LRD	.08	.051	.083	.06	.171	.19
TSO-0S	.115	-.034	.032	.128	.047	.228
TSO-WS	-.028	-.059	.011	.031	-.021	.175
TSO-TB	.144	-.108	-.093	.127	.025	.152
TSO-CA	-.009	-.049	-.007	.158	.125	.304
TSO-NDW	.084	.014	.029	.092	.128	.107
TSO-TT	.008	.114	.147	.182	.267	.3
TSO-DS	-.01	-.016	.046	.05	-.036	.109
L-VI	.069	-.032	.095	.049	.198	.316
L-CS	.095	-.002	.086	.002	.151	.134
L-SC	.065	-.156	-.165	.029	.017	.175
L-NP	-.0003	-.037	-.0004	.077	.1	.178
GM-MS	.079	.086	.067	.12	.078	.236
GM-RPS	.191	.083	.194	.1	.258	.217
GM-HP	.259	-.002	.06	.12	.199	.236
GM-SG	.243	.04	.129	.151	.257	.327
GM-CB	.103	.075	.177	.027	.212	.236
R-RO	-.025	.013	.096	.087	.197	.129
R-RW	-.025	-.133	-.136	-.034	.004	.092

Table 4.4
<u>Correlation Matrix - Continued</u>

	VFM-CS	VFM-CD	VFM-VT	VP-VM	VP-DM	VP-VR
FM-IFM						
FM-MS						
FM-MSN						
FM-FO						
FM-EHB						
VFM-CF						
VFM-CS	1					
VFM-CD	.274	1				
VFM-VT	.186	.265	1			
VP-VM	.352	.358	.219	1		
VP-DM	.251	.413	.133	.309	1	
VP-VR	.281	.286	.118	.3	.3	1
VP-VRET	.382	.254	.146	.325	.303	.347
VP-LRD	.228	.204	.072	.095	.181	.165
TSO-0S	.088	.057	.056	.107	.063	.032
TSO-WS	.097	.095	-.021	.088	.138	.213
TSO-TB	.098	.057	.003	.042	.034	.187
TSO-CA	.341	.281	.134	.307	.266	.275
TSO-NDW	.226	.149	.014	.198	.129	.194
TSO-TT	.289	.357	.156	.29	.215	.165
TSO-DS	.11	.092	-.051	.053	.097	.151
L-VI	.198	.249	.033	.357	.237	.259
L-CS	.038	.167	.083	.139	.206	.154
L-SC	.149	.131	.108	.088	.183	.067
L-NP	.063	.226	.036	.181	.073	.165
GM-MS	.177	.162	.067	.144	.168	.223
GM-RPS	.25	.256	.244	.165	.172	.184
GM-HP	.241	.193	.243	.138	.135	.261
GM-SG	.242	.311	.234	.262	.194	.139
GM-CB	.[illegible]89	.238	.22	.195	.212	.244
R-RO	.127	.112	.137	.173	.172	.208
R-RW	-.012	.092	.057	.098	.07[illegible]	-.032

Table 4.4

Correlation Matrix - Continued

	VP VRET	VP-LRD	TSO-OS	TSO-WS	TSO-TB	TSO-CA
FM-IFM						
FM-MS						
FM-MSN						
FM-FO						
FM-EHB						
VFM-CF						
VFM-CS						
VFM-CD						
VFM-VT						
VP-VM						
VP-DM						
VP-VR						
VP-VRET	1					
VP-LRD	.159	1				
TSO-0S	.152	.196	1			
TSO-WS	.142	.1	.31	1		
TSO-TB	.263	.151	.465	.397	1	
TSO-CA	.375	.244	.23	.198	.213	1
TSO-NDW	.266	.199	.131	.095	.154	.415
TSO-TT	.2	.197	.072	.083	.082	.432
TSO-DS	.147	.142	.293	.592	.24	.218
L-VI	.303	.236	.272	.445	.179	.302
L-CS	.147	.138	.141	.278	.062	.151
L-SC	.234	.152	.232	.214	.22	.199
L-NP	.193	.19	.253	.33	.233	.273
GM-MS	.189	.142	.09	.124	.099	.224
GM-RPS	.217	.091	.139	.096	.082	.133
GM-HP	.265	15	.239	.176	.293	.198
GM-SG	.216	.123	.297	.132	.157	.188
GM-CB	.2	.072	.141	.095	.146	.242
R-RO	.217	.182	.004	.03	.004	.124
R-RW	.125	.152	.172	.075	.028	.233

Table 4.4
Correlation Matrix - Continued

	TSO-NDW	TSO-TT	TSO-DS	L-VI	L-CS	L-SC
FM-IFM						
FM-MS						
FM-MSN						
FM-FO						
FM-EHB						
VFM-CF						
VFM-CS						
VFM-CD						
VFM-VT						
VP-VM						
VP-DM						
VP-VR						
VP-VRET						
VP-LRD						
TSO-0S						
TSO-WS						
TSO-TB						
TSO-CA						
TSO-NDW	1					
TSO-TT	.385	1				
TSO-DS	.112	.137	1			
L-VI	.215	.241	.33	1		
L-CS	.115	.161	.312	.45	1	
L-SC	.176	.008	.12	.251	.182	1
L-NP	.111	.198	.337	.343	.299	.284
GM-MS	.077	.111	.146	.076	.06	.024
GM-RPS	.162	.174	.073	.159	.081	.189
GM-HP	.197	.113	.154	.214	-.036	.091
GM-SG	.086	.189	.163	.202	.115	.111
GM-CB	.124	.14	.123	.148	.225	.126
R-RO	.089	.095	.028	.2	.128	.041
R-RW	.091	.008	.002	.123	.151	.088

Table 4.4
<u>Correlation Matrix - Continued</u>

	L-NP	GM-MS	GM-RPS	GM-HP	GM-SG	GM-CB
FM-IFM						
FM-MS						
FM-MSN						
FM-FO						
FM-EHB						
VFM-CF						
VFM-CS						
VFM-CD						
VFM-VT						
VP-VM						
VP-DM						
VP-VR						
VP-VRET						
VP-LRD						
TSO-0S						
TSO-WS						
TSO-TB						
TSO-CA						
TSO-NDW						
TSO-TT						
TSO-DS						
L-VI						
L-CS						
L-SC						
L-NP	1					
GM-MS	.108	1				
GM-RPS	.116	.31	1			
GM-HP	.18	.258	.212	1		
GM-SG	.202	.409	.4[illegible]7	.49[illegible]	1	
GM-CB	.328	.321	.20	.17	.346	1
R-RO	.117	.193	.185	.112	.168	.154
R-RW	.066	.061	.021	-.009	.128	.101

Seven Component PEEX

The first analysis involved setting the number of components to seven, then running the principal component analysis, followed by a varimax rotation. The seven component solution accounted for 50.7 percent of the variance. Table 4.5 shows the components and the loadings for each of the 32 PEEX variables. All loadings of 0.4 or higher are in bold print. As well, the communality for each variable is also reported. The communality figure (h^2) gives the total proportion of the variance for a specific task that is predicted from the number of components in that solution. If the component structure is as Levine hypothesized, then one would expect the Fine Motor component to have five variables; the Visual Fine Motor to have four; Visual Perceptual, five; Temporal Sequential Organization, seven; Linguistic, four; Gross Motor, five variables; and Recall, two.

The first component (eigenvalue = 6.155), accounted for 19.2 percent of the variance, and consisted of seven variables with loadings ranging from 0.5 to 0.708. The variables defining this component represent visual fine motor skills, involving either pencil and paper tasks, or other eye hand coordination tasks. As well, visual scanning and eye tracking tasks are involved in this component. It could be called a Visual Fine Motor and Scanning component.

The second component (eigenvalue = 2.593), accounted for 8.1 percent of the variance, and consisted of six variables with loadings ranging from 0.424 to 0.741. The tasks defining this component predominantly represents short-term auditory sequential

Table 4.5
Orthogonal Transformation Solution - Varimax
Seven Component PEEX

Variable	h^2	Component 1	2	3	4	5	6	7
FM-IFM	.398	.143	-.072	.239	.13	-.003	-.037	**.545**
FM-MS	.69	.113	-.018	**.817**	.045	-.08	.015	.013
FM-MSN	.785	.177	.047	**.854**	.107	.004	.0003	.103
FM-FO	.399	-.135	-.057	.173	.053	.004	.395	**.434**
FM-EHB	.459	**.559**	-.027	.286	.07	.211	.083	.087
VFM-CF	.575	**.688**	.138	-.043	.126	-.104	.183	.14
VFM-CS	.571	**.5**	-.003	-.148	.201	-.343	.371	-.049
VFM-CD	.593	**.708**	.09	.206	.053	.108	.124	.108
VFM-VT	.376	**.522**	-.118	-.084	.214	.11	-.067	.144
VP-VM	.484	**.599**	.149	.006	.108	-.052	.232	-.188
VP-DM	.352	**.526**	.144	.095	.117	.081	.141	-.073
VP-VR	.495	.297	.304	.163	.318	-.281	.252	-.21
VP-VRET	.401	.339	.165	-.066	.251	-.099	**.417**	.089
VP-LRD	.264	.162	.122	.018	.074	.244	.374	.134
TSO-0S	.549	.047	.397	-.156	.058	.116	.091	**.582**
TSO-WS	.679	.025	**.8**	-.082	.068	-.145	.012	.076
TSO-TB	.558	-.046	**.424**	-.213	.065	-.182	.187	**.509**
TSO-CA	.609	.216	.212	-.169	.144	.074	**.68**	.004
TSO-NDW	.504	.05	.048	-.027	.057	.052	**.701**	.026
TSO-TT	.521	.284	.068	.169	-.056	.034	**.633**	.034
TSO-DS	.595	-.056	**.741**	.026	.137	-.117	.087	.052
L-VI	.544	.337	**.605**	-.003	.005	.148	.205	-.002
L-CS	.556	.172	**.554**	.143	-.032	**.433**	.027	-.097
L-SC	.364	.248	.282	-.395	.02	.201	.02	.162
L-NP	.414	.095	**.556**	-.037	.144	.23	.118	.081
GM-MS	.599	-.006	.098	.029	**.751**	-.056	.146	-.033
GM-RPS	.37	.276	.01	.071	**.518**	.055	-.013	.129
GM-HP	.518	.195	.087	-.096	**.483**	-.225	.105	**.41**
GM-SG	.626	.289	.081	-.027	**.632**	.093	-.018	.357
GM-CB	.426	.18	.25	.142	**.486**	.259	.065	.062
R-RO	.428	.059	.031	.075	**.421**	.363	[illegible]	-.236
R-RW	.514	.062	.018	-.278	.105	**.631**	.152	-.013

