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Neuropsychological testing of adults: further considerations for neurologists

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Abstract

The recent report on neuropsychological testing of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology (AAN) has implications for neuropsychologists as well as neurologists. The subcommittee's report omits mention of standardized neuropsychological test batteries used by a majority of practicing neuropsychologists, and of the demonstrated validity of such measures for localization and lateralization of brain impairments, in apparent ignorance of the empirical research literature on which such neuropsychological examination is based. This paper elaborates the research-based context of neuropsychological assessment in an attempt to clarify possible false conclusions concerning neuropsychological assessment that could result from noncritical reading of the subcommittee report. © 2001 National Academy of Neuropsychology. Published by Elsevier Science Ltd.

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In recent years, the American Academy of Neurology (AAN) has published a number of technical subcommittee reports dealing with assessment in such practice areas as EEG brain mapping (1989), thermography (1990), and positron emission tomography (1991), as well as performance/interpretation guidelines involving computerized tomography (1994a) and magnetic resonance imaging (1994b). The recent *Neurology* (AAN, 1996) report of the Therapeutic and Technology Assessment Subcommittee of the AAN follows the format of the prior reports of assessment issues relevant to neurologists, and addresses its focus on neuropsychological testing of adults. A prominent and very important difference between the neuropsychology report and those covering EEG, thermography, positron emission tomography and magnetic resonance imaging involves the fact that, while the previous reports deal with topics within the realm of education and training of neurologists, neuropsychology represents a totally different cognate area. The goal of the task force is laudable and their report makes a number of points that are well and properly heeded by both

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neurologists and neuropsychologists. Unfortunately, there is sufficient admixture of facts, beliefs, and biases (without differentiation into which category a given conclusion or statement best fits) as to require a review of the paper to accomplish such differentiation. Specifically, there is need to segregate and identify what those conclusions supported by both clinical consensus and empirical research, those supported by clinical practice with selective but not conclusive empirical research support, and those based on one's perspective or theoretical persuasion. Such clarification is of more than academic, heuristic, or philosophic implication, since certain aspects of professional neuropsychology may be defined, for better or worse, by what is concluded concerning it by such a technical report, if no formal clarification, rebuttal, or refutation is provided. Absence of response showing flaws in the AAN report may be interpreted as evidence that no such flaws exist.

Although it is tempting to address, in order, each of the issues addressed by the AAN report, with exposition as needed concerning each specific problem, such an approach is limited by its being restricted to adherence to the content, format, and sequence of a report prepared by individuals other than representatives of neuropsychology. Rather, it may be more productive to prepare for presentation to our colleagues in neurology a paper describing the basis of sound neuropsychological practice covering the areas addressed in the subcommittee report, which can be used to enhance, expand or support neurological activities in both clinical and research contexts. Since the focus of the AAN report was limited to neuropsychological testing of adults, attention will not be directed toward other facets of clinical neuropsychology, such as treatment and rehabilitation, or work involving children and adolescents. Focus will be on the context of adult neuropsychological examination, with emphasis on issues raised by the AAN report.

1. Context and evolution of adult neuropsychological testing

Individual assessment of mental abilities has a recorded history of more than 2500 years in Europe (Doyle, 1974) and 2000 years in China (Bowman, 1989), and factors potentially influencing performance such as social class, memory, and geographical representation have been recognized since the beginning of such assessment (Matarazzo, 1972). Most progress in test refinement based on statistical concepts such as normalization, factor analysis, validity, and reliability has been manifest during the present century, and this progress has fairly consistently taken into progressive account such issues as various types of validity and reliability and the psychometric structure and interrelationships among tests (e.g., Cohen, Montague, Nathanson, & Swerdlik, 1988; DuBois, 1970; Matarazzo, 1990). The use of psychological testing in neurologic diagnosis initially tended to focus on detection of deficits that were not readily observable on mental status interviews (perhaps to some extent reflecting the practice at that time of certification of neurology and psychiatry as a single neuropsychiatry specialty), with principal interest in such measures as constructional praxis and mental operations without obvious verbal cues (e.g., Ackerly & Benton, 1947; Bender, 1938; Benton, 1962). Interest in differentiation of psychiatric and neurologically based problems among returning World War II veterans lent added impetus to development of sophisticated neuropsychological procedures and Halstead (1947) developed an approach to

