Assessment Issues in Child Neuropsychology

Edited by

Michael G. Tramontana
Bradley Hospital
East Providence, Rhode Island
and Brown University
Providence, Rhode Island

and

Stephen R. Hooper
Clinical Center for the Study of Development and Learning
University of North Carolina School of Medicine
Chapel Hill, North Carolina

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Contributors

GLEN P. AYLWARD, Division of Developmental and Behavioral Pediatrics, Departments of Pediatrics and Psychiatry, Southern Illinois University School of Medicine, Springfield, Illinois

RUSSELL A. BARKLEY, Department of Psychiatry, University of Massachusetts Medical Center, Worcester, Massachusetts

ERIN D. BIGLER, Austin Neurological Clinic, and Department of Psychology, University of Texas at Austin, Austin, Texas

THOMAS A. BOYD, Cleveland Metropolitan General Hospital, and Case Western Reserve University School of Medicine, Cleveland, Ohio

ROBERT T. CONNOR, Kennedy Institute, Johns Hopkins School of Medicine, Baltimore, Maryland

MICHAEL A. CRARY, Departments of Communicative Disorders and Neurology, University of Florida Health Science Center, Gainesville, Florida

RAYMOND S. DEAN, Neuropsychology Laboratory, Ball State University, Muncie, Indiana, and Indiana University School of Medicine

DOROTHY EDGELL, Department of Psychology, Jack Ledger Child and Adolescent Psychiatric Unit, Arbutus Society for Children, Victoria, British Columbia, Canada

JANE M. FLYNN, Gundersen Medical Foundation, LaCrosse, Wisconsin

JEFFREY W. GRAY, Neuropsychology Laboratory, Ball State University, Muncie, Indiana

NANCY J. HAAK, Departments of Communicative Disorders and Neurology, University of Florida, Gainesville, Florida

STEPHEN R. HOOPER, Department of Psychiatry, University of North Carolina School of Medicine, and Clinical Center for the Study of

Development and Learning, University of North Carolina, Chapel Hill, North Carolina

GEORGE W. HYND, Departments of Educational Psychology and Psychology, University of Georgia, Athens, Georgia, and Department of Neurology, Medical College of Georgia, Augusta, Georgia

JOEL LEVY, Department of Psychology, Texas Institute for Rehabilitation and Research, Houston, Texas

G. REID LYON, Departments of Neurology and Communication Science and Disorders, University of Vermont, Burlington, Vermont, Gundersen Medical Foundation, and Department of Special Education, St. Michael's College, Winooski, Vermont

LOUISA MOATS, Associates in Counseling and Education, East Thetford, Vermont

GRANT L. MORRIS, Department of Psychology, University of Northern Colorado, Greeley, Colorado

NAOMI NIEVES, Kennedy Institute, Johns Hopkins School of Medicine, Baltimore, Maryland

FRANCIS J. PIROZZOLO, Department of Neurology, Baylor College of Medicine, and Neurology Service, Houston VA Medical Center, Houston, Texas

ANTHONY H. RISSER, Department of Neurology, University of Wisconsin Medical School, Mount Sinai Medical Center, Milwaukee, Wisconsin

MICHAEL G. TRAMONTANA, Bradley Hospital and Department of Psychiatry and Human Behavior, Brown University, East Providence, Rhode Island

KYJTA K. S. VOELLER, Department of Neurology, University of Florida Health Science Center, Gainesville, Florida

W. GRANT WILLIS, Department of Psychology, University of Rhode Island, Kingston, Rhode Island

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From Assessment to Treatment

Linkage to Interventions with Children

G. REID LYON, LOUISA MOATS, and JANE M. FLYNN

INTRODUCTION

Within the past decade, child clinical neuropsychologists have been called upon increasingly to make relevant and informed recommendations for the treatment of both documented (i.e., traumatic head injury) and putative (i.e., learning disabilities) neurologically based developmental disorders. This increase in requests for specific therapeutic recommendations reflects a change in how the role of the child clinical neuropsychologist is perceived and, in particular, how the data obtained from neuropsychological assessments are used.

Historically, neuropsychological assessment practices were applied primarily to identify the presence, nature, and possible site(s) of brain damage or dysfunction (Beaumont, 1983). However, the emphasis in clinical neuropsychology has shifted from assisting in the diagnosis of lesion type and location to the assessment of the functional capacities of the child in order to select and implement efficacious management, rehabilitation, and/or remediation programs.

There appear to be several reasons for this transition in the practice of clinical neuropsychology. For example, recent technical advances in specialized neurodiagnostic procedures for brain imaging gradually are replacing neuropsychological approaches to lesion classification (Stoddart

G. REID LYON • Departments of Neurology and Communication Science and Disorders, University of Vermont, Burlington, Vermont, Gundersen Medical Foundation, and Department of Special Education, St. Michael's College, Winooski, Vermont. LOUISA MOATS • Associates in Counseling and Education, East Thetford, Vermont. JANE M. FLYNN • Gundersen Medical Foundation, LaCrosse, Wisconsin.

& Knights, 1986). Less documentable, but equally influential, are the social, political, and educational trends that have created and fostered a major role for neuropsychological treatment approaches in the fields of learning disabilities and cognitive rehabilitation. Models for treatment that claim to derive validity from biological science are appealing in the field of learning disabilities (LD), in particular, where previously employed aptitude–treatment interaction models have failed to generate the foundations of a clinical science (Lyon, 1987; Lyon & Moats, in press). The heterogeneity of the LD population, although now recognized, continues to beg classification and validation (Lyon & Risucci, 1988). Thus, treatment models that invoke biological explanations for intellectual and behavioral differences are welcome in the void. A focus on intrinsic biologic variables permits us to minimize the importance of educational, cultural-familial, and societal causes for individual differences (Chall & Mirsky, 1978) and, thus, to empower ourselves by defining treatment problems in terms of simple, often dichotomous neurobehavioral constructs (e.g., right vs. left brain learners, sequential vs. simultaneous processing).

Taken at face value and for whatever reasons, the shift in emphasis from neuropsychological assessment for classification purposes (i.e., presence or absence of brain damage) to assessment for prescriptive purposes (i.e., treatment) reflects a possibly productive transition toward enhanced clinical relevance. Indeed, Alfano and Finlayson (1987) and others (Lyon & Moats, in press; Newcomb, 1985) have pointed out recently that the power of the clinical contributions that evolve from neuropsychological practice ultimately depends upon the field's capacity to (1) delineate neuropsychological strengths and weaknesses in a reliable and valid fashion, (2) predict the extent to which these information-processing characteristics influence recovery of function and/or learning, and (3) generate testable hypotheses concerned with remedial methodologies for individuals who either lost or did not acquire information because of known or suspected neural insult.

Perusal of the current literature in both child and adult clinical neuropsychology reveals significant support for the concept of establishing valid linkages between the information generated from neuropsychological assessment practices and the development of management, rehabilitation, and remediation programs (Rourke, Fisk, & Strang, 1986). However, such support is generally given in the form of rhetorical and testimonial presentation, case study information, or anecdotal reports. Although these particular forums underscore the value of attempting to develop valid neuropsychologically based treatment programs, we feel that popular views regarding the clinical benefits of such practices go beyond the data. Given this observation, it should be made clear that our purpose in this chapter is not to advocate dismissal of the concept of neuropsycho

logical aptitude–treatment interaction as a useful clinical possibility. On the contrary, our goal is to clarify what actually is known about the relationships between neuropsychological assessment outcomes and treatment decisions and to make relevant recommendations regarding continued research and clinical practice.

