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Methodological Issues in the Classification of Attention-Related Disorders

Jack M. Fletcher, Robin D. Morris, and David J. Francis

The classification and identification of children with attention deficit–hyperactivity disorder and related disorders involving learning and behavior are only rudimentarily developed. A major problem is the substantial overlap among children with attention, learning, and behavioral problems. The science of classification provides conceptual and methodological approaches addressing these problems. For successful classification of these children, major issues include (a) the need to provide explicit studies of identification criteria, (b) the need for systematic sampling strategies, (c) development of hypothetical classifications, and (d) systematic assessment of reliability and validity of hypothetical classifications. With the methodological advances provided by classification-oriented research, investigators and practitioners may be able to address issues involving definition and identification of children with attention and related disorders.

The classification of attention disorders and related disorders of behavior and learning (i.e., attention deficit–hyperactivity disorder, oppositional-conduct disorder, learning disability) can be conceptualized from a number of perspectives. First, there are traditional clinical perspectives that have resulted in diagnostic classifications such as those in the *Diagnostic and Statistical Manual-III–Revised* (DSM-III-R) of the American Psychiatric Association (1986). This type of classification has been developed primarily on the basis of consensus among clinical practitioners and researchers. Such classifications are usually categorical in nature and attempt to specify a set of core symptoms that are usually sufficient, but not necessary, for defining membership in a classification. For example, DSM-III-R criteria for attention deficit–hyperactivity disorder (ADHD) identify 14 symptoms in three areas: attention, impulsivity, and hyperactivity. If eight of these symptoms are present, a child can be classified as ADHD.

A second approach is derived from quantitative research and reflects a more general attempt to classify "behavior problems" in children. This research focuses on the results of empirically driven classification studies. Such classifications are usually based on a set of core *dimensions* that are generally present in all children,

with statistically based cutting scores used to identify children with different disorders.

Whereas clinically derived classifications tend to identify many disorders, quantitative classifications tend to focus on the fewest possible reliable dimensions and, consequently, identify fewer disorders. For example, Quay (1979) argued that behavior problems (excepting psychosis, autism, etc.) in children could be represented by four primary patterns of behavior: conduct disorder (CD), anxiety and withdrawal, level of maturity, and socialized aggression. In addition, Quay argued that it was difficult to identify patterns associated with hyperactivity that were not subsumed by CD. In contrast, Shaywitz and Shaywitz (1988) suggested that inadequate sampling and the absence of instruments allowing for differentiation of aggression and hyperactivity were responsible for those difficulties. This type of issue is clearly a classification problem hinging on measurement and sampling issues (Fletcher, Francis, & Morris, 1988).

For both clinically derived and quantitative classifications of attention-related disorders, the crux of the problem is how to disentangle the disorder of interest from other, overlapping disorders. Shaywitz and Shaywitz (1988) pointed out that about 50% of children who meet

DSM-III-R criteria for ADHD have a specific learning disability, and at least 50% will meet DSM-III-R criteria for Oppositional-Conduct Disorder (O-C). These children will only partially overlap. Similarly, virtually all children who meet criteria for O-C will meet criteria for ADHD, and approximately 25% will meet criteria for a specific learning disability. The critical question is whether these are quasi-independent disorders that are co-morbid (i.e., coexist in the same child), or simply represent different phenotypic manifestations of the same underlying disorder.

Current classification investigations do not permit resolution of these complex questions. When the literature on the classification of ADHD is reviewed (Shaywitz & Shaywitz, 1988), there is a continued emphasis on categorical versus dimensional classifications, which often amounts to simple contrasts of clinically oriented versus quantitatively oriented approaches. There is also considerable attention paid to issues created by differences in DSM-III and DSM-III-R, especially the issue of whether attention disorders occur without hyperactive behavior (i.e., ADD-noH in DSM-III).

To address these issues, some investigators are beginning to apply quantitative techniques, such as cluster analysis, to descriptive data derived from ADHD samples. Unfortunately, much of this research occurs without adequate consideration of either the nature of classification research or the complexities of both clinically oriented and quantitative investigations of various classification hypotheses. Hence, ADHD research is hampered by disagreements in terms of (a) how the disorder is to be defined, (b) how it is related to other disorders, and (c) how relevant dimensions should be measured.