memory requiring either a verbal or motor response. The tasks vary with respect to meaningfulness. One task requires short-term visual memory. As well, a task requiring expressive language skills (i.e., Name Pictures) was included in this component. Therefore, this is primarily a Short-Term Sequential Memory component, with Name Pictures apparently included for reasons other than sequential memory.

The third component (eigenvalue = 1.818), accounted for 5.7 percent of the variance, and consisted of two variables with loadings of 0.817 and 0.854. The tasks defining this component represent fine motor speed; however, this component has only two variables, calling into question whether or not it is a legitimate component. It could be considered a Fine Motor Speed component.

The fourth component (eigenvalue = 1.734), accounted for 5.4 percent of the variance, and consisted of six variables with loadings ranging from 0.421 to 0.751. Five of the six tasks defining this component represent gross motor skills; one is a Recall Objects (long-term memory) task. Why this last task loads onto this component is unclear. This could be considered a Gross Motor component.

The fifth component (eigenvalue = 1.446), accounted for 4.5 percent of the variance, and consisted of two variables with loadings of 0.433 and 0.631. The first variable defining this component appears to be primarily a linguistic task (Complex Sentences), involving to some degree, short-term auditory memory. The second variable defining this component (Recall Words) is a long term memory task involving the recall of a number of words after 20 to 30 minutes. Given that there are only two variables, and they appear to be tapping quite different skills, it is unclear what this component is really measuring.

The sixth component (eigenvalue = 1.266), accounted for 4.0 percent of the variance, and consisted of four variables with loadings from 0.417 to 0.701. The tasks defining this component primarily (3 of 4) represent long term memory abilities; however this component also includes a short-term memory task requiring visual closure abilities. Therefore this can be viewed as primarily a Long Term Memory component.

The seventh component (eigenvalue = 1.203), accounted for 3.8 percent of the variance, and consisted of five variables with loadings from 0.41 to 0.582. The tasks defining this component reflect sequentially imitated motor patterns. Of the four variables in this component, Tap Blocks also loads on Short-Term Sequential Memory (Component 2) and Hopping also loads on Gross Motor (Component 4). This component can be viewed as Sequential Motor Imitation.

Three of the 32 variables do not load on any of the seven components. These three are Visual Recognition, Left-Right Discrimination, and Serial Commands. As well, three variables load on two different components (i.e., Tap Blocks, Components 2 and 7; Copy Sentence, Components 2 and 5; and Hopping, Components 4 and 7). This suggests that these tasks are not discrete.

When the seven component solution is examined, the variables in Levine's Fine Motor area are split among Components 1, 3, and 7, suggesting that this area is not measuring a discrete set of skills or abilities. The variables from Levine's Visual Fine Motor area stay together; however, the Vigilance Matching and Direct Matching variables form Visual Processing, and the Eye Hand Board from the Fine Motor area combine to comprise Component 1, Visual Fine Motor and Scanning. This would suggest that Levine's distinction (Levine & Rappaport, 1983) between Visual Fine Motor and Visual Processing is not borne out by the data. Two of the Visual Processing tasks (Visual Recognition and Left Right Discrimination) do not load on any of the seven components. The tasks in Levine's Temporal Sequential Organization area are split among three components, Short-Term Sequential Memory (Com[illegible] 2), Long-Term Memory (Component 6), and Sequential Motor [illegible] (Component 7). Most of the Linguistic area tasks, three of four, load on Short-Term Sequential Memory (Component 2), with one, Serial Commands, not loading on any of the seven components. Levine's Gross Motor area stays intact (Component 4); however, Recall Objects is added. His Recall area divides between Gross Motor (Component 4) and Component 5, which could not be interpreted.

It would appear that the seven component solution does not support the distribution of the variables as Levine groups them. In fact, most of his groupings break down completely. Also, two of the seven components contain only two variables each. At this point it will be more useful to determine if there is another component solution that can be used to better interpret the results.

<u>Sixteen Component PEEX</u>

The next step was to run the principal component analysis without predetermining a specific number of components (default setting). This analysis generated 16 components which were subjected to a varimax rotation. The 16 component solution accounted for 77.2 percent of the variance. The communalities were all very high ranging from 0.666 to 0.917, with only two variables having communalities below 0.7. However, the results of the 16 component analysis do not allow a meaningful interpretation; therefore, no table of results will be given. Of the thirty-two variables, only one (Direct Matching) loaded on more than one component (i.e., Components 12 and 16). Two components had 4 variables each. Four components had three variables each. Four components had only two variables, and six components had only one variable. Therefore, although 77.2 percent of the variance was accounted for, the results were not interpretable, and ten of the 16 components did not even contain enough variables to be considered legitimate components. Therefore, the 16 component solution must also be rejected.

Four Component PEEX

The third run involved allowing the root curve method to select the number of components to be retained and then running the principal component analysis, followed by a varimax rotation. Using the root curve method, a four component solution was generated. The four component solution accounted for 38.4 percent of the variance. Table 4.6 shows the components and the loadings (0.4 or higher are in bold print) for each of the 32 PEEX variables. As well, the communality for each variable is also reported.

The first component (eigenvalue = 6.155), accounted for 19.2 percent of the variance, and consisted of twelve variables with

Table 4.6

Orthogonal Transformation Solution - Varimax

Four Component PEEX

Variable	h^2	Component 1	2	3	4
FM-IFM	.281	-.006	-.008	.231	**.477**
FM-MS	.652	.136	-.007	**.793**	.061
FM-MSN	.757	.184	.071	**.833**	.155
FM-FO	.091	.033	.05	.028	.294
FM-EHB	.377	**.516**	-.028	.299	.141
VFM-CF	.454	**.602**	.083	-.016	.29
VFM-CS	.407	**.563**	-.082	-.167	.236
VFM-CD	.485	**.629**	.061	.231	.18
VFM-VT	.25	.366	-.145	-.017	.308
VP-VM	.421	**.644**	.07	.021	.032
VP-DM	.321	**.54**	.101	.112	.082
VP-VR	.288	**.437**	.224	.149	.157
VP-VRET	.364	**.493**	.151	-.132	.284
VP-LRD	.176	.359	.178	-.079	.099
TSO-0S	.422	-.01	**.475**	-195	.398
TSO-WS	.603	.026	**.766**	-.069	.099
TSO-TB	.45	-.062	**.468**	-.268	.394
TSO-CA	.494	**.573**	.236	-.318	.091
TSO-NDW	.246	**.439**	.1	-.207	.029
TSO-TT	.34	**.574**	.1	.022	-.009
TSO-DS	.54	.029	**.725**	.007	.113
L-VI	.529	**.426**	**.59**	-.023	-.009
L-CS	.448	.27	**.572**	.136	-.172
L-SC	.266	.189	.284	-.37	.112
L-NP	.388	.201	**.578**	-.064	.098
GM-MS	.296	.183	.086	.004	**.505**
GM-RPS	.306	.26	.001	.099	**.478**
GM-HP	.499	.141	.09	-.099	**.679**
GM-SG	.558	.234	.099	-.001	**.703**
GM-CB	.292	.29	.27	.132	.343
R-RO	.129	.349	.051	.018	.065
R-RW	.172	.236	.087	-.325	-.05

loadings ranging from 0.426 to 0.644. The variables defining this component represent skills which cluster around visual motor, visual scanning, and memory areas. This component contains the most variables. The Eye Hand Board involves eye hand coordination and visual scanning, and although it is timed, it is only an upper limit and the score is not reflected by the time allotted. Only the number of errors/incompletes is recorded. Copy Forms requires pencil and paper skills, and some perceptual abilities, but does not involve any memory as the form is always present. Copy a Sentence requires copying skills, and again the sentence is present at all times. Connect Dots is a pencil and paper task requiring the examinee to replicate a connect the dot design. Vigilance Matching is a visual scanning task requiring the identification (by circling) of designs exactly like the stimulus. It does not have a memory component, but does require attention to detail. Direct Matching requires visual scanning abilities. On this task there is no stimulus, however two identical designs must be identified. Again there is no memory component, but attention to detail is required. Visual Recognition requires short-term visual memory (recognition) and the identification of a design exactly like a stimulus. Visual Retrieval requires short-term visual memory (recall) as the stimulus design is removed and the design must be completed or drawn. This requires many of the same skills as Copy Forms, in addition to short-term memory skills. Count Aloud requires long-term memory and the ability to count backwards. Name Days of the Week also requires long-term memory skills. Tell Time is also a long-term memory task, with some perceptual requirements as the stimulus clocks are analog. Verbal Instructions involves short-term auditory memory (one or two step instructions) with a motor, often a pencil and paper, response. From the brief description of the task requirements, Component 1 can be viewed as requiring visual fine motor, visual perceptual, visual scanning, short-term visual memory, and short-term auditory memory skills, all of which require a motor response, most often using a pencil. In addition, three tasks of this component require long-term memory skills. Component 1 will be called Perceptual Visual Motor and Memory.