the standardized collection of a variety of psychological measures with potential for relating brain dysfunction to measurable test data (Egel & Hughes, 1989). The approach promulgated by Halstead, Merryman, and Klein (1963) was further developed, modified, refined, and validated by Reitan and his associates, as the Halstead–Reitan Neuropsychological Battery. In a series of studies, Reitan studied aphasia (1953), differential effects of lateralized cerebral lesions (1955), comparative effects of brain damage on the Impairment Index and intelligence (1959), psychological deficits resulting from cerebral lesions (1964), psychological deficits in relation to acuteness of brain dysfunction (Fitzhugh, Fitzhugh, & Reitan, 1961, 1962, 1963), and concept attainment with lateralized cerebral lesions (Doehring & Reitan, 1962). By the early 1960s, attention had been addressed to the application of discriminant functions to prediction of brain damage using behavioral variables (Wheeler, Burke, & Reitan, 1963). These studies, and an impressive number of others reported during this same period, had demonstrated convincing evidence of the validity of the battery for the detection of brain damage resultant from a variety of causes. More than two decades ago, Reitan (1964) had addressed the sorts of methodical issues and conceptual concerns raised by the AAN Task Force. In this same period, the first university course in neuropsychology was offered, and a number of medical centers began offering postdoctoral training programs in clinical neuropsychology. Many psychologists began attending workshops in neuropsychology, and incorporating neuropsychological concepts and procedures into their practice (Parsons, 1970).

In the context of this widespread proliferation of individuals interested in neuropsychology, a new diagnostic battery patterned after Luria's concepts of neurological organization and assessment was introduced (Golden, 1979; Golden, Hammeke, & Purisch, 1978, 1980; Hammeke, Golden, & Purisch, 1978; Lewis et al., 1979; McKay & Golden, 1979; Moses & Golden, 1979) with diagnostic hit rates as high as 87% (Golden, Moses, Graber, & Berg, 1981) and 80% with mild impairment (Malloy & Webster, 1981), this battery gained a degree of acceptance, especially among newcomers to neuropsychology. Reasons for this acceptance include the fact that it took considerably less time to administer, required less neuropsychological experience and sophistication to interpret, and was considerably more portable than the Halstead–Reitan Neuropsychological Battery. Indeed, early studies suggested that the Luria–Nebraska Neuropsychological Battery (LNNB) was comparable with the Halstead–Reitan Neuropsychological Battery (e.g., Berg, Bolter, Ch'ien, Williams, Lancaser, & Cummins, 1984), with hit rates by both batteries over 85% (Golden, Kane, et al., 1981).

Of considerable relevance to the issues addressed in the AAN Task Force report, validity and reliability of the batteries were well established and empirically demonstrated, with classificatory accuracy at or above 80%, even in mixed psychiatric and brain-damaged populations (Kane, Sweet, Golden, Parsons, & Moses, 1981). It should be noted that the LNNB was greeted with some skepticism (Snow & Hynd, 1984; Spiers, 1981) and even derision (e.g., Adams, 1980, 1984), although cogent rebuttals have been offered (e.g., Hutchinson, 1984; Reynolds, 1984).

By the early 1980s, a series of surveys of practicing neuropsychologists had revealed a fairly stable pattern of test usage, with slightly more than a third of practicing neuropsychologists using the Halstead–Reitan Neuropsychological Battery, approximately a third using the LNNB, and the remainder using some admixture of various psychological tests

(Hartlage, 1985; Hartlage, Chelune, & Tucker, 1981; Hartlage & DeFilippis, 1983; Hartlage & Telzrow, 1980). Later surveys essentially confirmed previous findings (e.g., Seretny, Dean, Gray, & Hartlage, 1986). The divergence from use of a standardized neuropsychological battery with demonstrated validity and reliability with brain-injured populations may have evolved from Benton's (1972, 1975) promulgation of the desirability of a neurodiagnostic approach that would include tests of general intelligence, reasoning, problem solving, memory, orientation, perceptual and perceptuomotor performance, language functions, speech, flexibility of responses, attention, and concentration. This array of domains has, to varying extent, served as a general framework for the sorts of tests chosen for neuropsychological assessment by those practitioners who do not use a standardized battery such as the Halstead–Reitan or Luria–Nebraska. Neuropsychologists who use a battery, depending upon the question to be resolved for a given patient, may well add additional tests for that purpose. The AAN subcommittee lists a table of "tests commonly used" that includes some of the domains mentioned by Benton, but completely ignores both the Halstead–Reitan and LNNB. Thus the questions raised by the task force concerning validity appear to involve only the tests listed in their table and text. However, since validity is an important and relevant issue, it deserves attention.