Within this context, we first examine neuropsychological assessment principles frequently used with children with an eye toward delineating the purposes for which they were developed as well as their measurement and content characteristics. In doing so, we also attempt to point out how such characteristics relate or do not relate to the content of the clinical treatment process. Following this overview, we describe specific neuropsychological assessment models that have been reported to be useful in generating treatment programs for children with a range of neuropsychological deficiencies. Our purpose is to address the question of which models are most efficacious for the treatment of particular clinical populations (i.e., learning-disabled) and which ones hold the most promise for developing even more robust linkages between assessment outcome and instructional decision making. Finally, we present what we believe are the major limitations in clinical neuropsychological assessment practices that impede our ability to formulate relevant and powerful intervention programs for children with neurodevelopmental disorders. This discussion serves as the basis for what we hope are productive recommendations for enhancing the descriptive, predictive, and ecological validities of assessment practices as they relate to treatment methodologies.

NEUROPSYCHOLOGICAL ASSESSMENT: PURPOSES AND MEASUREMENT CHARACTERISTICS

In order to provide a context for conceptualizing how linkages can be forged between assessment and treatment, it is necessary to examine first the purposes (goals), psychometric properties, and task domains common to neuropsychological batteries and approaches. Given this information, one then can attempt to determine if the inferential process inherent in neuropsychological assessment can be related efficiently to specific treatment methodologies. The reader should note that concepts relevant to neuropsychological assessment have been covered in depth throughout this volume. Thus, what follows is a brief discussion of factors that guide the measurement of brain–behavior relationships.

One's purpose for conducting neuropsychological assessment obviously influences how brain–behavior relationships are measured and assessment results interpreted. As Boll (1981) pointed out, the primary purpose or goal of neuropsychology is to describe brain–behavior relationships in a reliable and valid manner. Boll also indicated that the

ultimate, but yet to be realized goal is "the development of remediation and rehabilitation procedures based upon the empirically validated understanding of the behavioral consequences specific to the condition in question in each patient" (p. 582). Although it is noteworthy that Boll (1981) and others (Beaumont, 1983; Obrzut & Hynd, 1986; Rourke *et al.*, 1986) have emphasized the need for neuropsychology to establish valid relationships between assessment and treatment, it seems clear that the majority of batteries and allied procedures designed to infer brain function from behavior have been constructed by incorporating psychometric principles and task content primarily useful for descriptive purposes, not necessarily prescriptive purposes.

To clarify this point, consider the following. Prominent neuropsychological assessment batteries and diagnostic procedures have been developed and refined over the past 50 years by selecting or developing tasks and applying inferential interpretive methods to (1) understand the impact of brain damage or dysfunction on a range of human abilities, (2) differentiate reliably those individuals who present with brain damage and dysfunction from those who do not, and (3) discern the specific behavioral effects of different types of neuropathology (e.g., tumor vs. stroke vs. head injury).

It is reported frequently in the neuropsychology literature that these clinical outcomes are realized most effectively when (1) the assessment procedures consist of objective, standardized, and quantitative measures of an individual's neuropsychological ability structure (Alfano & Finlayson, 1987; Reitan, 1966; Reitan & Wolfson, 1985; Rourke, 1981; Rourke *et al.*, 1986); (2) the assessment procedures include measures that are scaled psychometrically to measure abilities on a continuous scale rather than on an interval scale (Golden, Hammeke, & Purisch, 1978); (3) the assessment tasks and measures are valid and reliable reflections of cerebral dysfunction and are not confounded by the effects of age and education (Finlayson, Johnson, & Reitan, 1977); and (4) the assessment tasks sample a broad range of abilities to include measures of general intellectual ability, the ability to retain verbal and nonverbal information, motor and psychomotor abilities, sensory-perceptual functions, receptive and expressive language skills, attentional skills, analytical reasoning and concept formation, and personality, behavioral, and emotional status (Alfano & Finlayson, 1987; Reitan & Wolfson, 1985).

A number of studies have shown that neuropsychological assessment batteries and allied procedures that have been developed according to these principles are valid for the purposes of identifying the presence of brain damage or dysfunction in both adults (Boll, 1981; Golden *et al.*, 1978; Reitan & Davison, 1974) and children (Hynd & Obrzut, 1986; Rourke, 1981; Rourke *et al.*, 1986; Teeter, 1986). Further, there are data indicating that widely used neuropsychological batteries (e.g., Halstead-

Reitan, Luria-Nebraska) are capable of describing the nature of the neural insult (e.g., type of lesion, site of lesion), particularly when applied to adult clinical populations and interpreted by skilled clinicians. There is also some evidence, albeit limited in scope, that the information derived from adult neuropsychological assessment batteries can be useful in constructing some remediation and rehabilitation programs (Diller & Gordon, 1981a, 1981b; Diller & Weinberg, 1977; Finlayson, Gowland, & Basmajian, 1986; Luria, 1966; Luria & Tzetkova, 1968; Rao & Bieliauskas, 1983).

Despite the success achieved by traditional neuropsychological assessment practices in the diagnosis and description of neuropathology in both adult and pediatric populations, the clinical utility and validity of such practices in designing treatment programs for children remains questionable. This appears to be the case for several reasons. First, a large portion of the assessment tasks that constitute the most widely used standardized neuropsychological batteries for children are downward extensions of batteries initially developed and validated on adult clinical populations. This is particularly true of the Halstead Neuropsychological Test Battery for Children (Reitan & Davison, 1974), the Reitan-Indiana Neuropsychological Test Battery (Reitan, 1969), and the Luria-Nebraska Battery-Children's Revision (Plaisted, Gustavson, Wilkening, & Golden, 1983). Likewise, the type of stimuli (content) used in tasks to assess specific brain–behavior relationships are downward extensions of stimulus items presented to adults.

These test development practices could compromise a battery's power in predicting which treatment methods are most efficacious for particular children because (1) the tasks employed and their content are based primarily on models of adult brain function and dysfunction that occur following a period of normal development; (2) many tasks are designed to assess the effects of focal neuropathology typically seen in adults (e.g., tumors, cerebral vascular accidents, penetrating head wounds) rather than the generalized neural disorders usually observed in children (e.g., closed head injury, anoxia, epilepsy, perinatal trauma); and (3) the neuropsychological task content may bear minimal relationship to the ecological demands that the child is facing in home and school environments. For example, even though many widely used children's batteries contain tasks assessing reading, mathematics, and writing skills, such tasks rarely possess adequate content validity. Consider that the Wide Range Achievement Test, a staple of many child neuropsychological batteries and procedures, assesses only the oral reading of single words, mathematics calculation, and spelling, leaving abilities in reading comprehension, math reasoning, and written language open to question.

Second, and related to the previous points, some neuropsychological assessment procedures employed with children use tasks that yield static

measures of competence in neuropsychological ability structures. The data obtained from such measures reflect only a child's past and current declarative knowledge of perceptual, linguistic, cognitive, psychomotor, and academic skills, not how they use or do not use such abilities in their daily lives (Brown & Campione, 1986; Lyon & Moats, in press). A notable exception is the Category Test, known for its sensitivity to abstract concept formation, mental efficiency, and the ability to assess new learning (Boll, 1981).

Third, there is increasing concern that tasks making up neuropsychological assessment batteries for children primarily assess general cognitive ability, not distinct neuropsychological processes (Hynd & Obrzut, 1986; Seidenberg, Giordani, Berent, & Boll, 1983; Tramontana, Klee, & Boyd, 1984). Given this possibility, administering time-consuming batteries beyond administration of a Wechsler Intelligence Scale for Children-Revised (WISC-R) may net redundant information. Further, the consistent finding that the WISC-R is not particularly useful for the development of instructional or remediation programs (Ysseldyke & Algozzine, 1982; Ysseldyke & Mirkin, 1981) does not bode favorably for the use of redundant neuropsychological batteries for the same purpose.