The second component (eigenvalue = 2.593), accounted for 8.1 percent of the variance, and consisted of seven variables with loadings ranging from 0.475 to 0.766. Object Span requires short-term sequential memory skills with a motor response. Word Span also requires short-term sequential memory skills only with a verbal response. Tap Blocks requires short-term sequential memory with a motor response. Digit Span taps auditory sequential memory, with a verbal response. Verbal Instructions, described above, involves short-term auditory memory and although sequence is not scored, the instructions request that one task be completed first. Complex Sentences orally presents sentences with phrases and clauses in unusual positions and then questions regarding meaning are asked. Perhaps the repositioning of the words makes this a sequential task as well. The linguistic complexity of the sentences also requires short-term auditory memory skills for success. Name Pictures reflects a child's expressive language skills. It is difficult to perceive why this variable loaded on to Component 2; however, it could be a function of the fact that other linguistic tasks (i.e., Complex

Sentences, Verbal Instructions) are included in this component, although the sequential memory aspect of each has been emphasized. Component 2 will be identified as Short-Term Sequential Memory (Linguistic).

The third component (eigenvalue = 1.818), accounted for 5.7 percent of the variance, and consisted of two variables with loadings of 0.793 and 0.833. The tasks defining this component represent fine motor speed. The time taken to touch the tip of the index finger to the thumb 20 times is recorded (dominant and non-dominant). This component has only two variables, calling into question whether or not it is a legitimate component. However, these two, and only these two tasks sort as a separate component in every solution from the four component solution through to the sixteen component solution, inclusive. Component 3 is therefore Fine Motor Speed.

The fourth component (eigenvalue = 1.734), accounted for 5.4 percent of the variance, and consisted of five variables with loadings ranging from 0.477 to 0.703. The only fine motor task to load on this component requires the examinee to copy the examiner's finger movements without the benefit of visual feedback. The other tasks all require gross motor skills. Motor Stance reflects balance and body position. Rapid Probation-Supination involves the muscles of the forearm. Hopping requires balance, motor rhythm, and to a degree sequencing. Stressed Gait taps agility and balance as well as requiring a sense of body position. Component 4 is Motor Skills.

The four components are: Perceptual Visual Motor and Memory (1); Short-Term Sequential Memory (Linguistic) (2); Fine Motor Speed (3); and Motor Skills (4). Eight tasks do not load on any of the four components. Of these eight, two (Left-Right Discrimination and Serial Commands) also failed to load on to any component in the seven component solution. Left-Right Discrimination requires the examinee to be able to identify his or her own left or right. Serial Commands requires the completion of five step commands in the proper sequence. The other six tasks will be outlined briefly. Finger Opposition requires the child to imitate a fine motor sequence (dominant hand) three times. Visual Tracking reflects eye tracking. Catch Ball involves upper limb coordination. Neither of the two tasks (i.e., Recall Objects, Recall Words) which Levine suggest combine to comprise the Recall area loaded on to any of the four components. These tasks require long term memory skills and performance may be inhibited by the fact that the objects and words were initially used in the performance of other tasks.

Three Component and Five Component PEEX

As the root curve method provides only an estimate of the number of components, a cursory examination of a three component and a five component solution was undertaken. The three component solution accounted for 33 percent of the variance. When the components were examined, it was noted that the first and second components were very similar to Component 1 and 2 from the four component solution. The major difference was that Component 4 from the four component solution disappeared with all of the Gross Motor variables failing to load on any component and the one fine motor variable loading with Component 3 (Motor Speed) to form the third component. Therefore, as the three component solution failed to identify the Gross Motor dimension of the PEEX, and did not increase the interpretability of the three remaining components, it was rejected.

The five component solution accounted for 44.1 percent of the variance. With this solution the variables from the second, third, and fourth components remained identical to the variables of Components 2, 3, and 4 from the four component solution. The variables from component 1 of the four component solution were redistributed, in no apparently meaningful way between the first and fifth components. Therefore, as the five component solution was less clear as to the interpretation of the components, and only an additional 4.5 percent of the variance was accounted for, it was therefore rejected.

In summary, the four component solution of the PEEX provides for the most meaningful interpretation of the data. It would appear that Levine's hypothesized structure of the PEEX is not supported when the instrument is subjected to a principal component analysis. It is clear from the manual that Levine expects children of different ages to perform differently on the PEEX. It was decided that a principal component analysis would be conducted on subsets of the original sample.

Principal Component Analysis - Seven and Eight Year Olds

Two additional analyses were conducted using the seven year old group and the eight year old group as subpopulations. Briefly, using the root curve method, a four component solution (37.4 percent of the variance) was retained for the seven year olds, while a three component solution (33.6 percent of the variance) was retained for the older group. Besides suggesting a different simple structure for the two subpopulations, there were two other differences. First, the results for the younger group did not show a Gross Motor component, whereas it was evidenced for the eight year olds. Second, tasks from Fine Motor and Visual Fine Motor tended to merge for the seven year olds while Visual Fine Motor tasks tended to cluster with Visual Processing tasks for the eight year olds. For a more detailed discussion, of these analyses see Appendix E.

The PEEX and the WISC-R

The final principal components analysis was run using the 32 tasks from the PEEX and 11 scaled scores from the WISC-R. The WISC-R subtest scores were to be used as marker variables. That is, by determining which tasks from the PEEX they clustered with, it was hoped that the interpretability of the PEEX tasks, or perhaps even areas, could be improved. This did not turn out to be the case; however, some useful data was obtained from this analysis. The principal component analysis was run using 43 the variables 32 PEEX, 11 WISC-R), with 130 subjects who had completed both the PEEX and the WISC-R. The root curve method was again used to estimate the number of components to be retained. The results, which show a three component solution are presented in Table 4.7. The three component solution accounts for 32.7 percent of the variance. The results will be discussed globally. This solution does not lend itself to a clear and succinct interpretation, especially with respect to Components 2 and 3, although Component 2 looks somewhat similar to Component 1 from the total group four component solution (Table 4.6). One difference is the addition of some gross motor variables to Component 2.

Table 4.7

Orthogonal Transformation Solution - Varimax

PEEX and WISC-R

Variable	h^2	Component 1	Component 2	Component 3
FM-IFM	.038	.002	.141	.133
FM-MS	.273	.218	.379	-.286
FM-MSN	.322	.238	**.482**	-.182
FM-FO	148	-.077	.252	.28
FM-EHB	.413	.264	**.566**	-.153
VFM-CF	.485	.213	**.644**	.16
VFM-CS	.343	.048	**.567**	.139
VFM-CD	.464	.382	**.555**	-.097
VFM-VT	.264	.135	**.494**	-.043
VP-VM	.37	.222	**.566**	-.003
VP-DM	.315	.362	.425	-.053
VP-VR	.226	.265	.374	.125
VP-VRET	.315	.279	.39	.292
VP-LRD	.131	.113	.336	.078
TSO-0S	.463	-.03	.165	**.66**
TSO-WS	.569	.37	-.06	**.654**
TSO-TB	.494	.004	.022	**.703**
TSO-CA	.346	.17	**.432**	.361
TSO-NDW	.177	-.07	.369	.19
TSO-TT	.289	.173	**.508**	.026
TSO-DS	.431	.315	-.024	**.575**
L-VI	.443	**.441**	.247	**.434**
L-CS	.233	**.437**	.056	.198
L-SC	.151	.128	-.0002	.366
L-NP	.266	.294	-.004	**.424**
GM-MS	.274	-.18	**.402**	.282
GM-RPS	.184	.031	.389	.179
GM-HP	.311	-.078	.364	**.416**
GM-SG	.396	-.157	**.457**	**.403**
GM-CB	.25	-.031	**.426**	.259
R-RO	.158	.258	.301	.027
R-RW	.019	.069	.072	.093

Table 4.9 - Continued
Orthogonal Transformation Solution - Varimax
PEEX and WISC-R

Variable	h^2	Component 1	2	3
INF	.405	**.636**	.017	.012
SIM	.541	**.726**	.072	.096
ARI	.357	**.532**	.205	.177
VOCAB	.579	**.759**	.006	.05
COMP	.396	**.591**	-.135	.171
DS	.411	**.592**	.217	.117
PC	.287	**.478**	.237	.046
PA	.442	**.66**	.071	.037
BD	.505	**.673**	.227	-.025
OA	.488	**.645**	.255	.081
CD	.098	.306	.059	.036

Note: Loadings of 0.4 or greater are in bold print

Ten of the eleven variables from the WISC-R load on to one of the three components (Component 1). Only Coding loads onto another component. This suggests that Component 1 is a measure of general intelligence (*g*). Only two variables from the PEEX loaded onto this component, both from the Linguistic area. One of these was Verbal Instructions, which also loaded onto component 3, suggesting that it is not a discrete task. The other variable was Complex Sentences, which only loaded on Component 1. It would appear that the majority of the tasks of the PEEX are measuring something other than *g*; therefore, the results of the PEEX cannot be said to reflect general intelligence. This is further borne out by examining the correlation matrix. Of the over 250 correlations between WISC-R and PEEX variables, the highest correlation was 0.486 between Digit Span on the WISC-R and Verbal Instructions. As well, there were only 11 correlations over 0.300. This suggests that there is little in common between the PEEX variables and the WISC-R variables. Finally, since the variables of the WISC-R did not cluster with the variables of the PEEX, they did not add to the interpretability of the PEEX tasks.

