

What Constitutes Neuropsychological Data, and How are These Data to Be Interpreted?

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Outline

- I. Introduction
 - A. History of the area
 - B. Current trends

- II. What Constitutes Neuropsychological Data?

- III. How Are Neuropsychological Data to Be Interpreted?

History: Ward Halstead

- Work began between the World Wars
- Observed people with brain injury in everyday settings
- Biological intelligence
- He devised a group of laboratory procedures measuring biological intelligence and brain injury
- Formulated a theory of brain functions--FA
- An overall index of brain dysfunction, HII
- Doctoral students, including Ralph Reitan

History: Ralph Reitan

- Work began at the end of World War II
- Refined Halstead's battery
- Included Wechsler-Bellevue, Perceptual Examination, dynamometer, children
- Especially important publication years:
 - 1955—Major validation study; W-B study
 - 1964—Large blinded brain damage study
 - 1969—Methods of inference
 - 1983—REHABIT
 - 1993—General Neuropsych Deficit Scale

History: Alexandr Luria

- Behavioral neurologist from Russia
- Great thinker and observer of human behavior
- Emphases on behavioral observation and on simple testing procedures
- Qualitative rather than quantitative in approach
- Higher Cortical Functions in Man (1966)

History: Summary

- Neuropsychological test selection tied to and validated by an external assessment of the condition of the brain
- Selection of tests based on external criteria
- Use of complimentary methods of inference
- Emphasis upon a formulated battery of tests
- Inclusion of an index of overall functioning
- Rigorous approach

Current Trends in Neuropsychology

- Neuropsychological test selection more tied to cognitive domains than to brain condition
- Sharply diminished emphasis upon a formulated battery
- Heavy emphasis upon level of performance
- Frequent inference of “impairment” without a clear basis
- Little emphasis on an overall index of functioning

Current Trend #1

Test Selection Tied to Cognitive “Domains” Rather Than Brain Condition

- A tremendously strong emphasis upon cognitive “domains” in the past 15 years
 - Has greatly impacted neuropsychology
 - Most reports are organized by domains
 - Research is often organized by domains
 - Which domain(s) test measure is determined by apparent content
- Empirical bases for these domains is limited

Perceived Cognitive “Domains” vs. Brain Condition in Test Selection

- The emphasis on determining brain condition and locating lesions has sharply diminished
 - Neurology can do it better (CT, MRI, etc.)
 - Neuropsychology can focus upon behavior, rehabilitation, theories of brain function, etc.
- Domain names are convenient handles to put on areas of function

Some Problems with Cognitive Domains

- Lack of agreement about which domains exist
- Lack of agreement about which tests measure what domain (Rabin et al., 2005)

--747 North American neuropsychologists

--Tests used: memory--273 tests;

attention--220 tests; executive

functioning--219 tests

Rabin et al., Archives of Clinical Neuropsychology 2005;20:33-46

Common Conceptual Grouping—HRB+

- **Executive functioning (Category, Trail Making)**
- **Verbal memory (WMS-I Logical Memory, AVLT)**
- **Visual memory (WMS-I Vis. Rep., TPT Mem. & Loc.)**
- **Attention (Stroop—high interference; Seashore Rhythm & Tonal Memory)**
- **Language (Aphasia Screening, VIQ, Stroop simple reading, FAS, Animal Naming)**
- **Visual-spatial (Aphasia Screening drawings, PIQ)**
- **Motor (TPT Time, Finger Tapping, dynamometer)**
- **Perceptual (Sensory Perceptual Examination)**

Median Correlations—60 Normals

Domain	Within domain	Across domains
Executive	.57	.39
Verbal memory	.38	.25
Visual memory	.31	.27
Attention	.35	.22
Language	.46	.30
Visual-spatial	.21	.28
Motor	.31	.21
Perceptual	.40	.21

Median Correlations—936 Neurological

Domain	Within domain	Across domains
Executive	.59	.47
Verbal memory	.58	.36
Visual memory	.52	.40
Attention	.36	.38
Language	.50	.38
Visual-spatial	.48	.42
Motor	.47	.34
Perceptual	.62	.34

Median Correlations—Summary

Group	Within domain	Across domains
Normal	.38	.25
Common variance	14%	6%
Neurological	.51	.38
% common variance	26%	14%

Principal Components, Verimax Rotation Based Upon 846 Patients with Epilepsy

Factors

1

WMS Visual

Category

TPT Mem.