2. Validity issues

Although there are a number of procedures for determining validity often corresponding to the type of validity being studied, for most neurologic diagnostic questions the primary question at issue typically involves some parameter of defective vs. intact brain function. Thus one practical approach to assessing diagnostic validity is study of whether a neuropsychological battery can differentiate individuals with brain injury from individuals with intact brain function, with hit rate a commonly used criterion for such validity. Ideally, as has been observed by Reitan and Wolfson (1993), each test in a neuropsychological battery should be carefully validated for its sensitivity to cerebral damage, and each test should show differentiation between groups of persons with known cerebral damage as compared with individuals with no past or present evidence of brain disease or damage. The approach most likely to adhere to this ideal involves a standardized neuropsychological battery, of which the Halstead–Reitan Battery has been the most researched (Dean, 1985). As an example, Reitan's early validation of the HRB showed differentiation between brain-injured and control groups at the .000000000001 level (Reitan, 1955; Reitan & Wolfson, 1993). Although not at a level of this statistical magnitude, subsequent research by Rietan and his coworkers demonstrated diagnostic validity more than three decades ago for lateralization of cerebral defects beginning with his 1955 paper with Wechsler data, and with other measures (Doehring, Reitan, & Klove, 1961; Heimburger & Reitan, 1961; Klove & Reitan, 1958; Wheeler et al., 1963; Wheeler & Reitan, 1962). In the last listed study, correct identification of lateralized dysfunction vs. controls was 91% for left hemisphere damage, 93% for right hemisphere damage, and 99% for diffuse damage. Classification accuracy at almost this same rate has also been demonstrated by Reitan (1964) for both location and type of cerebral damage. It is of interest that the task force referenced only two papers published before the 1980s. By no

means has all validation research been limited to the 1950s and 1960s or to the work by Reitan and his colleagues. Validation work with the LNNB has documented its efficacy in correct classification of brain-damaged vs. neurologically intact controls, as well as for lateralization and localization (e.g., Golden, 1979; Golden et al., 1978; Golden, Moses, Fishburne, et al., 1981; Golden, Moses, Graber, et al., 1981; Hammeke et al., 1978; Lewis et al., 1979; McKay & Golden, 1979; Moses & Golden, 1979; Sears & Hirt, 1984). Similarly, considerable research has addressed validity issues involving individual scales of the Luria–Nebraska (e.g., Golden & Berg, 1980; Golden, Hammeke, et al., 1981; Golden, Osmon, et al., 1980; Golden, Purisch, et al., 1980; Golden, Sweet, et al., 1980). Differentiation between psychiatric and brain-damaged patients has been demonstrated for both the Halstead–Reitan and Luria–Nebraska Batteries (e.g., Golden, Graber, Moses, & Zatz, 1980; Kane et al., 1981; Moses & Golden, 1980; Purisch, Golden, & Hammeke, 1978) suggesting that both neurological classificatory accuracy and neurologic–psychiatric discriminability, as well as lateralization and localization, may reasonably be expected with either of the batteries.

The AAN statements that "no neuropsychological tests have been shown to have consistent diagnostic validity" and "have little capacity for distinguishing among different causes of performance impairment" (p. 593) suggests an unawareness of this empirical database. Rather, the task force appears to have limited its review of neuropsychological testing in adults to include only the tests in this tabular listing (p. 597), no source for which is identified. It should be noted that the list of tests commonly used to assess the major domains of neuropsychological functioning makes absolutely no mention of any sensory measures, and lists the New Adult Reading Test (along with WAIS-R and WISC) as a test of intelligence. It is unlikely that the WISC is used to assess adult neuropsychological functioning by any qualified neuropsychologist. The New Adult Reading Test is similarly not used as an intelligence test; rather (along with the WRAT, which is listed under educational achievement) it has been occasionally used as an estimate of premorbid intellectual level (Johnstone, Callahan, Kapilla, & Bouman, 1996). Further review of the "tests commonly used" (p. 597) reveals that a majority (11 of 21) is not even mentioned in a summary of 13 test instruments most commonly used by neuropsychology practitioners in a national survey (Guilmette, Faust, Hart, & Arkes, 1990), two are subtests of the WAIS-R and three are portions of the Halstead–Reitan Battery. This raises possibility that the AAN paper may be based, to considerable extent, on practices and tests that do not represent the procedures or standards used by the majority of practicing neuropsychologists, and thus cannot reach conclusions that have applicability to the way the profession is practiced. Further support to this possibility comes from the findings of the Guilmette et al. (1990) survey, which noted that the majority of neuropsychology practitioners who attended workshops listed either Halstead–Reitan or Luria–Nebraska workshops, yet neither of these batteries is listed as "tests commonly used" nor discussed in the text beyond a dismissive mention of the Halstead–Reitan Battery that concluded "Differential diagnosis of neurologic disorders or precise delineation of the underlying neuronal system affected was not intended" (p. 592). Again, search for possible sources of the AAN list of tests cited reveals reference to a statement "Most current neuropsychological assessment approaches use several of the traditional tests in combination with newer techniques developed specifically to evaluate neurocognitive activities and provide insight into brain function in different disease states"

(p. 592), citing as support for this statement a single reference to a paper dealing with subcortical dysfunction (Massman, Delis, Cuttees, et al., 1992).