<u>Summary</u>

It has been shown that when the PEEX is subjected to a principal component analysis, to retain enough components to account for eigenvalues greater than one, 60 percent, or 75 percent of the variance, one is left with so many components that the results can not be clearly interpreted. With the root curve method, the resultant four component solution for the total population is interpretable; however, it only accounts for 38.4 percent of the variance. This finding suggests that the PEEX requires further refinement to increase the variance accounted for without significantly increasing the number of components.

It has also been shown that Levine's hypothesized seven areas (Levine & Rappaport, 1983) are not supported by a principal component analysis and that four areas allow for a more parsimonious interpretation. As well, his suggestion that the age of the child needs to be taken into account when applying the results of the PEEX needs to be strengthened. It appears that the number of components, hence the simple structure of the PEEX, is different for seven year olds and for eight year olds.

Finally, it appears that there is little correlation between the PEEX variables and the WISC-R variables. As well, when the results of the principal component analysis for the PEEX and WISC-R variables combined is examined, it can be seen that the component which represents general intelligence contains ten of eleven WISC-R variables and only two of thirty two PEEX variables.

CHAPTER FIVE

Discussion

General Discussion

Levine, Brooks and Shonkoff (1980) believe that with instruments like the PEEX assessment should follow a descriptive rather than psychometric model. Further they believe that an overall score was deemed inappropriate and misleading. Levine (1985) states that test scores are seductive in that they imply a measure of exactitude that is not there. From his perspective, the results must yield functional profiles and thorough narrative accounts. Ideally these profiles are to be developed across disciplines. He states that the PEEX meets these criteria and can be found to be extremely helpful in this process.

Levine, Meltzer, Busch, Palfrey, and Sullivan (1983) state that the PEEX was designed to fulfill four objectives: One, to provide a set of age appropriate tasks in order to screen for low-severity disorders. Two, to assist physicians in identifying areas requiring further evaluation. Three, to indicate developmental areas of concern instead of an overall score. Four, to enhance the contribution made by the pediatrician. Further, they state that the PEEX was not meant to be administered alone, rather it is to be used with other data gathering systems (i.e., ANSER). As well, information from other disciplines is to be integrated with the PEEX results, although there is no specific suggestion as to how that is to be done.

Levine (1987a) gives, "An implicit conceptual model [which] governed the selection and division of the subject matter" (p. 8). This subject matter consists of the seven developmental functions which Levine postulates have a profound effect on the lives of school aged children. He lists the seven functions as: attention and intention; simultaneous and sequential processing and production; memory; language; higher-order cognition; motor implementation; and social ability. In 1992 Levine (1992d) adds an eighth function, Visual Spatial Ordering.

The PEEX itself has 32 tasks (variables) which are grouped by Levine into seven areas. The areas are Fine Motor, Visual-Fine Motor, Visual Processing, Temporal-Sequential Organization, Linguistic, Gross Motor, and Recall. As can be seen there is some overlap between his eight functions and the seven areas of the PEEX.

Levine's supporters, reflect his views. With respect to neurodevelopmental assessments, Busch (1992) sounds very much like Levine when she states that these assessments allow the pediatrician to observe a child directly, and assist in explaining the developmental processes that are responsible for academic difficulties. She states that they also assist the pediatrician to determine what further diagnostic assessments might be needed, and permit the translation of the observations of brain function into practical suggestions. The result is a constructive collaboration between educators and physicians, which she believes ultimately helps children with developmental disorders.

However, statements made by Levine and his supporters have fueled some controversy. Levine (1991) states that within developmental-behavioral pediatrics, "there must exist diagnostic tools that provide for the rigorous and valid assessment of problems during childhood" (p. 2). He goes on to say, "There is an ongoing need to refine our instrumentation" (p. 2). Further he states (1992a) that, "It would be inappropriate to superimpose psychometrics over pediatrics" (p. 170). These statements succinctly reflect the controversy surrounding the PEEX. Levine calls for the development of local norms, yet gives insufficient information as to how the PEEX was originally normed. At the same time that he calls for norms, he says that verbal, not numerical descriptors and functional profiles, not scores are important. He says there is a need for valid tools, yet gives no evidence for the validity of the PEEX.

Although Levine is very clear that the development of a functional profile of the child is one goal of the PEEX, there is no guarantee that others who use this instrument will generate such a profile. Levine has done his best to prevent users from generating a numeric descriptor, or even a label; however, there are still numbers generated and labels could be used. Even if a developmental profile is developed, it will be generated following the seven areas of the PEEX; therefore, the validity of the PEEX will determine the extent to which the profile is accurate. The belief that the seven areas are accurate is reflected in Hagerman's (1984) statement that, "These evaluations [PEEX] are thorough [and] useful because of their standardization and organization of learning tasks" (p. 280).

Levine, Meltzer, Busch, Palfrey, and Sullivan (1983) focus on the development and standardization of the PEEX. Although they present some interesting results the study is lacking in several key areas. First, there is no detailed description of the sample population which was used for the study. They failed to provide evidence for the validity or reliability of the PEEX. In fact, to date there does not appear to be a publication, including the manual, where this has occurred. Finally, they do not present any data as to how the specific tasks were developed, nor do they indicate how they were clustered. As this was the only published study of this magnitude, it would have been reasonable to expect that norms, validity, and reliability statements would have been reported.

Levine (1982) recognizes the controversy with respect to whether or not a physician should be involved with children when the difficulties are primarily educational. He responds that the physician has a place if the standard medical services are augmented with the identification of the neurodevelopmental contributors to school failure, in this case the administration of the PEEX. Therefore, by his own assertion, the value of the contribution of the physician will be directly related to the contribution of the PEEX itself. The second area of importance is the evaluation of family functioning and the assessment of the environmental factors involved in school failure. How the physician is to evaluate family functioning, as this is not generally part of the training physicians receive, is open to speculation. School environmental factors would likely be assessed through the ANSER system, which although not central to this study, appears to have its own difficulties.

The published literature on the PEEX, its development, and current applications is scant. Generally however, the research and reviews have been negative to neutral. Kenny et. al. (1990) state that the sensitivity of the PEEX is moderately acceptable while the specificity (64.3%) is unacceptable. They conclude that as a screening tool, the PEEX has limited generalizability and is not cost effective.

Grill (1987) views the one strength of the PEEX is that the examinee's behaviour, as well as the score, is recorded. He sees some significant problems: the lack of reliability or validity data, norms, or demographic data "renders the PEEX useless except to record observations" (p. 604). He also says no meanings are given for how a student does on a specific task. Schwartz (1987) also sees one strength of the PEEX in that it can assist in determining what further assessment is required. He expresses concerns regarding the lack of validity, reliability, and norms, as well as how the cut scores for each of the four levels were determined. He suggests PEEX use should be restricted to times when descriptive statements are required. The concerns regarding validity, reliability and development, and revision were echoed when the writer reviewed the PEEX in relationship to the Standards for Educational and Psychological Testing.

Given the importance of the structure of the PEEX to its application in the field of pediatrics and education, it was decided that this study would examine the simple structure of the PEEX using a principal component analysis. First, a seven component solution was examined in order to observe whether the tasks clustered as Levine (Levine & Rappaport, 1983) hypothesized. When the results of the seven component solution, which accounted for 50.7 percent of the variance, were examined it was noted that the outcome bore little resemblance to Levine's clustering of the tasks. Component 1, had seven variables from three areas, and was labeled Visual Fine Motor and Scanning. Component 2, primarily Short-Term Sequential Memory, contained six variables from two areas. Component 3, Fine

Motor Speed, had only two variables, both from the Fine Motor area. Component 4, Gross Motor, contained six variables, five from the Gross Motor area. Component 5 had two variables from two areas and could not be interpreted. Component 6, Long Term Memory, had four variables from two areas. Component 7 included four tasks from two areas and was labeled Sequential Motor Imitation, although its importance is open to speculation. It was demonstrated that the seven component solution did not support Levine's clustering of the variables. When the eight areas Levine (1992d) says are important to school success are compared to the components from this solution, there are two memory components (short-term and long-term); however, neither one includes either of the two tasks he assigned to the memory area. There is a component that likely reflects what he calls Visual Spatial Ordering (Visual Fine Motor and Scanning). No other areas are clearly represented. Therefore, when the seven component solution of the PEEX is examined, it can be seen that it does not accurately reflect either Levine's clustering of the variables, nor does it account for many of the eight areas he deems significant for school success.