In the remainder of this article, we will address some of these issues as they pertain to the classification of attention disorders and related disorders of behavior and learning. We will discuss the nature of classification research and various methodological issues that seem critical to this area of investigation. Finally, we will try to demonstrate that many of the issues presently viewed as involving classification could be resolved

by more emphasis on traditional methodological issues involving sampling and measurement (Fletcher et al., 1988).

NATURE OF CLASSIFICATION RESEARCH

Classification research is a time-honored tradition in many areas of science. Some investigators are taxonomists and simply study various approaches to classification (Kendall, 1975). In biology, for example, there are classifications of flora, fauna, and various species. Maps of the galaxies can be considered classifications. Anthropologists develop classifications of various cultures. The notion in the behavioral sciences that classification is either unnecessary or not useful is generally naive. In education, for example, there is controversy concerning aptitude-treatment interactions, with many investigators finding little evidence to support this approach to individualization of instruction (Lloyd, 1984). These findings lead some investigators with educational backgrounds to view classification research as unnecessary, despite some evidence for learning disability subtype interactions with treatment (Lyon & Moats, 1989). Some neuropsychologists and educators have searched extensively for "subtypes" of learning disabilities (e.g., Rourke, 1985). Those who find little support for aptitude-treatment interactions view this research with similar skepticism.

Although both these examples are variants on classification research, we would like to suggest that classification issues are complex, embedded in the research and interventions of any childhood disorder. Even at the single-case level, an implicit classification is present that leads to the identification of the case as relevant or important. Such a classification may have no relationship to treatment, but most practitioners develop treatments on the basis of their internal classifications, which are derived from their experience with children.

One of the major problems with behavioral research is that classifications are often implicit, poorly elaborated, and not clearly recognized, leading to biased conclusions (Fletcher et al., 1988). Even when classification is an explicit goal of

research, sample-based influences are paramount. For example, many of the studies cited by Quay (1979) are based on samples of children referred to mental health practitioners for behavior problems. It is possible that nonaggressive and nonhyperactive children with attention problems are treated by pediatricians and educators and are never referred to mental health clinics (Shaywitz & Shaywitz, 1988; Swanson, 1988). Hence, ADHD would not emerge as an independent pattern in a clinic-referred sample.

Independent Variables Become Explicit. When classifications are studied or developed, these implicit factors, which represent a set of independent variables, are made explicit. In other words, there is a specific attempt to identify criteria whereby entities (e.g., disorders) can be sorted, separated, and identified. The implicit criteria of the practitioner become more explicit criteria in DSM-III-R. Quantitative approaches identify specific criteria and cut-points representing major patterns in a sample.

In both examples, classifications reduce a large set of people to a smaller set of groups. The members of a given group are presumably homogeneous on the basis of some index of similarity; members of different groups are dissimilar on the same index. If there are no true "groups" of observations (i.e., subjects) in the state of nature, then each observation stands alone as a group unto itself. Such a situation is rarely forthcoming in the behavioral sciences. The problems are to identify the criteria whereby the set of observations is distinguished from other possible sets of observations, and to identify indices of similarity/dissimilarity that reliably and validly define meaningful groups. For ADHD, these processes translate into the tasks of (a) separating ADHD children from the population of all children, the population of all children with "problems," and the population of all children with similar behavioral symptoms; (b) determining relationships of ADHD with other possible disorders; and (c) distinguishing among subgroups within the ADHD sample.

In a report to Congress, the Interagency Committee on Learning Disabilities (1987) emphasized the importance of research

oriented to the development of a classification system that more clearly defines and diagnoses learning disabilities, conduct disorders, and attention deficit disorders, and their interrelationships. Such information is a prerequisite to the delineation of homogeneous subgroups and the development of more precise and reliable strategies for treatment, remediation, and prevention that will increase the effectiveness of both research and therapy. (p. 224)

Communication, Prediction, and Theory. Classification research would facilitate not only treatment and etiology, but also communication and prediction (Blashfield & Draguns, 1976). Communication is enhanced when the resultant classification is simple and based on variables that are widely used, thus permitting straightforward operationalization of definitions for placing subjects into a particular group. The communicative utility of any classification will be evaluated continuously by those who use it. A classification that facilitates communication should be simple and reflect various clinical, political, and theoretical views within the field.