Addressing validity from another perspective, the subcommittee states that "there has been inadequate exploration of the ecological validity of neuropsychological test results" (p. 593), mentioning a study relating clock-drawing to wandering behavior in patients with Alzheimer's disease (Henderson, Mack, & Williams, 1989) as an example of the few studies that have addressed this type of validity. Given the wealth of data typically contained in a comprehensive neuropsychological evaluation, it does not seem necessary to depend on measures such as clock drawing to relate patient status to activities in the real world. Neuropsychologists have devoted considerable attention to this issue. Williams (1988), for example, has traced the relationship of ecological validity and everyday cognition to three sources, including the study of practical intelligence, in cognitive psychology (Neisser, 1982a), everyday cognition in gerontology (West, 1986), and the prediction of everyday function in neuropsychological rehabilitation settings (Chelune & Moehle, 1986). Ecological validity in memory assessment was well discussed in a 1978 conference on "Practical Aspects of Memory" (Neisser, 1982b) and ecological validity of memory testing and the assessment of everyday memory with neuropsychological tests has been well reviewed and integrated in work by Larrabee and Crook (1986). Fairly comprehensive compilations of research involving ecological validity of neuropsychological tests have appeared in edited books (e.g., Hartlage, Asken, & Hornsby, 1987; Sbordone & Long, 1996; Williams & Long, 1988) with individual chapters addressing specific aspects of the relationship of neuropsychological test data to ecological validity criterion measures such as everyday activities (e.g., Acker, 1990; Hale, 1986; Heaton & Pendleton, 1981; Kerns & Mateer, 1996; McSweeney, Grant, Heaton, Prigitano, & Adams, 1985; Shallice, 1982; Williams, 1996). Acker, for example, studied correlations between various neuropsychological or psychological tests and rating of functions in everyday activities, and found that up to 85% of variance in outcome could be accounted for using a multivariate approach.

Since the relationship of neuropsychological tests and an ecological validity criterion measure has been well covered in the research literature and well synthesized in a number of individual book chapters, readers of the AAN report who feel a need for verification of the ecological validity of neuropsychological tests are referred to the most recent (Sbordone & Long, 1996) book covering the topic.

A puzzling statement "Detailed testing tends to over identify cognitive impairments ... and neuropsychological testing will often provide an exaggerated estimate of the possibility of brain dysfunction" (p. 596) suggests an unawareness of the issue of supersedence of test data over criterion measures. The fact that comprehensive neuropsychological testing reveals functional deficits not evidenced on neurologic or neuroradiologic examination may reasonably be interpreted as reflecting greater sensitivity to such impairments by neuropsychological test data (Hartlage, 1990, 1991; Tsushima & Popper, 1980; Tsushima & Wedding, 1979; Varney & Varney, 1995). The implications of this statement are obvious in suggesting that absence of criterion sensitivity should be viewed as evidence of lack of impairment. It is interesting that a practice maxim "Absence of evidence is not evidence of absence" appears to be directly contradicted by this AAN statement.

A final comment concerning AAN statements involves reporting practices.