A sixteen component solution was generated, accounting for 77.2 percent of the variance, but it did not lend itself to a meaningful interpretation. Using the root curve method, estimating the number of components to be retained from the point of inflection, a four component solution was generated. This solution accounted for 38.4 percent of the variance. Component 1 was labeled Perceptual Visual Motor and Memory. This component contained 12 variables from three areas. Component 2 consisted of seven variables from two areas. It was deemed Short-Term Sequential Memory (Linguistic). Component 3, Fine Motor Speed, had two variables from one area. Although it had only two variables, these two variables remained together, with no others, from the four component solution through to the 16 component solution. Component 4 had five variables from two areas and was called Motor Skills. Four of the five variables were Gross Motor. The four component solution does as well as the seven component solution in representing Levine's (1992d) stated eight areas necessary to school success.

As the root curve method only estimates the number of components to be retained, three and five component solutions were also generated and analyzed. Neither proved to be a better solution than the four component solution.

As Levine suggests that the interpretation of the PEEX results is somewhat dependent on the age of the child, it was decided to complete a principal component analysis with the seven year olds as a subpopulation and the eight year olds as a subpopulation. Again, the root curve method was used to estimate the number of components to generated. For the younger group a four component solution was retained. For the older group, a three component solution was generated. With the younger subjects, the Motor Component (primarily gross motor) disappears and a Fine Motor/Visual Fine Motor component emerges; whereas with the total population the variables from the visual fine motor area cluster with the visual perceptual tasks. The results for the older group are generally closer to the results for the total population. Of significance is the fact that the PEEX appears to have a different simple structure for the different age groups. This has important implications for the interpretation of the results.

The final analysis was conducted using the 32 PEEX variables and 11 variables from the WISC-R. Using the root curve method a three component solution was generated. This solution did not lend itself to a clear interpretation; however, one significant finding did emerge. Ten of the WISC-R variables loaded onto the same component (1), while the eleventh loaded on to some other component. Only two of the PEEX variables loaded onto Component 1, and one of those also loaded onto another component. This suggests that as the PEEX variables did not load on Component 1 (general intelligence) they are measuring something other than intelligence.

Conclusions

Levine deserves recognition for his interests and efforts in the area of learning difficulties. He has forwarded the cause of developmental-behavioral pediatrics and has actively addressed many issues related to school success from a theoretical and pragmatic perspective. Using his process commits the physician to more than a 15 minute office visit with the child. He solicits information from the school, home, and other disciplines (e.g., psychology).

Levine's desire to develop an instrument that will pinpoint the low severity, high prevalence disorders, which he postulates adversely affect the academic functioning of school aged children is apparent, and laudable. He concretized this desire through the development of a family of instruments, including the PEEX, whose objective is to yield, for the physician, a functional profile of individual strengths and weaknesses of the child. The developmental profile is placed in an environmental context by obtaining information, using a standardized format, from the parent and the school. He has clearly come down on the side of standardized narrative description as opposed to psychometric, numerical description. Unfortunately, by ignoring psychometrics, he has sacrificed the potential quality of the centerpiece of the assessment of seven to nine year olds, namely the PEEX.

It has been adequately demonstrated, through the literature review, and *Standards,* that the PEEX lacks adequate evidence for validity, reliability, and its norms. Regardless of whether Levine uses this instrument for obtaining developmental profiles, or others try to use it numerically (e.g., cut scores, total scores, number of level 1 scores) there must be evidence, especially of validity, or the results have no meaning. Even the seminal study done by Levine, Meltzer, Busch, Palfrey, and Sullivan (1983), failed to present adequate evidence for validity and reliability. He calls for the development of local norms, yet the same study failed to demonstrate how the "norms" were originally developed.

The principal component analyses conducted on the clinically referred sample in this study yielded several important findings. Globally, there was evidence presented that the PEEX requires a significant revision, not just at the area and task level, but perhaps at even the item level. To retain enough components to account for 75 percent of the variance on the PEEX, 16 components were required. If the standard of eigenvalues greater than 1.0 was used, 10 components would need to be retained. When these solutions were examined, neither could be readily interpreted, and a number of components had only one or two variables, which is deemed inadequate. When the four component solution was generated through the root curve method it accounted for only 38.4 percent of the variance. Therefore, to be able to interpret the results of the principal component analysis only a relatively small percentage of the variance can be accounted for, while accounting for more of the variance yields a meaningless solution. This suggests that a major revision of the PEEX is required. The intent would be to develop items that will allow for the tasks to become more discrete, measuring a narrower band of skills.

It was also evidenced that Levine's hypothesized structure, specifically, the seven areas, was not supported when the data were subjected to a principal component analysis, seven component solution. Several of the tasks did not load on any of the seven components. When those which did load were examined, it was seen that the vast majority (except for the Gross Motor tasks) merged with tasks from different areas. Some of the components reflected areas given by Levine, while new "areas" emerged. Some of Levine's areas (e.g., Recall) were not reflected in this analysis. Again, this points to the need for the PEEX to undergo further analysis. A determination of how the tasks cluster will be required subsequent to the examination of each task and its items.

When the data from subpopulations was examined (i.e., younger group, older group) it was apparent that the simple structure, and the interpretability of the PEEX was different for the two groups. This would suggest that an examiner cannot draw the same conclusions for a seven year old who is given the PEEX as would be drawn for an eight year old. However, it should be remembered that first the items and tasks require revision and then evidence for validity and reliability must be presented. Until then the differential application of the PEEX to various age groups is a moot point.

The final analysis, with the WISC-R and PEEX variables combined, demonstrated the WISC-R variables clustered together, to the virtual exclusion of PEEX variables. The PEEX variables clustered among two components, to the total exclusion of the WISC-R variables. This suggests that the PEEX is measuring something other than general intelligence. Therefore, the inclusion of data like that from an intellectual assessment is important when considering the educational implications for a student.

One limitation of the generalizability of these conclusions is an artifact of the sample population being clinically referred. Also, relatively low subject to variable ratios for the subpopulation analyses, and for the combined PEEX and WISC-R variables will also limit the generalizability of the results.

In summary, at this point in its development, the Pediatric Early Educational Examination fails to meet even the minimum standards required for such an instrument. Until evidence can be presented for its validity and reliability the pediatrician cannot say anything about an individual's strengths and weaknesses. This is further exacerbated by the lack of norms, local or otherwise. It is also the case that the seven areas are not supported in this study, either as discrete areas, nor with respect to how the tasks cluster within them. The only exception is the gross motor skill area, which continues to form a cluster. Subsequently, even a functional profile cannot discuss fine motor abilities or visual fine motor abilities as discrete areas; therefore, even a narrative profile following the seven areas will be misleading, and is not supported by this analysis. It also appears that the results of this instrument have different meanings for seven year olds and eight year olds, with the structure of the PEEX for the older group resembling more closely the structure for the total population. This raises the question as to whether it should be used with seven year olds, and, if it is, what the results mean with respect for that age group. It appears at this time, that the PEEX, in its present form, raises more questions than it answers.

Recommendations

Although the PEEX does not stand up to even basic scrutiny, the fact that there are physicians who are concerned about children's school success should be viewed positively. There is a place for transdisciplinary assessment, and medicine can add a unique and important dimension. Therefore, several recommendations for further research can be put forth.

First, the PEEX could be reexamined using another population, perhaps of non-referred as well as referred individuals. The starting place should be with the development of evidence for validity and reliability. This could be combined with a norming study. However, to norm this instrument examiners must be alerted to the fact that the protocol in its present form is inadequate for that task. Specifically, for some tasks the examiner is not required to record the raw data. This makes the determining of norms, and even cut scores, impossible. Therefore, compensatory methods would have to be developed prior to the data collection to ensure that all raw data is available. Were this type of study to be undertaken, it would likely result in the exclusion of some items and perhaps even tasks, and a major reworking of others.

Second, once the items and tasks have been re-examined, a further refinement could be completed by using a principal component analysis. The objective would be to account for more of the variance using the most parsimonious component solution. This would allow the pediatrician to make meaningful statements regarding a child's neurodevelopmental functioning.

Third, consideration should be given to reviewing other assessment instruments in this family (e.g., the Pediatric Examination of Educational Readiness at Middle Childhood (PEERAMID)). The results of this study regarding the PEEX may be an anomaly, or some of the stated difficulties with the PEEX could be common to other instruments developed by Levine.

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APPENDIX A

Developmental Areas and Specific Tasks of the PEEX

	Developmental Area	Task Name and What it Measures
1	Fine Motor	Imitative Finger Movement - assesses finger localization. "Finding fingers in space with no visual support. 8 items
2	Fine Motor	Motor Speed - Dominant - assesses the ability to manipulate fingers efficiently; neuromotor speed. 1 item; timed 20 repetitions.
3	Fine Motor	Motor Speed - Non-Dominant - assesses the ability to manipulate fingers efficiently; neuromotor speed. 1 item; timed 20 repetitions.
4	Fine Motor	Finger Opposition - Imitating sequenced finger movements with dominate hand. 1 item.
5	Fine Motor	Eye-Hand Board - Measures eye-hand coordination and speed by threading a string through a series of loops. 1 item, 30 seconds.
6	Visual-Fine Motor	Copy Forms - Untimed, requires the copying of geometric forms; visual-perceptual-motor function. Minimum 4 drawings; maximum 8.
7	Visual-Fine Motor	Copy a Sentence - Timed, measures letter formation, detail, spacing, and speed. 1 item.
8	Visual-Fine Motor	Connect Dots - Untimed, assesses eye-hand coordination and spatial orientation. 3 items.
9	Visual-Fine Motor	Visual Tracking - Assesses visual pursuit or scanning by following a pencil with eye movement only. 1 item.