TPT Loc.

VIQ

PIQ

2

Stroop reading

Perceptual errors

Tac. Form Recog.

Name writing

Trails A & B

Aphasia Screening

3

Tapping, total

Grip, total

Summary: Current Trend #1

Test Selection Tied to Cognitive “Domains” Rather Than Brain Condition

- Role of neuropsychology—changed
- Cognitive domains
 - Easily applied, help to organize the field
 - Often established without external anchors
 - Limited agreement as to what they are
 - Poor agreement on what tests measure them
 - Set the field on less than a secure footing
- A question raised: What does the “neuro-” part of “neuropsychology” now mean?

Current Trend #2

Sharply Diminished Emphasis Upon a Formally Developed Test Battery

- Much more emphasis upon individual tests and less on batteries
- Typically, the tests given are collections of procedures based upon mentor's influence, personal experience, and apparent content
- Patient complaints may influence selection
- Routinely, the tests have not been studied together or normed together

Sharply Diminished Emphasis Upon a Formally Developed Test Battery

- Typically, the test selection emphasizes cognitive functions such as memory, language, attention, and executive functions
- Motor functions are minimized, basic perception may not be tested at all
- Emphasis in test selection is experiential and conceptual rather than empirical
- No specific empirical requirements imposed upon the tests in order to be included

Common Result: “Flexible” Battery

- There is no need to be certain that every major area of brain functions be covered
- Insisting that each test meet certain basic empirical criteria such as sensitivity to brain functions is not necessary
- Insisting that complementary methods of inference be used has no real advantage
- Norming tests together isn't really necessary as the available norms are satisfactory
- Acquiring a standard set of data points across patients is not really necessary

Advantages--Formally Established Batteries

- Assurance that critical areas are covered
- Each test meets basic criteria to assure its neuropsychological relevance
- Insisting on complementary methods of inference insulates you from the weaknesses of the level of performance approach
- Knowledge of relative test validities and colinearities allows better interpretation
- A standard set of data points across patients and patient groups enhances breadth of knowledge and experience

Current Trend #3

Heavy Emphasis Upon Level of Performance in Evaluation of Test Data

- Level of performance
 - How well people do in comparison with a reference group
 - Most common method of interpreting test data (all clinical/counseling/other psychologists use it heavily)

Emphasis Upon Level of Performance

- Current tests sold (Psych. Corp., 2006)
 - 55 different neuropsych. tests for sale
 - 44 (80%) solely level of performance
 - 3 sign; 1 L-R; 4 sign + LP; 3 d.k.
- Current test usage (Rabin et al., 2005)
 - 25 top neuropsychological tests
 - 20 (80%) use only level of performance
 - 2 sign; 2 several methods; 1 other-MMPI
- Sets of norms—almost 100% level of performance (GNDS an exception)

Heavy Emphasis Upon Level of Performance in Evaluation of Test Data

- Level of performance data are easy to obtain
- Lend themselves to percentiles
 - Can be done for almost any measure
 - Are fraught with conceptual problems (e.g., degree of impairment)
 - Are fraught with statistical problems (inequality of intervals, number of impaired persons, etc.)

Bowman ML. The perfidy of percentiles. *Archives of Clinical Neuropsychology* 2002;17:295-303.