Fourth, issues related to development and brain maturation may obscure some possible benefits that accrue from administering standard neuropsychological batteries to children for the purposes of designing treatment programs. For instance, Hynd and Obrzut (1986) reported that a number of neuropsychological tasks simply are not age-appropriate, and no neuropsychological test battery has yet to establish adequate cross-sectioned norms. Further, these authors concluded that, without such norms, "it becomes nearly impossible to provide any accurate appraisal of the possible impairment of developing abilities" (p. 10).

Finally, as Lyon and Toomey (1985) have stressed, describing brain–behavior relationships through the application of assessment procedures does not ensure successful remediation of brain-based deficiencies. Whereas neuropsychological assessment may help to clarify the physiological correlates of dyslexia for example, altering the underlying neuropathology or identifying alternate intact processing routes via remediation may not be possible.

There is little doubt that attempts to use neuropsychological assessment data for the purposes of planning treatment programs reflect productive movement toward an exceedingly important clinical goal. However, forming clinically valid linkages between assessment and treatment methods may be hindered by the application of diagnostic procedures that were developed initially for descriptive rather than prescriptive purposes. Moreover, difficulties in identifying such linkages are exacerbated by inadequacies in the content, predictive, and ecological validities of standard neuropsychological tasks used with children, as well as limitations

in understanding normative development. These points are elaborated in the following sections.

RELATING ASSESSMENT TO TREATMENT: MODELS AND STUDIES

In general, neuropsychological models of developmental disorders conceptualize a child's learning strengths and weaknesses as manifestations of efficient or inefficient brain regions and/or systems (Gaddes, 1980; Hartlage & Telzrow, 1983; Obrzut & Hynd, 1986; Rourke, Bakker, Fiske, & Strang, 1983). A variety of standard neuropsychological batteries as well as selected neuropsychological assessment procedures have been employed to elucidate such patterns of strengths and weaknesses.

Despite the meager data base, it may be useful to examine specific findings that have been obtained from both clinical and empirical study of the assessment–treatment interface for no other reason than to explicate current clinical trends and future research possibilities. For clarity, we have organized our review of the extant literature in this area first to address treatment approaches and models that are linked to data obtained from standard neuropsychological assessment batteries. This review is followed by a review of intervention studies associated with the use of selected batteries. Treatment approaches will be examined with respect to their orientation (e.g., remediating strengths, weaknesses, or both) as well as to their demonstrated efficacy.

STANDARDIZED ASSESSMENT BATTERIES: IMPLICATIONS FOR TREATMENT

A number of recent papers have discussed the application of standardized neuropsychological assessment methods in formulating treatment programs for children (Alfano & Finlayson, 1987; Gunnison, 1984; Teeter, 1986). These efforts typically involve the use of assessment data obtained from the Halstead-Reitan Neuropsychological Test Batteries and Allied Procedures (Reitan, 1980), the Luria-Nebraska Battery-Children's Revision (Plaisted *et al.*, 1983), and the Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983). A discussion of these particular assessment methods and their relationship to treatment follows.

The Halstead-Reitan: Linkages to Treatment

The Halstead-Reitan assessment procedures (Boll, 1981; Hartlage & Hartlage, 1977; Teeter, 1986) are a mainstay of clinical neuropsychologi-

cal practice with children. The Halstead-Reitan procedures have been reported to be sensitive to brain dysfunction in a number of developmental disorders, including asthma (Dunleavy & Beade, 1980), autism (Dawson, 1983), Gilles de la Tourette's syndrome (Bornstein, King, & Carroll, 1983), juvenile delinquency (Yendall, Fromm-Auch, & Davies, 1982), and epilepsy (Herman, 1982). An abundance of data show that the Halstead-Reitan batteries are valid for the differential diagnosis of brain damage in children (Boll & Reitan, 1972; Reed, Reitan, & Klove, 1965; Reitan, 1979). Further, the batteries have been found useful for the neuropsychological classification of minimal brain dysfunction in young children (ages 5–8) (Reitan & Boll, 1973) and learning disabilities in older children (ages 9–14) (Reitan, 1980: Selz & Reitan, 1979).

In 1980, Reitan initiated formal attempts to relate neuropsychological assessment data explicitly to treatment through the development of a program titled Reitan Evaluation of Hemispheric Abilities and Brain Improvement Training (REHABIT). According to Reitan (1979, 1980), the efficacy of REHABIT for the purposes of remediation is dependent upon (1) a comprehensive neuropsychological evaluation (using the Halstead-Reitan procedures) that clearly identifies areas of brain-related strengths and weaknesses and, (2) a determination from the assessment data as to whether the particular neuropsychological deficits reflect neural-cognitive deficiencies or generalized cognitive problems affecting several functional systems.

According to Reitan (1980), direct linkages between assessment and treatment are forged by the training concepts inherent in the REHABIT model. For example, REHABIT proposes treating the general area of neuropsychological deficit directly by using alternate forms of neuropsychological tests as training items. According to Alfano and Finlayson (1987), such an approach seems reasonable because challenging the areas measured by neuropsychological tasks could provide direct stimulation of the wide range of neural functions that they assess. (For an alternate point of view, refer to Mann, 1979; Mann & Sabatino, 1985.) Following this general form of deficit training, remediation in five specific areas (tracts) is carried out using previously developed educational materials and tasks. The tracts include (1) Tract A, materials for the development of expressive and receptive language and verbal skills; (2) Tract B, materials to develop abstract language functions to include verbal reasoning, verbal concept formation, and verbal organization; (3) Tract C, materials designed to enhance general reasoning capabilities; (4) Tract D, materials for developing abstract visual-spatial and temporal-sequential concepts: and (5) Tract E, materials designed to promote understanding of basic visual-spatial and manipulation skills. Thus, Tracts A and B are generally linked to left hemisphere functions, Tracts D and E to right hemisphere functions, and Tract C to general logical analysis and reasoning functions subserved by all functional systems.

Data to support the REHABIT rehabilitation and remediation concepts are difficult to find. Reitan (1979, 1980) does report a few case studies, but the information provided in them cannot be construed as empirical validation for the REHABIT model In fact, reviews of similar neuropsychological process remediation models (Lyon & Moats, in press; Mann, 1979) have indicated that such practices suffer from a lack of both construct and ecological validity, particularly with respect to their application with children who display academic achievement deficits without demonstrable brain injury. In the absence of empirical validation for the REHABIT model, the clinician is ultimately responsible for judging whether the time spent in assessment and training activities is in the best interests of the child.

Rourke and his colleagues (Rourke *et al.*, 1983, 1986) have argued convincingly that the aims, content, and style of neuropsychological assessments are improved significantly when a comprehensive battery of neuropsychological tasks are administered to children and the data interpreted according to several frames of reference (level of performance, pathognomonic signs, differential [pattern] score approach, comparisons of performance on two sides of the body, pre- and postlesion comparisons). Rourke's (1975, 1981) orientation to assessment practices and how assessment data relate to treatment is influenced significantly by his use of Reitan's neuropsychological measurement concepts and modes of clinical interpretation (Rourke, 1981). As such, Rourke's concepts of how brain-related deficiencies in children should be assessed and related to remediation are presented in this section.

Rourke *et al.* (1986) propose that linkages are best formed between assessment and remediation when a developmental neuropsychological model is employed. Within the context of such a model, specific information related to the child's neuropsychological ability structure is collected and interpreted in relation to (1) the immediate demands in the environment (e.g., school and social demands); (2) hypothesized long-range demands (e.g , occupational and social functioning); (3) specific short- and long-term behavioral outcomes that best characterize the child with respect to developmental status, information-processing strengths and weaknesses, and neuropsychological status; (4) an ideal remediation program for the child given the above information; and (5) the development of a realistic remediation program given the child's characteristics and the actual availability of remedial sources for family, school, and child.