Developmental Area	Task Name and What it Measures
10 Visual Processing	Vigilance Matching - Assesses primarily visual attention to detail, secondarily visual discrimination by requiring matching designs to be circled. 3 items.
11 Visual Processing	Direct Matching - Less complex than Vigilance Matching; circle identical configurations; figures involve gestalt as well as visual sequencing. 5 sets of items.
12 Visual Processing	Visual Recognition - Assesses visual recognition memory. 2 items.
13 Visual Processing	Visual Retrieval - Assesses visual recall memory; completion or reproduction of a form. 7 items.
14 Visual Processing	Left-Right Discrimination - Assesses ability to distinguish left/right on own body. 10 items.
15 Temporal-Sequential Organization	Object Span - Assesses visual sequencing ability. Examine is require to point to varying numbers of objects in the same order as the examiner. 6 items.
16 Temporal-Sequential Organization	Word Span - Assesses auditory sequential ability. Examiner is required to recall a list of words presented orally. 5 items.
17 Temporal-Sequential Organization	Tap Blocks - Assesses visual sequencing ability. It is similar to Object Span except the objects have no meaning

	Developmental Area	Task Name and What it Measures
18	Temporal-Sequential Organization	Count Aloud - Measures sequential organization, the child counts backward from 10 or 20 (age dependent); or backward by 2's from 30 or forward to 20 (ability dependent). 20 items max.
19	Temporal-Sequential Organization	Name Days of the Week - The child is required to name the days of the week forward, then backward (ability dependent). 1 item.
20	Temporal-Sequential Organization	Tell Time - Examine is required to tell time when presented with a number of clock faces. 4 items.
21	Temporal-Sequential Organization	Digit Span - Assesses auditory sequential memory in a digits forward format.
22	Linguistic	Verbal Instructions - Measures auditory attention, comprehension, and short-term auditory memory by having the examine follow oral commands. 20 items.
23	Linguistic	Complex Sentences - Assesses the child's understanding of syntax. No motor response required. Sentences are read and the child answers questions. 16 items.
24	Linguistic	Serial Commands - Assesses auditory processing and sequential organization by requiring the examine to follow a specific sequence of commands. 2 sets.

Developmental Area	Task Name and What it Measures
25 Linguistic	Name Pictures - Measures expressive language and word find ability by having the examine name presented pictures. 20 items.
26 Gross Motor	Motor Stance - Measures a sense of body position and balance. The examine is required to stand with feet together, arms and fingers outstretched, eyes closed and tongue out. 1 item.
27 Gross Motor	Rapid Probation-Supination - Measures distal musculature of forearm by requiring pronation/supination of the dominant hand. 1 item.
28 Gross Motor	Hop in Place - Measures motor rhythm and sequencing by asking the child to hop twice on each foot (alternate left and right) for 15 seconds. 1 item.
29 Gross Motor	Stressed Gait - Measures body position sense, agility and balance (cerebellar function) by using a sideways tandem gait for 10 feet. 1 item.
30 Gross Motor	Catch Ball - Measures eye-upper limb coordination by having the examine catch a squash ball from 10 feet with both hands. 6 items.
31 Recall	Recall Objects - Measures short-term memory by asking the examine to recall the objects presented during the Object Span task. 6 objects.

Developmental Area	Task Name and What it Measures
32 Recall	Recall Words - Measures short-term memory by asking the examine to recall the objects presented during the Word Span task. 5 objects.

APPENDIX B

The ANSER System and Its Relationship to the PEEX

The ANSER System

The forerunner to the ANSER system questionnaires were called the Boston's Children's Hospital Parent and Teacher Questionnaires and appear to have been developed by Levine circa 1974-1975. The actual ANSER System (Levine 1984b) was first published in 1980 and revised in 1985. It consists of a parent Questionnaire and a School Questionnaire appropriate for one of three age levels (i.e., 3-5 years, 6-11 years; 12 or older). In addition, there is a self-administered questionnaire, developed in 1981 by Levine, Clark and Ferb (1981), for those ages nine or older.

The questionnaires were designed to complement the PEEX. Levine (1980) said the system was designed for educators or clinicians who desire information about a child's learning and/or behavioral problems. The parent form consists of 10 major areas. Each area has a number of questions which relate to it. The parent is to read the statement and rate it. The categories vary with the area. The areas are: Possible pregnancy problems (True, Not true, Cannot Say); Newborn infant problems (True, Not true, Cannot Say); Health problems (Never, or check the appropriate age 0 months to 7 years); Functional problems (e.g., poor appetite, colic) uses the same rating scale as heath problems; Early development (check appropriate age 0 months to 5-6 years); Family history (Child's mother, father, brother(s), sister(s), others (specify)). Specific skills (or abilities) (Has great difficulty; Has some difficulty; Does pretty well; Does very well) and Specific Interests (Has little or no interest; Has moderate interest; Has strong interest); Selective attention-activity (Definitely applies; Applies somewhat; Does not apply; Cannot say); Associated behaviors (e.g., cries easily, is often tired) (Definitely applies; Applies somewhat; Does not apply; Cannot say); Associated Strengths (e.g., usually seems happy) (Often true; Occasionally true; Seldom true; Cannot say).

The School Form samples three major areas; Performance, Selective Attention-Activity, and Behavioral Observations. The performance area samples a broad range of academic and non-academic curriculum performance (e.g., reading rate, musical ability). The selective attention-activity samples attentional behavior on 12 dimensions, although there are only three questions for each dimension. The final area, behavioral observations reflects behaviors which can be seen at school. This form was designed to be completed by the child's teacher. A format similar to the parent form is used. For the performance area the teacher rates the student on two dimensions for each item. The first is "Typical Performance" which has four categories (i.e., Strong for age; Appropriate for age; Delayed less than 1 year; Delayed more than 1 year). The second is "Variability of Performance", which also has four categories (i.e., Consistent performance; Somewhat variable; Highly unpredictable; Cannot say). The portion which relates to selective attention-activity has four categories (i.e., Definitely applies; Applies somewhat; Does not apply; Cannot say). The behavioral observations section also has four categories (i.e., Does not apply; Applies somewhat; Certainly applies; Cannot say).

Busch (1992) indicated that for children of school age with low severity developmental behavior problems, the ANSER system questionnaire is well-rounded and will elicit general information about academic, medical, and behavioral concerns. Busch stated it features information about children's interests and areas of competence.

The ANSER system seems to have obtained its notoriety in the area of measuring Attention Deficit Hyperactivity Disorder (ADHD). Blondis, Accardo and Snow (1989) stated that "ADHD remains one of the most frequently diagnosed childhood disorders in North America" (p. 222). Given that part of the ANSER system focused on attentional problems it is often included in reviews which focus on instruments which measure attention. Blondis, Accardo and Snow (1989) placed the reading level of the parent forms at grade 7.5 and the teacher forms at grade 11.5. They stated that the ANSER system is a series of unscored questionnaires and that norms do not exist, "no data are published in the manual that accompanies these questionnaires." (p 226). They also said that the questionnaires take an inordinate amount of time to complete and interpret and in the end, without norms, all they provide is a subjective result.

Glascoe, Martin, and Humphrey (1990) rated a number of instruments using a team of two pediatricians and one special education teacher. The team used an evaluation instrument developed specifically for this study. This instrument, which was described in detail in the article, "culled best practices and standards for educational and psychologic tests" (p.548). The ANSER system was reviewed using this methodology and instrumentation. They indicated that it was designed to organize observations about children, is used to supplement other tests (e.g., PEEX) and to assist in designing appropriate services for the child. They stated that "it functions much like a screening test by attempting to identify delayed children and specify appropriate referrals" (p. 553). They further stated that given the lack of standardization or scores it may be "unfair to include it in a review of screening tests" (p. 553). They proceeded to suggest that the ANSER System would be most helpful to those who have limited skills however its use is mitigated by the complexity of the instrument. They concluded that "The absence of validity studies, the atypical conceptualization of development, and the dearth of referral guidance further limit the applicability of the measure" (p. 553).

This study apparently captured Levine's attention as he responded in a letter to the editor (Levine, 1992a) and said that he was perplexed by Glascoe, Martin and Humphrey including the ANSER in their study. He stated that it is not a screening device. He said it was to be used primarily by pediatricians as "part of the evaluation (but not screening) of children with learning and developmental problems" (p. 170). The system is, according to Levine, not a psychometric instrument and therefore does not nor should it have percentiles or standard scores. It organizes a history, which he said cannot be measured that way, including the developmental milestones. The system is not intended to generate a score or a label. He stated that while it is true that there are "no well established norms, it is important to recognize that the collection of such norms would be relatively futile" (p.170). He suggested there are too many variables (e.g., cultural) which would render norms useless. As well, he indicated that one cannot standardize something that does not get scored. He also suggested that the system is revised so frequently that by the time any norms were collected the instruments would have been revised. He concluded "The treatments are based on accurate descriptions rather than statistically derived means or cut off points. . . . It would be inappropriate to superimpose psychometrics over pediatrics" (p. 170). It appears that Levine is saying two things at once. First, norms cannot be derived since scores are not determined. Second, that attempting to develop norms would be futile. If the first statement is true it is difficult to understand why there needs to be a second statement at all. While it is true that the questionnaires themselves do not have scores, given their format it would be a relatively easy thing to convert the answers into numerical scores allowing for a statistical interpretation. This however is a procedure that Levine is emphatically against and perhaps is why he argues against the development of norms even though it "cannot" be done. It also leads one to speculate as to whether his philosophy and approach to the ANSER system are the same as his approach to the PEEX.