These aspects of communication are in contrast to the purposes of prediction, whereby the evaluation of the classification is based on its empirical validation. To meet those needs, a classification would necessarily be complex and reflective of new research findings in an area, which might be in direct conflict with the simplicity required for communication (Blashfield & Draguns, 1976).

The joint purposes of communication and prediction are important considerations in the development of classifications. It is important to recognize that the development of any classification system is neither a beginning nor an endpoint of a process that is influenced by practical and social-political influences, and by requirements for methodological rigor, all of which can be in conflict. For example, a researcher may develop and validate a new classification of childhood behavioral disorders. However, if the researcher does not relate this classification to DSM-III-R, the classification will have little credibility because of the extent to which DSM-III-R criteria are embedded in current conceptualizations of childhood disorders. Similarly, alternative definitions of reading disability must be related in some fashion to Public Law

94-142, because public schools are obligated to follow those guidelines. Unfortunately, these sociopolitical concerns will vary across school districts in interpretation and will be subject to change, in part due to self-interest among legislators and practitioners. A scientific approach to classification is often hampered by these factors and, to a certain extent, should be developed independently of such influence. Implementation, however, will require consideration of these extrinsic factors.

Current theories and conceptualizations of childhood disorders are also important. Although a classification sets limits on the theories that may evolve, those theories also determine characteristics of the classification. Those theories dictate hypothesized classifications and selection of subjects and variables. Neither theory nor classification systems develop when they are independent considerations. Ultimately, these theories must guide how classifications are developed (Sokal, 1974). A classification may need revision with changes in theory, but that is how classifications evolve and improve (Morris & Fletcher, 1988).

HYPOTHETICAL NATURE OF CLASSIFICATIONS

Classifications should be conceptualized as a set of hypotheses requiring empirical investigations. One of the major problems with quantitative studies of possible ADHD classifications is the tendency to derive these classifications from samples that are poorly defined in terms of their relationship with the population of all children who have problems. Application of quantitative classification methods to such samples will yield types of disorders, but the types may be specific to each sample. Studies of reliability and validity, when completed, may show little generalizability beyond the initial sample. In contrast, clinically derived classifications sometimes exist only in the mind of the practitioner and become self-perpetuating myths taken as reality. Those "bootstrapping effects" (Golden, Galob, & Watt, 1983) are epitomized by such notions as minimal brain dysfunction and dyslexia (Satz & Fletcher, 1980), both of which represent classification

hypotheses with little apparent validity. If adequate numbers of practitioners believe in a disorder, it becomes hypostatized and impervious to the results of empirical investigation. Indeed, quantitative investigations may show few differences between ADHD and O-C disorders, but convincing a believer that these disorders are not different co-morbid disorders is virtually impossible.

The problem with many current quantitative and clinical classification studies is that the derivation of groups is treated as an endpoint of the research. In fact, derivation of the groups represents an initial set of hypotheses requiring extensive validation. It is the attempt to validate hypothetical classifications that allows classifications representative of the state of nature to evolve. The development of any classification is a dynamic, continuous process that may change depending on the purpose of the classification, or as new discoveries are made. All classifications should be considered as hypotheses needing empirical scrutiny from a falsifiable framework (Goodall, 1966).

FRAMEWORK FOR CLASSIFICATION RESEARCH

In our research on the classification of learning disabilities (Fletcher, 1985; Fletcher & Satz, 1985; Morris, 1989; Morris & Fletcher, 1988), we have found it useful to adopt Skinner's (1981) general framework for classification research. That framework makes explicit the hypothetical nature of classifications and the need for ongoing, empirical scrutiny as a methodology for developing classifications of learning and attention disorders.

Skinner's (1981) framework has three components: theory formulation, internal validity, and external validity. Theory formulation involves decisions concerning the variables that are used for a classification and the hypothetical or clinically defined groups that are presumed to exist. Internal validity represents an assessment of the reliability, coverage, and replicability of the classification. External validity concerns the evaluation of a classification in terms of whether the groups in the classification differ from one another in response to treatment, biological markers, or other indices.