Rourke's developmental neuropsychological remediation/habilitation model appears to have potential for linking assessment data to treatment because it stresses a comprehensive analysis of how child variables interact systematically with environmental factors and the pragmatics of clinical service delivery. However, as with other models incorporating the use of Halstead-Reitan tasks and modes of clinical interpretation (i.e., REHABIT), there simply are not the empirical data to support the validity

and clinical efficacy of Rourke's (Rourke *et al.*, 1983, 1986) model. Clearly, however, the model does offer well-reasoned and comprehensive guidelines for intervention that can serve as clinical frames of reference.

The Luria-Nebraska: Linkages to Treatment

A. R. Luria's (1973, 1980) seminal conceptualization of the human brain as being composed of functional units has led to the development of a standardized neuropsychological assessment battery for use with both adults and children. The Luria-Nebraska Battery-Children's Revision (Plaisted *et al.*, 1983) has been found to be sensitive in detecting demonstrable neuroencephalopathy in children (Teeter, 1986). Some recent studies also have shown that the battery can discriminate between learning-disabled children and normally achieving students (Geary & Gilger, 1984; Nolan, Hammeke, & Barkley, 1983).

To date, no formal attempts have been made to relate assessment data obtained from the Luria-Nebraska to structured remediation programs for children. However, Luria's (1973) concepts of brain–behavior relationships can be clinically useful if applied to intervention practices in an informed manner. This conclusion may be a reasonable one for at least two reasons. First, Luria's model incorporates concepts related to both brain systems *and* their development. As such, a dynamic theoretical basis exists from which to make predictions about outcome and potential for remediation. Second, Luria's model argues that disturbances in complex cognitive functions can be related to a wide variety of brain-related deficiencies. For example, failure to learn to write could be attributable to deficits in any of several brain systems. Thus, children who display written language deficits may not respond equally well to the same remediation procedure.

One additional point is in order. Luria (1963, 1973, 1980) advocated the use of dynamic, nonstandardized assessment methods that could vary across patients depending upon the nature of the clinical question. He supported the use of these procedures with substantial clinical case-study data. Further, Luria (1963, 1980) presented a rationale for applying assessment procedures directly to the treatment and rehabilitation process and reported case-history data to substantiate his point of view. It is possible that attempts to standardize Luria's dynamic assessment methods could reduce their power in relating assessment findings to treatment program planning. The reader should keep in mind that this possibility remains an open question.

The K-ABC: Linkages to Treatment

Another standardized assessment tool that relies on neuropsychological constructs is the Kaufman Assessment Battery for Children (K-ABC;

Kaufman & Kaufman, 1983). Emphasizing a dual-processing model of cognition, the K-ABC Test purports to measure simultaneous and successive information-processing strengths and weaknesses in children up to 12 years of age. In addition to scores on the Simultaneous and Successive scales, a third Achievement test cluster is used to measure acquired knowledge and verbal learning ability. The test user then is encouraged to formulate hypotheses regarding remediation of academic deficiencies that emphasize the preferred processing mode of the subject. Unique to the K-ABC remediation framework (Gunnison, 1984) is the specificity of these recommendations to academic domains—reading, arithmetic reasoning, and written language—and the well-elaborated models of intervention that attempt to code both learner behavior and task demands along the simultaneous–sequential dichotomy.

Unfortunately, the usefulness of the K-ABC even for descriptive and classification purposes has not been accepted uniformly. For example, Sternberg (1984) argued that the test lacks construct validity, a problem that may be related to the authors' misrepresentation or misreading of the evidence supporting a simultaneous–successive processing dichotomy. Further, in equating processing style with scores on selected tasks, the test fails to assess constructs that pertain to dynamic problem solving. Selecting and conducting remediation on the basis of K-ABC results thereby would constitute a tenuous practice.

Empirical support for remediation based on the K-ABC, as with other neuropsychological approaches reviewed in this chapter, is sparse. Although Gunnison and her colleagues (research in press), cited in Gunnison, 1984) have shown meaningful gains in reading for children taught with methods described as simultaneous or sequential in emphasis, both the assumptions underlying the aptitude–treatment linkages and the data base supporting them are weak (Ayres & Cooley, 1986; Salvia & Hritchko, 1984). Where the logical–intuitive classification of child responses and teaching strategies appears to have most value is in the provision of a conceptual framework for diagnostic teaching. The concept of dual-processing modes may simply encourage the clinician to behave in a flexible manner when alternative representations of concepts are needed by the learner.

SELECTED ASSESSMENT BATTERIES: LINKAGES TO TREATMENT

The majority of studies that have attempted to identify empirically the linkages between assessment data and treatment options have measured children's neuropsychological characteristics with tasks that are not standardized in battery form. Generally, the tasks are selected on the basis of their relevance to a particular theoretical test of a research ques-

tion. Because the tasks included in selected assessment batteries lack a common standardization sample from which to derive scores, control groups matched on relevant variables generally are assessed along with the clinical group of interest.

In the main, studies employing this type of assessment approach are conducted for the purpose of establishing a classification scheme for children who are included in heterogeneous clinical populations (i.e., learning disabilities). Within this classification context, children are assigned to different subtypes on the basis of their performance on the selected neuropsychological tasks. Once a classification solution is obtained, it must be validated internally and externally. Internal validation is achieved by ensuring that the subtypes identified are reliable, replicable, and robust enough to include most members of the clinical population of interest. External validity is examined by determining whether the classification solution is useful for description, prediction, and clinical practice. One specific way to address external validity is to determine whether subtypes differ from one another in response to treatment (Lyon & Risucci, 1988). It is this area of classification research that is relevant to this chapter.

To date, a number of research programs have reported preliminary data that suggest that subtypes respond differently to various forms of remediation. Although all of the published investigations have been carried out with learning-disabled readers (dyslexics), the studies differ with respect to theoretical orientation, assessment tasks used to form subtypes, and classification methodology. For example, Lyon and his colleagues have identified several subtypes by applying empirical multivariate quantitative clustering methods to information-processing task scores obtained by large samples of LD readers. External validity studies have then involved attempts to teach the disabled learners and to determine subtype–teaching method interactions. In contrast, Bakker (1983) has classified dyslexics into two major subtypes according to clinical criteria, the most important of which is left/right ear asymmetrics in dichotic listening tasks. External validation consisted of hemisphere-specific stimulation via presentation of words to right and left visual fields and identifying whether subtypes responded differently to both the site of presentation and the type of stimulus used. Flynn and her associates (Flynn, 1987) have concentrated on clinically identifying dyslexic subtypes on the basis of their reading and spelling error patterns. She has presented compelling pilot data showing that children with particular patterns respond well to specific methods of reading instruction. Each of these research programs is reviewed in more detail in this section. Emphasis is placed on describing the theoretical orientation that drives the selection of assessment tasks used in the various research programs, the types of remediation procedures employed, and the clinical relationship between tasks and interventions.

Empirical Subtype Intervention Studies: The Lyon Research Program

Lyon and his associates (Lyon, 1983, 1985a, 1985b; Lyon, Stewart, & Freedman, 1982; Lyon & Watson, 1981) have questioned the appropriateness of a single-deficit classification model for reading disability and hypothesized that LD readers (dyslexics) constitute a population that is composed of a number of subtypes, each of which is defined by its own particular array of linguistic, perceptual, and reading characteristics. The theoretical background underlying Lyon's research can be viewed as a logical extension of Luria's (1966, 1973) clinical neuropsychological theory and Benson and Geschwind's (1975) multiple syndrome model of alexia. For example, Lyon (1983) proposed that reading development is a complex process that requires the concerted participation of cognitive, linguistic, and perceptual subskills. As such, deficiencies in any one subskill can limit the acquisition of fluent decoding and/or comprehension abilities.