Levine (1980) discussed the ANSER system and stated that the purpose of the questionnaires was not to generate an overall score but rather to look at the relative contributions of specific traits as part of describing a child's overall functioning. He saw the advantages of questionnaires as providing cumulative rather than cross-sectional data like testing does. That is to say, when completing a questionnaire the data collected reflects the experience of the child over time. Levine also stated that they are easy to administer and interpret but are also easily influenced by other factors such as observer bias, and intentional distortions. Later he discussed the social ability of children and again introduces the ANSER system, specifically the self-administered questionnaire. He indicated that this form contains a section on social interaction which can be used "as a rapid screening test" (p. 169) if the child is willing to report social difficulties. In a section on history taking Levine (1980) again discussed the ANSER system. He stated that this system "provides a standardized systematic approach to history taking from multiple sources" (p. 487). It is interesting that in these instances this non-scorable instrument is not only standardized but can be used as a screening test.

APPENDIX C

The PEEX and the Relevant Primary Standards for Educational and Psychological Testing

Part I of Standards for Educational and Psychological Testing is divided into five areas which will, at this point, be examined in detail.

Validity

The first area is validity, which, "is the most important consideration in test evaluation, validity always refers to the degree to which [the] evidence supports the inferences that are made from the scores" (p. 9). Validity has 25 standards of which 17 are primary and three of which are not relevant to the PEEX.

Standard 1.1 states, in part, "Evidence of validity should be presented for the major types of inferences for which the use of a test is recommended" (p. 13). Broadly, the PEEX is recommended to be used to identify low-severity developmental disorders which impact on school performance, attentional difficulties, and defining areas for further assessment. The writer has been unable to identify any statements of validity in the literature. Most certainly there are no statements made in the manual.

Standard 1.2 states that if the validity has not been investigated for some aspect, that should be made clear along with a caution regarding the making of interpretations. Again, there is no evidence that this has been done.

Standard 1.3 indicates that evidence should be presented to justify the interpretation of subscores, score differences, or profiles. This has not been done.

Standard 1.4 speaks to the issue of using the results of a response to a single item as a basis for assessment. Either evidence supporting this action should be given, or a statement made about the absence of such information. The PEEX samples a number of behaviors based on a one item response. Usually the responses are in the motor area; however, there are no statements regarding the appropriateness of usage, nor comments regarding the absence of such data.

Standard 1.6 requires that content-related evidence (i.e., the degree to which the items represent the larger domain being evaluated) be used to establish validity. A clear statement of the domain, its relevance to the test use, and the procedures used in developing the test items is required. Undoubtedly content related validity is important, yet again the criteria for this standard are not met.

Standard 1.8 is similar to Standard 1.6, except it addresses using the test to measure a construct (i.e., measuring a psychological construct, for example, Temporal-Sequential Organization). The construct is required to be differentiated from other constructs, and the interpretation of the score clearly stated with evidence given to support this interpretation. In this area Levine (Levine & Rappaport, 1983) does a little better. The manual does describe each of the constructs in some detail. As one reads the manual the constructs appear discrete. However, the constructs are not placed within a global framework, nor is any clear evidence given to support them in the manual. However, as one reads Levine's work (often referenced in the manual) the construct related evidence is incipient but not clearly defined as such.

Standard 1.11 states that criterion-related validity should provide a description of the sample and the statistical analyses used.

Levine uses the cut score of 3 / 4 areas as demonstrating a significant difference in performance. Neither the sampling methodology, nor the statistical procedures are outlined in the manual. In the literature (Levine, M. D., Meltzer, L. J., Busch, B, Palfrey, J, & Sullivan, M.,1983) the sample is poorly described and the statistical procedures loosely described. Certainly they are not described well enough to meet the criteria set by this standard.

Standard 1.12 suggests that the rationale for choosing specific criterion measures should be given. Again, there is no evidence of any rationale for specific items or areas in the manual. Even the literature does not give a rationale for including these items on the PEEX, although there is a global rationale for including the seven broad areas. Again however, this standard is not met.

Standard 1.13 requires the technical quality of the criteria be examined and if there is evidence that they are affected by "irrelevant factors", it is to be reported. There is no evidence of such examination.

Standard 1.14 speaks to the issue of rater judgments. If these are used, the degree of knowledge regarding the performance should be given as well as the training and experience of the raters, if possible. This was accomplished globally in the 1983 (Levine, Meltzer, Busch, Palfrey, & Sullivan) article.

Standard 1.18 requires that validation reports should state clearly the date and the time interval for data collection. This was described globally as the "1980/1981 study". No specifics were given.

Standard 1.21 requires that when studies of differential prediction are conducted the reports should include regression equations computed separately for each group. In the 1983 study the calculation of regression equations were conducted for the community group with respect to WISC-R and CAT scores. Similar regression analyses were not reported for the referred population. Therefore no comparisons can be made between regression equations. Thus it would appear that this standard was not met.

Standard 1.24 discusses cut scores in that if they are used for decision making it should be stated that the rates of misclassification will vary by the percentage of individuals tested who belong to each category. No such statement exists.

It can clearly be seen that the PEEX fails to meet the vast majority of the Standards and therefore validity of this instrument is not substantiated.

<u>Reliability and Errors of Measurement</u>

The second area is reliability and errors of measurement. "Reliability refers to the degree to which test scores are free from errors of measurement" (p. 19). There are 12 standards of which 8 are primary and relevant.

Standard 2.1 requires that, for each score, reported estimates of reliabilities and standard errors of measurement must be provided. No such statistical evidence is presented in either the manual or the research literature.

Standard 2.2 requires the nature of the population be described, as well as the procedures used to obtain the sample. Again, this is not done in the manual, although the 1983 article gives the sample size, age range and mean age, gender mix, and the procedure "drawn randomly from lists of second grade students in Brookline and Melrose" (Levine, Meltzer, Busch, Palfrey, & Sullivan 1983, p. 897)

Standard 2.3 addresses the reporting of reliability estimates. The specific conditions, as well as the statistical procedures, should be reported. As no reliability figures are reported in the manual discussion of this standard is moot.

Standard 2.4 discusses the requirements if the reliability coefficients are adjusted. Since none are reported there is no discussion as to whether they were adjusted.

Standard 2.5 involves estimates of reliability when alternate forms are used. The PEEX has only one form therefore this standard does not apply.

Standard 2.6 suggests internal coefficients must be supplemented with alternate form or stability over time figures. Again, no such evidence has been reported; therefore, neither part of this standard has been met.

Standard 2.7 discusses speeded tests and using the appropriate statistical applications. In general, the PEEX is not a speeded test, although parts of it do require quick performance. However, again with no figures of reliability reported, this standard's issues cannot be addressed.

Standard 2.8 requires that when judgmental processes (e.g., subjective rating) are part of the test score, the degree of agreement between the raters should be presented. Although the manual does not report such figures, the 1983 article does. Ratings were done on

49 children. Agreement ranged from 90 percent to 98 percent with the exception of minor neurological indicators where the agreement was 87 percent. Unfortunately only the areas at the maximum and minimum of the range were identified. Therefore, agreement by specific area cannot be determined. The requirements of this standard, with minor reporting changes could likely be met.

As with the validity section, it can be seen that the vast majority of the reliability standards have not been met. Standard 2.8 is the closest to being satisfied, while none of the others approach technical standards.

Test Development and Revision

Section three details issues of concern to the test developer. It is stated that "Test developers have a responsibility to provide evidence regarding reliability and validity, as well as manuals and norms" (p. 25). This section presents 25 standards, of which 12 are primary and eight are relevant.

Standard 3.1 describes test development as based upon scientific principles and the need for appropriate research. There is no indication in the manual of such work; however, the literature generally would suggest that the PEEX is the result of some scientific inquiry. Without the presentation of a formal model or theory, is difficult to evaluate to what degree this standard has been met. It is sufficient to say, however, that there is no easily discernible statement made which will satisfy this standard.

Standard 3.3 requires that the domain definitions and test specifications be clear enough that the relationships of the items to the domains can be determined. This is an area where there is some superficial evidence which would support the items being appropriately placed in each domain. However, the relationship is not clear in that some items have been moved into new areas, from the original to the later version, with no explanation as to why. As well, it is unknown whether each area is measuring a discrete characteristic. There is no indication that a factor analysis has been done on the PEEX to assist in this determination.

Standard 3.11 indicates that test directions should be clear enough to assist each test taker in producing an optimal performance (e.g., will guessing help). It would appear that the directions for the PEEX are clear enough to optimize the child's response.

Standard 3.16 requires that the report forms and instructional materials should facilitate proper test interpretation. The record form for the PEEX is sufficient to make the scoring and interpretation understandable. However, there is no report form or supplementary material available to facilitate interpretation. Therefore it appears that this is an area which is emerging but is not fully developed.

Standard 3.18 requires that a test be revised when it is appropriate and that the passage of time alone is not a sufficient reason to revise a test. Levine has stated that the PEEX is undergoing constant revision. The current version appears somewhat different from the version used in the 1980/1981 study. However, there is no "official revision", nor any statement as to when or how a revision was done. It would appear that this standard has not been met.

Standard 3.21 requires the directions for administration be presented clearly so as to approximate the administrative conditions under which the test was given when it was normed. It is likely that the directions in the manual are sufficient to allow the examiner to reproduce the conditions under which the test was developed. However, the description of the norming process is so poor that it is not possible to determine the practical effects of meeting this standard.

Standard 3.22 requires that the test taking instructions be detailed enough so that the test taker can respond in the manner the developer intended. It appears that the directions meet this standard.