Theory Formulation. In the theory formulation component, a decision concerning the content domain or variables (attributes) to be used in identifying the types must be made. The classification of ADHD and related disorders is typically based on rating scales, clinical interviews, and psychometric tests. A second decision must be made concerning the theoretical model used to specify the syndromes and their interrelationships. For example, "ideal types" are hypothetical individuals displaying a characteristic set of attributes that exemplify a subset of the population. Quay's (1979) hypothesis concerning four major patterns of aberrant childhood behavioral patterns could represent a set of ideal types. Any hypothesized groups, and their relationship to external variables/attributes, must also be specified as part of theory formulation. In ADHD research, hypotheses concerning how children with ADHD are different from the population of all children with problems must be formulated and clearly specified, as well as hypotheses concerning relationships of ADHD with parallel disorders (e.g., O-C) and subsumed disorders (e.g., ADD with and without hyperactivity). The attempt to systematically disconfirm these a priori hypotheses is essential for establishing the validity of the definitions.

Internal Validity. Internal validity addresses the reliability and replicability of the classification (Skinner, 1981). For a reliable classification, considerations include (a) the number of subjects typed (i.e., coverage), (b) homogeneity of the groups, (c) the reliability of the individual classification attributes, (d) replicability across statistical techniques, and (e) replication within other samples (Fletcher, 1985; Morris, Blashfield, & Satz, 1981).

External Validity. This component concerns how well the groups can be differentiated according to variables not used in their formation (Fletcher, 1985). There are few classification studies of ADHD that contain an external validity component. The demonstration of a subgroup by remediation or subgroup by experimental task interaction is a powerful evaluation of the validity of a classification (Lyon, Moats, & Flynn, 1988).

This brief outline of the Skinner (1981)

framework provides only a sketch of the issues that must be considered in designing a classification study. Those issues are discussed in greater detail by Morris and Fletcher (1988). For the classification of ADHD and related disorders, four issues are especially critical: (a) the theoretical model underlying the classification, (b) specification of hypothetical types, (c) sampling of the population, and (d) selection of classification and validation variables. As we shall see, selection of a theoretical model leads to decisions concerning hypothetical types, sampling, and measurement.

Theoretical Models in the Classification of ADHD. The distinction between clinically oriented and quantitative approaches to classification can be conceptualized in terms of differences between categorical and dimensional models. For ADHD, the distinction is not as sharp as in other areas of classification. Morris and Fletcher (1988) summarized several models that have been used for classification: Categorical models are based on the assumption that neurobehavioral problems represent disease entities, that is, discrete disorders that are presumed to follow a syndrome model in terms of etiology, pathogenesis, clinical characteristics, and prognosis—the usual framework in thinking about many disease processes (Shaywitz & Shaywitz, 1988). Clinical interviews and examinations of the patients are used to place subjects into specific diagnostic groups based on their behavioral or historical attributes. The main drawback, of course, is the expectation that most children fit neatly into such discrete categories.

In contrast, the dimensional paradigm conceptualizes neurobehavioral problems in terms of a quantitative deviation from "normality," rather than as discrete entities. In this system, rating scales, test scores, and inventories are utilized to quantify individual differences along particular dimensions. In ADHD, children may be assessed by rating scales along such dimensions as inattention, hyperactivity, and aggression. The problems with dimensional classifications concern how to define appropriate cutpoints.

Consideration controversy exists over which system is most appropriate in the definitions of attention and related disorders. Proponents of the categorical paradigm, exemplified by DSM-III and DSM-III-R, maintain that:

It is unlikely that a single cut-off score on any one particular rating scale, whether completed by parents or teachers, will be as good as or will substitute for a systematic clinical evaluation using standardized data collection instruments with proper synthesis of all data collected. (Shekim et al., 1986, p. 658)

In contrast, advocates of dimensional systems emphasize that categorical approaches impose arbitrary cut-offs that may limit information and create unnatural heterogeneous groups. Furthermore, it is often difficult to operationalize and apply categorical diagnoses in a consistent manner across clinicians or sites: "One difficulty with DSM is that it specifies *what* to assess but not *how* to assess it" (Edelbrock & Costello, 1988, p. 221).