Within this theoretical context, an initial series of studies was conducted (Lyon, Rietta, Watson, Porch, & Rhodes, 1981; Lyon & Watson, 1981) in which a battery of tasks designed to assess linguistic and perceptual skills related to reading development was administered to 100 LD readers and 50 normal readers matched for age (11–12 years) and IQ (M = 104). The data were submitted to a series of cluster analyses to test the hypothesis that subtypes could be identified. Six distinct subtypes were delineated and characterized by significantly different patterns of linguistic and perceptual deficits. The six-subtype solution remained stable across internal validation studies employing different variable subsets and clustering algorithms. Further, 94% of subjects were recovered into similar subtypes in a cross-validation study using a new subject sample (Lyon, 1983). A brief description of each of the subtypes' information-processing characteristics is provided here, followed by an overview of the intervention program. Readers are referred to cited references for specific details.

Children who were assigned empirically to subtype 1 (n = 10) exhibited significant deficits in language comprehension, the ability to blend phonemes, visual-motor integration, visual-spatial skills, and visual memory skills, with strengths in naming and auditory discrimination skills. Analysis of the reading and spelling errors made by members of subtype 1 indicated significant deficits in the development of both a sight word vocabulary and word attack skills.

Children in subtype 2 (n = 12) also exhibited a pattern of mixed deficits but in a milder form than observed in subtype 1. Specifically, significant problems in language comprehension, auditory memory, and visual-motor integration were observed and may have been related to the

reading problems of these subjects. No deficits were seen in these youngsters' performance on naming, auditory discrimination, sound blending, visual-spatial, and visual memory tasks. Subtype 2 members produced mixed visual and phonetic errors when reading but to a much milder degree than did subtype 1 children.

Members of subtype 3 (n = 12) manifested selective deficits in language comprehension and sound blending, with corresponding strengths in all other linguistic and visual-perceptual skills measured. The oral reading errors made by subtype 3 youngsters were primarily phonetic in nature, as would be expected from their diagnostic profile.

Children in subtype 4 (n = 32) displayed significant deficiencies on visual-motor integration tasks and average performance on all other measures. These youngsters displayed an assorted sample of oral reading errors, though most errors were made when attempting to read phonetically irregular words.

Subtype 5 (n = 12) members displayed significant deficits in language comprehension, auditory memory, and sound blending, with corresponding strengths in all measured visual-perceptual and visual-motor skills. These characteristics appeared related to the severity of their oral reading and written spelling errors. The major academic characteristic that distinguished subtype 5 youngsters from the other children was their consistently poor application of word attack (phonetic) skills to the reading and spelling process.

The pattern of scores obtained by members of subtype 6 (n = 16) indicated a normal diagnostic profile. These results were unexpected. It is quite possible that these children were reading poorly for reasons that were not detected by the assessment battery.

Following this subtype identification study, an external validation investigation (Lyon, 1983) was carried out to determine whether subtypes would respond differently to reading instruction. However, because of the relatively small sample size, a standard aptitude-by-treatment study could not be designed appropriately. Therefore, it was decided to explore the possibility that the six subtypes might respond differently to one teaching condition. Since the children for this exploratory study had to be matched for preintervention achievement levels and other relevant variables (age, IQ, sex, socioeconomic status), the initial subject pool available from the subtype identification study was reduced to 30. Thus, random assignment of children from each of the six subtypes to several teaching conditions was not feasible.

In light of these logistical difficulties, five subjects were selected from each of the six subtypes. They were matched on their ability to read single words, age, IQ, race, and sex. All 30 subjects were white males ranging in age from 12.3 years to 12.7 years and in Full Scale IQ from 103.5 to 105. Preintervention grade equivalents on the Reading Recognition subtest of

the Peabody Individual Achievement Test (PIAT) ranged from 3.0 to 3.3, with percentile ranks ranging from 4 to 8. It was not possible to control for the amount and type of previous reading instruction experienced by the children, their present curriculum, and the amount of time spent in classrooms for learning-disabled youngsters. Thus, the results obtained from this study must be evaluated in light of these confounding features.

The teaching method selected for the study was a synthetic phonics program (Traub & Bloom, 1975). This program was chosen because of its sequenced format, its coverage of major phonics concepts, and its familiarity to the teachers in training who were providing the instruction. All subjects were provided 1 hour of reading instruction per week (in addition to their special and regular classroom instruction) for 26 weeks.

Following the 26 hours of phonics instruction, the 30 children were posttested with the PIAT Reading Recognition subtest, and gain scores employing percentile ranks and grade equivalents were computed. A one-way analysis of variance indicated significant differences among the six subtypes for both types of gain scores achieved from preintervention to posttesting. An analysis of subtype gain scores and subsequent pairwise comparisons indicated that members of subtype 6 made the most progress (mean percentile rank gain = 18.0), followed by members of subtype 4 (mean percentile rank gain = 8.2). On the other hand, subtypes 1, 2, 3, and 5 made minimal gains in percentile ranks and were not significantly different from one another in terms of gains achieved. Subtypes 6 and 4 were both significantly different from one another and from all other subtypes with respect to their improvement in the oral reading of single words.

The data obtained in this subtype remediation study indicate that, for some subtypes, a synthetic phonics teaching intervention appeared to enhance significantly the ability to read single words accurately. Clearly, members of subtypes 6 and 4 demonstrated robust improvements in their decoding capabilities. Whether or not the absence of auditory-verbal deficits in these two subtypes was associated with their good response to instruction cannot be answered clearly at this time, but one could hypothesize that this might be the case. This hypothesis is made more tenable by the observation that those subtypes with the most severe auditory receptive and auditory expressive language deficits made either minimal gains (e.g., subtypes 2 and 3) or no gains (e.g., subtypes 1 and 5) in the ability to pronounce single words accurately and efficiently.

In a related program of research carried out with younger disabled readers (Lyon, 1985a; Lyon *et al.*, 1982), five LD subtypes were identifed and validated internally and externally by using different variable subtests, clustering algorithms, and subtype–teaching method interaction studies. Again, a brief description of each of the subtypes' information-processing characteristics is provided, followed by an overview of the external validation intervention program.

Children assigned to subtype 1 ($n = 18$) manifested significant deficits in visual perception, visual-spatial analysis and reasoning, and visual-motor integration. Visual memory was also below average but not significantly so. All measured auditory receptive and auditory expressive skills were within the average range. The reading errors made by members of subtype 1 appeared to be related to their diagnostic deficit profile. Frequent mispronunciations due to confusion of visually similar words were noted, as were reading errors involving medial vowels and vowel combinations.

Children in subtype 2 ($n = 10$) displayed selective deficits in morphosyntactic skills, sound blending, language comprehension, auditory memory, auditory discrimination, and naming ability, with corresponding strengths in all measured visual-perceptual skills. These deficits across auditory receptive and auditory expressive language domains appeared to seriously impede their ability to decode single words and to apply decoding principles to the pronunciation of nonsense words.

Members of subtype 3 ($n = 12$) scored in the normal range on all diagnostic measures and, thus, can be compared with youngsters in the subtype identified by Lyon and Watson (1981) that scored significantly below normal on reading tasks without concomitant low performance on diagnostic test batteries. It is possible that members of subtype 3 read inefficiently for social or affective reasons rather than because of inherent oral language or perceptual deficiencies. It is also quite possible that the diagnostic battery employed did not assess effectively all skills relevant to the developmental reading process. As was the case with Lyon and Watson's (1981) subtype 6 (normal diagnostic profile), members of subtype 3 scored higher than all other subgroups on the reading measures. These youngsters did have relatively more difficulties in comprehending reading passages than in the other measured reading skills. No systematic patterns of errors could be identified from analysis of their performance on word recognition and word attack measures.