Standard 3.24 requires that procedures for scoring tests locally be clear enough to allow for that to happen with maximum accuracy. It would appear that the criteria are sufficient to meet this standard.

Scaling, Norming, Score Comparability, and Equating

In this section it is stated that there are ways to enhance the interpretation of scores by linking the scores to theory or empirical evidence. This is a section that will require further attention after the issues raised in sections 1, 2 and 3 have been addressed.

Test Publication: Technical Manuals and User's Guides

The fifth section indicates that enough information should be provided for the test to be evaluated. This is clearly not the case with the PEEX. No technical manuals, user's guides or other supplementary materials are available. Therefore, a detailed examination of these standards would not be productive until such time as these documents exist.

APPENDIX D

Frequency of Level of Developmental Attainment Scores by Variable

Table D.1
Frequency of Level of Developmental Attainment
Scores by Variable (in Percent)

Level of Developmental Attainment Score (%)				
Variable	1	2	3	4
FM-IFM	7.389	6.897	35.961	49.754
FM-MS	16.749	15.271	30.542	37.438
FM-MSN	13.793	12.808	18.719	54.68
FM-FO	24.138	25.616	50.246	0.0
FM-EHB	8.867	15.764	35.468	39.901
VFM-CF	30.542	30.049	28.079	11.330
VFM-CS	12.808	29.064	34.975	23.153
VFM-CD	16.749	20.197	5.419	57.635
VFM-VT	8.867	36.453	54.680	0.0
VP-VM	50.246	19.704	18.719	11.330
VP-DM	17.241	19.704	27.094	35.961
VP-VR	36.453	35.961	27.586	0.0
VP-VRET	19.212	46.798	29.557	4.433
VP-LRD	13.300	13.793	26.601	46.305
TSO-0S	48.768	31.034	18.227	1.970
TSO-WS	25.616	28.571	32.512	13.300
TSO-TB	54.680	29.064	15.271	.985
TSO-CA	3.941	27.586	48.276	20.197
TSO-NDW	14.778	6.404	34.483	44.335
TSO-TT	20.690	32.020	44.828	2.463
TSO-DS	45.320	24.138	20.197	10.345
L-VI	44.335	37.438	16.256	1.970
L-CS	27.094	37.931	34.483	.493
L-SC	9.852	8.867	41.872	39.409
L-NP	16.256	34.975	38.424	10.345
GM-MS	17.241	17.241	27.586	37.931
GM-RPS	.985	24.631	55.172	19.212
GM-HP	7.882	50.246	27.586	14.286
GM-SG	3.941	16.256	60.099	19.704
GM-CB	6.404	21.182	40.394	32.020
R-RO	3.448	16.256	27.094	53.202
R-RW	47.291	23.153	19.212	10.345

Appendix E

Principal Component Analysis with Seven and Eight Year Olds

Seven Year Olds

This analysis involved applying the root curve method to select the number of components to be retained and then running the principal component analysis, followed by a varimax rotation with just the seven year old population (n=85). Using the root curve method, a four component solution was generated. The four component solution accounted for 37.4 percent of the variance. Although no detailed discussion of this analysis will be undertaken, for illustrative purposes, Table E.1 presents the communalities and loadings (0.4 or higher are in bold print) for the four components. The reader will be able to compare this structure to that of the four component solution for the entire population presented in Chapter Four (Table 4.6). At the macro level several observations can be made. First, the Motor (primarily gross motor) component, seen for the total population, disappears as two of the five tasks load on some component other than the four given, and the remaining three are dissipated among three components. Second, a Fine Motor/Visual Fine Motor component (Component 2) appears to emerge, whereas the results for the total population suggest that Fine Motor does not stand up as a component and the Visual Fine Motor tasks generally cluster with the Visual Perceptual tasks. Finally, the Recall area does not emerge in this analysis either.

Eight Year Olds

The identical process used with the seven year olds was used to analyze the data for the eight year olds (n=99). Interestingly, a three component solution was generated for this subgroup of the population. The three component solution accounted for 33.6 percent

Table E.1
Orthogonal Transformation Solution - Varimax
Four Component PEEX (7 year olds)

Variable	h^2	Component 1	2	3	4
FM-IFM	.32	.333	**.404**	-.031	-.213
FM-MS	.517	-.081	**.702**	-.024	-.131
FM-MSN	.631	-.099	**.78**	.097	-.065
FM-FO	.166	.046	.05	-.2	.349
FM-EHB	.404	-.189	**.587**	.039	.15
VFM-CF	.401	.264	**.419**	-.169	.356
VFM-CS	.403	.39	.272	-.269	.323
VFM-CD	.501	-.014	**.655**	.054	.262
VFM-VT	.27	-.069	.233	-.024	**.458**
VP-VM	.206	.215	.358	.094	.151
VP-DM	.169	.087	.359	.111	.142
VP-VR	.463	**.593**	.209	.256	-.044
VP-VRET	.48	**.618**	.272	.026	.153
VP-LRD	.14	.135	.165	.233	.201
TSO-0S	.343	**.517**	-.205	.18	.028
TSO-WS	.564	**.488**	-.189	**.538**	-.028
TSO-TB	.615	**.762**	-.13	.135	-.011
TSO-CA	.516	.208	-.043	.262	**.634**
TSO-NDW	.11	.173	-.012	.094	.267
TSO-TT	.373	-.036	.333	-.024	**.511**
TSO-DS	.563	.326	-.02	**.657**	.161
L-VI	.55	.326	.14	.65	-.043
L-CS	.692	.097	.229	**.794**	-.017
L-SC	.216	.26	-.191	.191	.275
L-NP	.359	.204	-.06	**.459**	.32
GM-MS	.16	.264	.064	.07	.286
GM-RPS	.197	.14	.255	-.219	.253
GM-HP	.471	**.648**	.01	.127	.185
GM-SG	.333	.27	.198	.201	**.425**
GM-CB	.436	-.046	.306	**.496**	.308
R-RO	.136	-.032	.025	.136	.341
R-RW	.266	-.107	-.189	.325	.337

of the variance. Again, no detailed discussion of this analysis will be undertaken, and Table E.2 (loadings of 0.4 or higher are in bold print) is presented for comparison with the four component solution for the entire population presented in Chapter 4 (Table 4.6). Globally, with this age group the Motor Speed Component disappears in that those tasks do not load on any of the three components. Second, a Motor component (Component 3) emerges, in which all the Gross Motor tasks are included, along with Visual Tracking and Imitative Finger Movement. This component looks very similar to Component 4 for the total population. Components 1 and 2 for this age group also closely resemble Components 1 and 2 for the total population. Generally then, for the older subpopulation, the components look more similar to the total population, than do those of the younger group.

The results of the principal component analyses for each sub-population can be compared. Using the root curve method, it appears that there is a different simple structure for the PEEX when it is used with seven year olds versus eight year olds. In addition to the obvious difference in the number of components retained, most noticeably, major differences occur in the fine motor and gross motor areas. With the younger group there is no Gross Motor component while there is with the older subjects. However, the younger group has a Fine Motor/Visual Fine Motor component, whereas the eight year olds do not have a Fine Motor component and the Visual Fine Motor tasks tend to cluster with the Visual Processing tasks. If a more detailed examination were undertaken, other perhaps less significant differences would emerge. What is significant at this

Table E.2

Orthogonal Transformation Solution - Varimax

Three Component PEEX (8 year olds)

		Component		
Variable	h^2	1	2	3
FM-IFM	.293	.055	-.028	**.537**
FM-MS	.362	.286	-.512	.133
FM-MSN	.373	.377	-.42	.233
FM-FO	.085	.046	.108	.268
FM-EHB	.418	**.555**	.004	.332
VFM-CF	.528	**.615**	.219	.319
VFM-CS	.348	**.544**	.125	.189
VFM-CD	.49	**.612**	.117	.319
VFM-VT	.253	.045	.012	**.501**
VP-VM	.433	**.658**	-.023	-.008
VP-DM	.459	**.651**	.085	.167
VP-VR	.393	**.6**	-.114	.139
VP-VRET	.309	**.491**	.12	.231
VP-LRD	.233	**.426**	.226	-.013
TSO-0S	.453	.118	**.61**	.258
TSO-WS	.496	.154	**.655**	.207
TSO-TB	.449	-.016	**.621**	.251
TSO-CA	.315	**.45**	.333	-.037
TSO-NDW	.16	.309	.166	-.192
TSO-TT	.205	**.417**	.149	-.094
TSO-DS	.323	.145	**.522**	.173
L-VI	.442	**.472**	**.468**	.002
L-CS	.114	.244	.221	-.079
L-SC	.257	.198	**.466**	-.021
L-NP	.255	.15	**.465**	.128
GM-MS	.321	.007	.001	**.566**
GM-RPS	.392	.138	.104	**.602**
GM-HP	.468	.078	.055	**.677**
GM-SG	.559	.133	.13	**.724**
GM-CB	.29	.078	.135	**.515**
R-RO	.16	.356	-.136	.122
R-RW	.116	.247	.162	-.17

point is that the PEEX appears to yield different interpretations of the data for seven versus eight year olds, which reflects the difference in the simple structure.

The implications go beyond Levine's suggestion that the Level of Attainment be viewed differently for the younger (age seven) and older groups (age 9) being examined using the PEEX. As well, as Levine is referring to the seven and nine year olds, it is not clear how differences with respect to eight year olds are to be viewed.