It is true that these approaches to classification are similar and possess considerable overlap. In fact, for ADHD they can be represented as parallel classifications. Comparisons and debates among categorical and dimensional models have a long history in classification research (Morris & Fletcher, 1988). Categorical models have generally been based on a set of specific criteria that are generally present or absent (e.g., classification of flora). The advantages of categorical classifications are parsimony and ease of implementation; the disadvantage is the loss of information on any classification attributes that are not polychotomous. Dimensional classifications can be more easily represented in multidimensional space and use more of the actual information gathered. The difficulties lie in the measurement of the attributes and specification of cutting scores. For the classification of ADHD, both approaches are more similar than different, with choice of measurement tool and the establishment of cutting scores representing the most debated issues (Shaywitz & Shaywitz, 1988). The primary dimensions (or constraints) ordering the relationship of ADHD, O-C, and learning disabilities are inattention, hyperactivity, impulsivity, aggression, and achievement. The main differences between current categorical and dimensional models are how these factors are assessed and conceptualized.

More important considerations for both categorical and dimensional classifications are poor class definitions and assignments, and difficulties in measuring inattention, hyperactivity, impulsivity, aggression, and achievement. It is likely that any classification of ADHD will be oriented toward identification of groups made up of subjects with overlapping attributes. A purely categorical model would be *monothetic*, that is, represented by a set of specific attributes that are both necessary and sufficient for each member of the group (Bailey, 1973). However, *polythetic* classifications of ADHD are more likely. Those classifications form groups based on shared features. No single feature is either necessary or sufficient, and may be shared across groups, with profiles differing in shape or elevation (magnitude) on these attributes.

For ADHD, the identification of groups that share these attributes but increase the homogeneity among members within a group would be a significant advance. We believe that the classification of childhood disorders of attention, learning, and behavior will be enhanced by polythetic classifications based on hierarchical models in which children are placed into groups according to a set of identifying characteristics on which members may overlap on a single attribute, but differ in specific profiles. This model represents a hybrid of the dimensional and categorical approaches to classification. The hierarchical nature represents the tiered decisions underlying the designation of ADHD, relationships with other disorders, and types within the ADHD group.

Hypothesized Classifications. Regardless of whether a categorical, dimensional, hierarchical, or hybrid model is used, a hypothetical classification must be developed (Morris & Fletcher, 1988). That classification should specify the population from which children with ADHD are derived and how they are different from (and similar to) children with other disorders. For example, ADHD can be identified in children with intellectual deficiency, learning disabilities, and behavior problems. The hypothetical classification should specify the breadth of the classifications and how ADHD is

related to those other presumed disorders. Those disorders could be conceptualized as nonoverlapping, but it is likely that substantial co-morbidity exists, or that current classifications are unnaturally partitioning these groups of children along arbitrary lines. Hence, a hypothetical classification should clearly specify relationships among related disorders. Further applicable subdivisions of the ADHD group should also be specified. By positioning these hypotheses in advance, decisions concerning the sample and measurement of attributes can be made. Simply searching for types of children, without explicit hypotheses, will yield groups that may not generalize to other studies, or be useful for communication or prediction.

A hypothetical classification can take several forms, but generally it represents a set of groups presenting a configuration of attributes, or *ideal types*. Skinner (1981) defined an ideal type as "a hypothetical pattern of attributes . . . that is characteristic of a subject or individuals in the population. Ideal types are mental constructs that may be used to summarize observed characteristics among relatively homogeneous groups of individuals" (p. 72). A hypothetical classification can be conceptualized as a set of classes represented by ideal members. Those classes may be hierarchically related and there may be overlap on any single variable. Moreover, no single class member may have the set of ideal characteristics. For ADHD, polythetic classifications based on hierarchical relationships among ideal types may represent a useful approach to the development of hypothetical classifications.

Sampling Issues. It is certainly possible to generate classifications that do not reflect the dimensional characteristics of the populations of interest. These are unnatural, arbitrary segments of the population. This consideration is especially pertinent for ADHD because many of the syndromes of interest occur co-morbidly. Consequently, the development of an adequate sampling strategy is a fundamental component of any classification study (Morris & Fletcher, 1988). If sampling is not carefully considered, the results will be data-driven and not generalizable or replicable. The sampling strategy does not have to be completely randomized, provided criteria for including and excluding subjects are clearly delineated and do not create groups based on referral bias. With careful delineation of the inclusion and exclusion criteria, practical sampling strategies can be developed.