Children in subtype 4 ($n = 15$) displayed significant deficiencies in sound blending, language comprehension, auditory memory, naming ability, and some aspects of visual perception. The difficulties manifested by subtype 4 members in remembering, analyzing, synthesizing, and correctly sequencing verbal and visual information appeared to have a significant effect on their ability to decode phonetically regular real and nonsense words. For example, in measures of oral reading and word attack skills, a large proportion of subtype 4 youngsters could not approximate the correct pronunciation of many words.

Members of subtype 5 ($n = 9$) manifested significant mixed deficits in morphosyntactic skill, sound blending, visual perception, visual-motor integration, visual-spatial analysis, and visual memory. These youngsters committed primarily "visual" errors when reading single words (both real

and nonsense), apparently reflecting their deficiencies in visual analysis and memory.

Following the subtype identification phase with younger disabled readers, Lyon (1985a) carried out a pilot remediation study. Similar to the Lyon (1983) subtype remediation study, a relatively low sample size and other logistical difficulties (funding, sample migration) prohibited any attempts to assign members randomly from each of the five identified subtypes to a variety of teaching approaches. However, rather than teaching all subtype members with the same general methods and materials, as was done in the first intervention study, one subtype (subtype 2) was split, with half of the members receiving reading instruction via a synthetic phonics approach and the other half receiving instruction through a combined whole-word and analytic phonics methodology.

Although this approach represents a significant departure from the experimental design necessary for an aptitude (subtype)-treatment (teaching method) interaction study, Lyon attempted to gain preliminary information about how children who are very similar to one another diagnostically would respond to different teaching methods. Subtype 2 ($n = 10$) was chosen as the target subtype for this pilot study because all of its members displayed both significant receptive language deficits (auditory discrimination), auditory comprehension, auditory memory) and auditory expressive deficits (retrieval, syntax, sequencing) within the context of robust visual perceptual-motor-memory strengths. Because all of the subtype 2 members also manifested significant difficulties reading single words and connected language, the opportunity existed to determine how two different reading approaches affected these skills in the presence of a number of linguistic subskill impairments.

For this pilot study, five children were randomly assigned to a synthetic phonics approach (Traub & Bloom, 1975), whereas the remaining five were placed randomly in a combined sight word, contextual analysis, structural analysis, and analytic phonics group. Preintervention assessment using the Woodcock Reading Mastery Word Identification subtest indicated that the five children in each remediation group were reading between the 8th and 10th percentile ranks for age. The mean percentile ranks for the two groups were not significantly different (Mann-Whitney $Z > .05$) prior to the initiation of the remediation programs.

Both remediation groups received approximately 30 hours of individualized instruction (3 hours a week for 10 weeks). Unfortunately, it was not possible to control for the type of previous exposure to reading instruction or for the type of ongoing regular and special class instruction the children were receiving in their typical school day. Thus, as in the Lyon (1983) study, any conclusions drawn from the results of this study must be interpreted in light of these confounding factors.

The synthetic phonics remediation group was taught via the scope

and sequence presented in the Traub and Bloom (1975) reading program. A brief description of the instructional format for this approach was presented earlier. The combined remediation group learned to label whole words (three nouns, three verbs) rapidly by first pairing the word with pictures, then recognizing the names of the words (by a pointing response), and then finally reading the words in isolation. Following the development of rapid reading ability for these six words, function words (*the, is, was, are*) were introduced and taught. Following stable reading of these words, short sentences using combinations of the sight and function words were constructed and read in order to introduce the concept of contextual analysis and to develop metalinguistic awareness of reading as a meaningful language skill. Following contextual reading drills, the combined group received instruction in structural analysis and the reading and comprehension of the morphosyntactical markers -ed, -s, and -ing. These morphemes were written on anagrams and introduced into context so that the children could readily grasp their effect on syntax and meaning. Finally, analytic phonics drills were initiated to develop letter–sound correspondences with the context of whole words. Specifically, phonetically regular words that could be read rapidly by sight were presented, and children were first asked to recognize a particular letter-sound correspondence ("Point to the letter that makes the /a/ sound") and then to give a recall response ("What sound(s) does this letter make?"). As children became more adept at recalling grapheme–phoneme relations, drills in auditory analysis and blending were initiated.

Following the 30 hours of remediation, children in both groups were posttested with an alternate form of the Woodcock Reading Mastery Word Identification subtest. Significant differences were found between the two remediation groups with respect to postintervention reading percentile rank scores (Mann-Whitney $Z < .0003$). Children within the combined remediation group gained, on the average, 11 percentile rank points, whereas members of the synthetic phonics group gained approximately 1 percentile rank point.

There is little doubt that subtype 2 members responded significantly differently to two forms of reading instruction. Apparently, the auditory receptive and auditory expressive language deficits that characterized each member of the subtype 2 impeded their response to a reading instructional method that required learning letter–sound correspondences in isolation followed by blending and contextual reading components. A tentative hypothesis might be that subtype 2 children did not have the auditory language subskills necessary for success with this approach but could deploy their relatively robust visual-perceptual and memory skills more effectively with whole words, as seen within the combined remediation. A more tenable hypothesis is that whole-word reading placed far less linguistic demands on these readers than alphabetic approaches that require a phonological awareness of sound structure and acoustic bound-

aries and the relationship of these units to letter sequences. Thus, whereas subtype 2 members learned to read whole words in structured, isolated context, their ability to generalize phonological and orthographic concepts to read new words is most likely to remain limited.

In general, the data derived from this series of subtype identification and remediation studies support a model of dyslexia that presumes that a number of diverse information-processing deficits can have specific reading disability as a common correlate. Although the results from these basic research endeavors are interesting, the findings have limited clinical utility for a number of reasons. First, the kinds of subtypes identified and their descriptions are limited by the range and quality of the tests that provide the data for cluster analysis. For example, the tasks selected for use in Lyon's assessment batteries did not provide adequate coverage of some linguistic factors (particularly phonology) implicated in the developmental reading process. Second, the specific nature of the relationship between subtype assessment characteristics and response to reading instruction is difficult to determine because the assessment tasks are indirect measures of associated symptomatology. Third, it is not well understood if the correlated information-processing deficits constitute necessary and/or sufficient conditions for reading disability. Fourth, methodological limitations in sample size and the number and type of dependent reading measures preclude adequate interpretations and confident generalization of the subtype–teaching method interaction studies. Finally, even though particular teaching (treatment) approaches had differential effects for some subtypes, it is difficult to determine if the effects should be attributed to subtype characteristics, the instructional program, the interaction between the two, the teacher, time spent in remediation, or previous or concomitant educational experiences.

Clinical Subtype Intervention Studies: The Bakker Research Program

Bakker and his colleagues (Bakker, 1983; Bakker, Moerland, & Goekoop-Hoefkens, 1981; Bakker & Vinke, 1985) have developed a classification model of reading disability that stresses the importance of balance in the functional development of the two hemispheres of the brain. He hypothesized that each of two dyslexic subgroups represents functional overdevelopment of one hemisphere for reading behavior. Thus, L-type dyslexics, who are hypothesized to be overreliant on a left hemisphere strategy for reading, are fast and inaccurate decoders of text, whereas P-types are believed to be overreliant on a right hemisphere strategy reflected in slow, relatively accurate reading. The groups are classified independently through dichotic listening tasks, with L-types showing a right ear advantage and P-types showing a left ear advantage.