3. Report format and content

The AAN recommendation that neuropsychological reports should contain the percentile of performance corrected for age and education and enduring brevity in reporting, can, if implemented, result in a number of ethical, conceptual, and interpretive problems. Since the neuropsychological report typically becomes part of a record accessible to the patient (or patient's family or attorneys either representing or inimical to the patient), promulgation of such data without elaboration, explanation, and interpretation may violate ethical guidelines. Most nonpsychologists do not recognize the implications of central tendency of percentile scores on external criterion measures. Even with very well normed and standardized percentile measures such as with Wechsler IQ tests, a range of 50 percentiles (25th to 75th) may represent a single (normal) classification, while a range of 5 percentiles at the left side of a distribution ranges from borderline through mild, moderate, severe, and profound mental retardation. Thus while a range of 5 percentile points from 45th to 50th percentile has no compelling implications for an individual's life potential, range of 5 percentiles from 0 to 5 may mean the difference between need for continuous lifelong care vs. potential for vocational self-sufficiency. Their requirement for corrections for age and education ignores compelling evidence (e.g., Reitan & Wolfson, 1995, 1996) that brain damage affects WAIS subtest scores more than age and education. Compatible findings involving differential effects due to brain damage vs. IQ have also been noted for the Wechsler Memory Scale (Sherer, Nixon, Anderson, & Adams, 1992). Thus adjusting or transforming scores for attribute variables for brain-damaged patients may produce erroneous data. Further, data reporting percentile scores need to identify the normative base on which such percentile scores are based, since some percentile rankings are done with controls; some with only brain-damaged patients; and some with an admixture of brain-damaged patients and controls. In the instance of a nationally standardized test, for example, which includes a sample of individuals with no known brain damage, percentile ranks cannot reasonably be used as comparable base rate data with a brain-damaged sample. Worse, mixing percentiles in a report, with some percentiles (e.g., purely neuropsychological test data) based on brain-injured populations and other percentiles (e.g., IQ, achievement) based on a non-brain-injured sample can be grossly misleading, confounding, confusing, and lending to misinterpretation. Even though some neurologists may have considerable sophistication in understanding and interpreting differential diagnostic implications of percentiles, use of such descriptive statistics can be meaningful only when the population described by the statistics is identified, and effective comparison across percentiles may be dependent on commonality of populations. Thus, listing of percentiles would require either use of percentiles based on all non-brain-damaged individuals for patients with brain damage or development of populations of brain-damaged individuals that could be translated into percentile ranks for each score. This leads to problems involving lumping of mild, moderate, and severe, lateralized and diffuse, and chronic and acute into a single database, or else developing separate databases for populations with specific types, degrees, loci, severity, and chronicity of each disorder to be translated into discrete percentiles.

Another related recommendation by the subcommittee, involving reporting of quantitative data, reflects an issue that has been discussed by the neuropsychological community in terms

of ethical, professional, and patient privilege issues. Following an initial proposal that neuropsychological reports display all quantitative data (Freides, 1993), there was opposition based on grounds of ethical issues (American Psychological Association, 1996) and misinterpretation of data by unqualified persons (Naugle & McSweeny, 1995, 1996). Recent survey data revealed a sizeable majority of neuropsychologists opposing inclusion of quantitative data in reports, with 86% of respondents opposing such inclusion, mentioning misinterpretation as a concern (Kelland & Pieniadz, 1996).

Comment regarding effects of psychiatric disorders on neuropsychological testing is in order. Although the apocryphal AAN table listing "tests commonly used" does not mention the MMPI nor MMPI-II, repeated surveys of neuropsychological practice (e.g., Guilmette et al., 1990; Hartlage & DeFilippis, 1983; Hartlage & Telzrow, 1980; Seretny et al., 1986) reveal that such personality assessment is fairly routinely included as part of comprehensive neuropsychological examination. Many clinicians include some type of additional behavioral assessment scales (e.g., Gouvier, Uddo-Crane, & Brown, 1988; Hartlage, 1989; Hartlage & Williams, 1991; Oddy, Coughlan, Tyerman, & Jenkins, 1985; Oddy, Humphrey, & Utley, 1978). In addition, some type of clinical interview is also commonly included. Since the majority of neuropsychology practitioners have primary education and training as clinical psychologists (Guilmette et al., 1990), the AAN caveats concerning need to be aware of psychiatric disorders and make some attempt to recognize them likely requires no comment in rebuttal, although the fact that the issue was raised by the AAN suggests considerable unawareness of the sophistication of most neuropsychologists in this respect.

A number of minor issues in the report merit mention, although not extended discussion. Effects of education on neuropsychological performance are addressed (p. 593) by mentioning that cutoff scores on the Mini-Mental State Examination may vary depending on the individual's educational level. Since neuropsychological examination regularly and routinely provides mental function data much more sophisticated than is provided by this scale, it is not an instrument regularly used in such examination, although its mention in the report might suggest that it forms the basis of neuropsychological diagnosis. The comment (p. 592) that "The WAIS-R has no memory subtests and is necessarily insensitive to memory-related deficit" suggests unawareness of the use of scales like digit span or vocabulary to provide clues concerning short-term vs. long-term memory status.

4. Conclusion

Given that the report was prepared without broad, comprehensive, and sophisticated input from mainstream neuropsychology, it pulls together a number of issues of relevance and importance to neurologists in a praiseworthy attempt to supply practice guidelines. Unfortunately, lack of reference to the neuropsychology literature and atypical representation of the practice of neuropsychology combine to produce a number of well-intentioned errors and omissions. Hopefully, the presentation of commentary on these issues will help clarify potential problems and help pave the road to further progress in the alliance of neurology and neuropsychology in their complementary efforts toward better understanding of brain–behavior relationships.

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