The inclusion criteria represent a set of classification attributes (independent variables). When a classification is not based on a completely random sample, the criteria used to select subjects should be studied to determine their validity as part of the classification. Exclusion criteria should also be studied to explore the limits of the classification. To illustrate, reading disorders in children are commonly defined in terms of discrepancies between IQ and achievement in the absence of an overt neurological disorder, low socioeconomic status, or emotional problems (Fletcher & Morris, 1986). However, the validity and usefulness of this definition can be questioned if a group with "specific" reading disorders does not differ from children with (a) reading problems and low IQ, (b) other learning problems, (c) lower IQ scores, (d) normal reading, (e) culturally disadvantaged backgrounds and poor reading, or (f) poor reading coupled with neurological and emotional disorders. Inclusion and exclusion criteria represent the heart of classification research, which is why sampling considerations are so critical. Careful study of the criteria used to select and identify subjects permits classifications to evolve and change when needed. Simply dumping data into a computer is not adequate for addressing these types of issues.

Selection of Variables. In classification research, some variables are used to define the groups and others are used to validate the group definitions against external criteria. Classification attributes are marker variables used to define the types of interest. Since all possible variables cannot be used, classification attributes should be selected to maximize hypothesized differences among the groups forming the classification, while external validation variables should be relevant dimensions expected to provide group discrimination. The basis for variable selection should derive from theory concerning the nature of the relevant types as well as pertinent dimensions of group discrimination.

In addition to traditional psychometric considerations, external variables should be selected to test hypotheses about the differentiation of types on the classification. These variables should be theoretically related to the types, but generally from a different measurement domain. Using highly intercorrelated variables from the same measurement domain as the classification attributes is likely to produce expected group differences, but will only provide a crude approximation of external validity. For example, demonstrating differences among children with ADHD on rating scales that are similar to the original classification variates is not particularly meaningful. However, generating a priori hypotheses about differences on evoked potential measures not used to form the classification *would* be meaningful. Variations in treatment outcome predicted by the classification would also prove good external validation (e.g., Lyon, Moats, & Flynn, 1988). More generally, external variables should be selected on the basis of theory in a manner generating falsifiable predictions concerning various dimensions of validity (Fletcher, 1985), and in the best case will be directly related to the stated purpose for developing the classification system (e.g., treatment facilitation).

CONCLUSIONS

The classification of children with ADHD is intrinsically related to classification efforts for children with other presumed learning and behavioral disorders. Such classifications are important because they permit development of operationalized definitions of these overlapping childhood conditions. When research is conducted as a traditional comparison of groups, the results reflect what is hypothesized to be different among groups, as well as how groups are formed. In a sense, all contrasting group comparisons are examples of external validity because of the implicit validation of the set of independent variables used to form groups (Morris & Fletcher, 1988). Research on children with ADHD

is hampered by continued disagreement and lack of precision on how to define the disorder and how ADHD is related to other childhood disorders. This controversy ranges from those who find no evidence for ADHD to those who find ADHD in every child they see.

These questions are a problem in classification. For those who believe that classification of ADHD is irrelevant, firmly established, or impossible, we can only suggest that methods and procedures for systematic evaluations of various classifications do exist and can be applied to children with attention-related disorders. Our goal is not so much to develop a nosology but simply to operationalize definitions of the disorders in a way that facilitates communication and prediction. These definitions may not be universally agreed upon, but they can be evaluated and studied for various purposes. In this manner, classifications can evolve and improve as new understandings are developed.

If research on childhood neurobehavioral disorders were better conceptualized from a classification perspective, our understanding of these children would be enhanced. At this point, any research on children with ADHD is a classification study because of the lack of precision of consensually accepted definitions of these disorders. There is a pressing need to make classification issues explicit in ADHD research, so that practitioners and researchers can at least know what type of child is the subject of treatment and research. With such a focus, the call of the Interagency Committee on Learning Disabilities (1987) for research on classification and definition of the overlapping disorders can be explicitly addressed.

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