Although a subtyping system that uses dichotic listening tasks as a

key variable for classification might be constrained by unreliability (Lyon & Risucci, 1988), Bakker's theoretical constructs have been validated externally by intervention studies (Bakker & Vinke, 1985). In these studies, structured presentation of reading stimuli produced changes in both event-related potentials and reading behaviors in the direction predicted by the balance model. The intervention paradigm assessed the effects of both direct hemisphere stimulation through right or left visual-field presentation of words, and indirect stimulation through the presentation of modified text formats. Thus, L-types were forced to attend to the graphic features of text with mixed and altered typefaces, whereas P-types were required to attend to the alphabetic code by having pictures and titles removed from the text, as well as having to rhyme and perform temporal order tasks. Significant changes in both event-related potentials and reading improvement in experimental groups followed stimulation of the underused hemisphere of the given subtype.

Although Bakker's work is promising in its demonstration of theoretically predicted changes in reading behavior as a consequence of clearly conceived treatment methodologies, the work needs to be interpreted with caution. Subject description and identification continue to be problematic; for example, in the Bakker and Vinke (1985) study, subjects were selected with IQs of 70 and above, and the mean IQ was a low average of 85. There were no group differences reported with respect to discrepancies between ability and achievement. This becomes important only because the results may not generalize to dyslexic samples chosen by commonly used sample marker variables. Further, the sample was teacher-selected, remediation sessions occurred only once per week for 22 sessions, and no control for concurrent reading instruction of the subjects in their classrooms was reported. The L-type and P-type dyslexics were not well differentiated according to reading behaviors. Without further internal validation, it will be difficult to evaluate the similarities between Bakker's classification system and others, as well as to apply Bakker's model more generally in clinical treatment.

Direct Assessment Intervention Studies: The Flynn Research Program

The work of one of the authors (Flynn, 1987) suggests that direct assessment of reading and spelling behaviors within a neuropsychological framework provides useful linkages to treatment. Assessment tasks in Flynn's studies were chosen on the basis of a conceptualization of reading as an interactive process composed of lower-level processes (phonology, memory, perception, attention) and higher-level processes (syntax, semantics, experiential knowledge, executive monitoring) that operate simultaneously and synergistically to produce fluent reading. Ecological assessment of intact, deficient, and compensatory reading strategies in-

cluded multiple oral reading samples using the reading model to classify errors and the Boder Test of Reading-Spelling patterns (BTRSP; Boder & Jarrico, 1982). Thus, test content was directly related to the tasks that children face on a daily basis.

The BTRSP was chosen as a direct measurement of word-recognition skills involving phonology, memory, and perception. Dyslexic children were classified as dysphonetic (deficient in sequential auditory processes), dyseidetic (deficient in visual-spatial skills), or mixed (deficient in both processes), according to an adaptation of the Boder procedures (Boder & Jarriso, 1982). The initial thrust of this research was to investigate the construct validity of the BTRSP through external validation studies involving quantitative neurophysiology and subtype–treatment remediation programs. As the reader will note, results of the studies indicate that a reconceptualization of the dyslexic subtypes originally proposed by Boder may offer greater explanatory power and lead more directly to testable reading remediation hypotheses.

With this direct assessment model, subtypes of children who demonstrated distinct profiles of reading behaviors were identified. One subtype, described as deficient in phonetic development, demonstrated difficulty with syntactical and alphabetic skills. Generally, semantics and sight word recognition skills were areas of strength. Oral reading was characterized by global substitutions, difficulty with sound–symbol relationships, and semantic substitutions. Often, comprehension was relatively intact despite numerous reading inaccuracies. Conversely, children with presumed deficits in whole word recognition skills displayed excellent phonetic analysis skills. Characteristically slow but accurate readers, they often failed to understand the meaning of a passage.

The question of whether these clinical description of reading profiles represent reliable, replicable subtypes that have ecological and predictive validity (i.e., lead to testable remediation hypotheses and prognoses) was investigated through external validation studies, including quantitative neurophysiology studies and a subtype–treatment remediation project. In the first neurophysiology study (Flynn & Deering, 1987), 44 children (ages 7–10) were assessed using direct measures of reading and spelling behaviors, a neurological evaluation, and spectral analysis of theta and alpha brain waves during cognitive tasks. The results suggested that distinct subtypes of reading-disabled children could be formed using direct measures of word recognition skills. The data also suggested that reading disability in the subtype of children identified variously as dyseidetic (Boder, 1971, 1973), L-type dyslexics (Bakker & Vinke, 1985), visual or visual-spatial (Johnson & Myklebust, 1967; Mattis, French, & Rapin, 1975; Pirozzolo, 1981) may be attributable to overutilization of early-developing linguistic skills (phonological decoding) rather than deficient visual perceptual processes.

Although this study clearly differentiated the dyseidetic dyslexics

from other groups on three of the six cognitive tasks, the direction and location of neurophysiologic difference was initially quite surprising given previous reports of this subtype's characteristics. For example, dyseidetic children's reading disabilities have been attributed to deficient visual-spatial abilities referable to atypical, right hemisphere development with concomitant strength in phonetic skills (Boder, 1971, 1973; Boder & Jarrico, 1982). In the Flynn and Deering (1987) investigation, however, dyseidetic children demonstrated significant increases from resting baseline in left temporal-parietal theta compared with the other groups. That this difference occurred in the area of the angular gyrus, presumed to be important in phonetic decoding (Hynd & Hynd, 1984), suggested that the reportedly normal phonetic skills of dyseidetic children may, in fact, indicate overutilization of a processing strategy that results in, or is caused by, relative inefficiency of right hemisphere visual gestalt abilities.

A second study of 64 children (ages 8–9), subtyped according to modified Boder procedures (Boder & Jarrico, 1982) and oral reading patterns, provided replicated evidence of increased left theta activity in dyseidetic children during task engagement (Flynn & Deering, 1987). Further external validation studies investigated the efficacy of the classification system for prescribing remediation (Flynn, 1987). Using the neuropsychological principle of teaching to intact or compensatory processes, a subtype–treatment research program was initiated. The study involved 22 first-, second-, and third-graders classified as dysphonetic or dyseidetic. Children were randomly assigned to a treatment group and received a full year of remediation, three sessions per week. The reading approaches included (1) a language experience, analytic phonetic approach using the Initial Teaching Alphabet; (2) Distar, a synthetic phonics approach; and (3) a multisensory, analytic phonetic approach using regular orthography.

Data derived from the reading remediation project provided additional validation of ecologically based assessment procedures for subtyping dyslexic children (Flynn, 1987). However, the data also demonstrated the inadequacy of a design that implies a simple match between reading subtype and remediation system. Specifically, within each treatment condition, there were some children who benefited whereas others with the same reading profile made less than average gains.

Data from the neurophysiology and remediation studies suggest that not all children fail to develop fluent reading behaviors for the same reason, that distinct subtypes of dyslexic children can be identified on the basis of direct measurements of reading and spelling behaviors, and that, to some degree, responses of subtyped children to specific reading approaches can be predicted. The data also suggest that more dynamic, interactive models of the teaching–learning situation must be developed in order to describe and predict adequately how the child's processing

deficits covary with instructional variables (e.g., the reading system and the learning context).

SOME FINAL THOUGHTS, CONCLUSIONS, AND DIRECTIONS

There is little doubt that establishing clinically valid linkages between neuropsychological assessment and the development of treatment options for children in need of rehabilitation and remediation is a laudable goal. Ecologically valid assessment data could provide a framework for the systematic development of hypotheses to determine which specific treatment methods and materials have the highest probability of success for a particular child with a particular array of neuropsychological characteristics. However, our review of efforts to achieve this goal indicates that a substantial distance remains to be traveled before one can conclude that the time spent in carrying out neuropsychological assessment contributes significantly to the treatment process. The first step in closing this distance is actually twofold. First, shortcomings inherent in neuropsychological assessment for treatment purposes must be recognized, and, second, a productive course and set of refinements to help correct our clinical weaknesses must be suggested.

Throughout this chapter, we have noted that linkages between assessment and treatment are weakened by factors associated with the limited construct, content, and ecological validities of the test batteries employed. We also have pointed out that a number of persistent difficulties in relating assessment to treatment stem from our use of assessment tasks that were not designed initially to predict and guide treatment options. In addition, specific issues associated with clinical training, developmental appropriateness of assessment tasks used with children, and the problem of static versus dynamic assessment also need to be addressed if clinical progress is to be made regarding the assessment–treatment interface. Our intent in the remainder of this chapter is to provide some meaningful direction with respect to these issues.

Professional Preparation and Experience

A majority of clinical neuropsychologists feel unprepared to undertake the task of recommending treatment or intervention options on the basis of assessment data. This may be expected, as Craig (1979) and others (Hynd & Obrzut, 1986) have pointed out, because clinical neuropsychologists spend significantly greater clinical time in assessment activities than practicing in an intervention context. Although this lack of experience with treatment issues is problematic, a more fundamental reason for clinical naivete in treatment situations is limited preparation. As

Hynd and Obrzut (1986) have reported, clinical neuropsychologists receive little or no formal training in intervention practices, particularly educational practices. Training programs typically emphasize assessment, diagnosis, and consultation with only general exposure to treatment methodologies. Moreover, when neuropsychologists are exposed to intervention and treatment approaches, such experiences usually take place in settings somewhat removed from the populations and problems that ultimately will demand expert clinical treatment services. More specifically, the types of intervention and treatment strategies applied with adults in hospital settings often are not generalizable to the school-related difficulties seen in pediatric populations.

If, in fact, clinical neuropsychology is to undertake a responsible role in applied settings where treatment is not only a logical but necessary outcome of assessment, then substantial improvements in formal clinical training must occur. Supervised practica and internships under the tutelage of master teachers and clinicians, preceded by relevant coursework in applied academic content areas, would seem helpful in this regard.

Developmental Issues in Assessment

In addition to improvements in professional preparation, advances in establishing clinically meaningful linkages between assessment and treatment could be fostered by emphasizing an understanding of developmental factors in child clinical practice. Test design, interpretation of data, and the application of instructional methodologies must be informed by a developmental perspective. A prime example of a neuropsychologically based assessment tool that could benefit from a reexamination of its developmental appropriateness is the Boder Test of Reading-Spelling Patterns (BTRSP; Boder & Jarrico, 1982). This instrument, which is used in some studies to assign dyslexics to dysphonetic, dyseidetic, and mixed-deficit subtypes, is a clinical-inferential tool yielding a classification based on direct assessment of reading and spelling behavior. It also is employed in clinical practice as a basis for remedial prescriptions. Although the test is designed ostensibly for all school-aged children, the methods for error analysis and classification of children to subtypes do not change with age. There is insufficient consideration given to the manner in which spelling strategies shift with normal development. Thus, a diagnostic term such as *dysphonetic* may capture the essence of the problem at one beginning stage of reading and spelling but mask the essence of the difficulty at more advanced developmental stages. Indeed, spelling strategies do shift in dyslexics over time (Cook, 1981), both in response to instruction and as a function of intelligence (Moats, 1983). This is but one example of how assessment data can be confounded by the lack of an informed developmental perspective.

No doubt, the majority of neuropsychological batteries that are downward extensions of adult batteries and which do not have adequate cross-sectional norms suffer from the same developmental inadequacies. Certainly, it would be erroneous to prescribe remedial treatment techniques on the basis of these types of assessment data until external validation studies are conducted to evaluate the relationships among assessment strategies, clinical subtypes, developmental level, and response to instruction.

The Need for Dynamic Assessment

As mentioned throughout this chapter, most neuropsychological tests are static measures of competence designed to allow standardized comparisons of a child with other children in specified populations. Such comparisons yield only indirect and nonspecific information regarding the nature of the child's problem as it is manifested in his learning context. The test data do not address motivational factors and their impact on learning, nor do they inform the teacher or clinician about the child's spontaneous use of strategies or procedural knowledge in learning.

One notable exception is the Halstead Category Test, one of the most sensitive measures of brain dysfunction, which does assess the child's ability to learn from corrective feedback on one kind of nonverbal problem-solving task. Its potential as a dynamic assessment tool is great, but it usually is used merely as a normative measure to add to the evidence for or against the presence of brain dysfunction. In fact, the power of the Category Test lies in its ability to sample the domains of impairment most commonly associated with brain dysfunction, such as adaptation, generalization, memory for recent experience, conceptual organization, consistency of response capability, and ability to reason abstractly. As a test, it successfully departs from truncated, structured, single ability measures that do not sample adequately the cognitive characteristics most relevant to academic performance and adaptation in general. More tools of this kind are needed in our assessment batteries if neuropsychology is going to provide evaluations relevant for the individualization of therapy or teaching.

At the present time, one of the more promising examples of dynamic neuropsychological assessment is the work of Ylvisaker and his colleagues (Szekeres, Ylvisaker, & Cohen, 1987) in closed head injury rehabilitation. Their delineation of variables to consider in the selection and training of compensatory strategies (Haasbauer-Krupa, Henry, Szekeres, & Ylvisaker, 1985) acknowledges the complex interaction of cognitive, motivational, and personality factors in recovery from head injury. Their approach to rehabilitation involves dynamic observations of patient response to real-life situations and meaningful activities in natural

settings. Ylvisaker and associates also systematically evaluate patients' performances according to (1) the efficiency or rate of performance, (2) the level of conceptualization or mastery that the patient can comprehend, (3) the scope or variety of contexts in which performance can be maintained, and (4) the manner of performance (impulsive–reflective, flexible–rigid, active–passive, dependent–independent). Functional integrative performance is the appropriate target of therapy, rather than the direct rehabilitation of basic cognitive processes such as attention and memory, which may result in improvements on neuropsychological tests but which may not generalize to everyday life.

Given the arguments against static measurement (failure of tests to predict real-life adaptation, to identify satisfactorily the impact of specific cognitive impairments on complex adaptive behavior, and to predict responses to specific interventions), one might ask if child neuropsychological test batteries, as currently designed, have any purpose or relevance in the treatment of documented or putative developmental disorders. Should we delete their use in rehabilitation settings? Should we bypass neuropsychological testing of learning-disabled students, for example, in favor of curriculum-based assessment or analysis of the learner's characteristics during instruction in a given context? We do not believe so. A number of advances have been made in the development of neuropsychological assessment batteries that consist of tasks that are ecologically valid and direct measurements of processes crucial to the development of reading and spelling behavior (Flynn, this chapter; Hynd, 1986). There is also an increased awareness that establishing valid linkages between assessment data and treatment options will require tasks and modes of clinical interpretation that are as dynamic and flexible as the learning process itself (Lyon & Moats, in press).

The Need for Continued Classification Research

In order to relate assessment findings ultimately to treatment options and predicted outcomes, the phenotypic or behavioral expression of different developmental disorders must be clearly defined, characterized, and categorized. To this end, subtype research must capitalize on what we know about theoretically driven dynamic assessment procedures, the developmental nature of both brain function and human learning, and the methodological requirements for taxonomic research (Lyon & Risucci, 1988). Some subtyping efforts (e.g., Bakker, 1983; Flynn, 1987; Flynn & Deering, 1987; Hynd, 1986; Lyon, 1985b; Lyon & Risucci, 1988) are making some advances in these directions with an eye toward treatment relevance for children. Significant work remains to be done, however, before any classification scheme has precise descriptive, communicative, and predictive power. An informed understanding of some of the issues raised in this chapter may help clinicians fill the therapeutic breech until sys-

tematic and reliable linkages between assessment and treatment are forged.

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