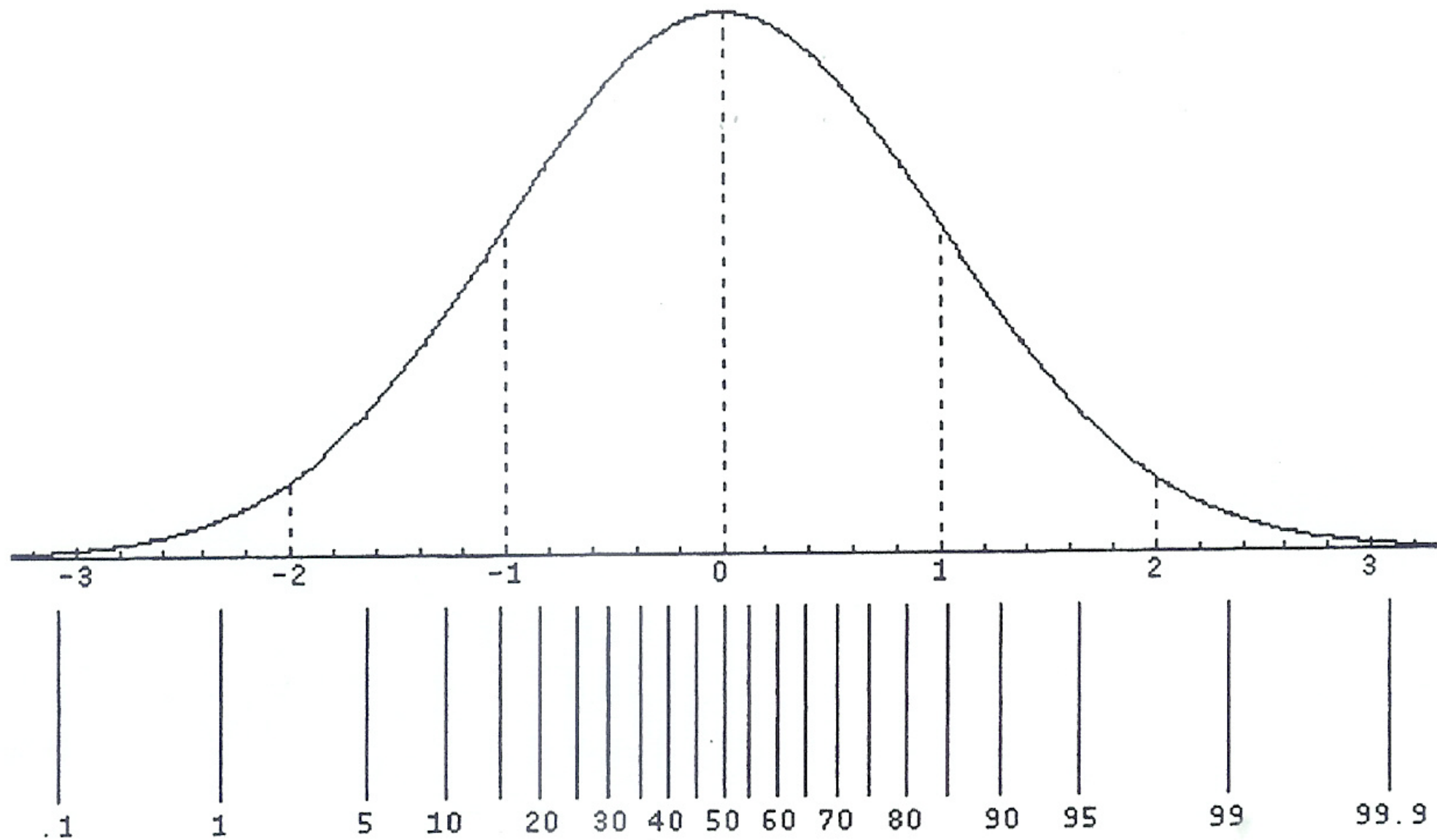


Fig. 2. The normal curve, with z scores as equal-sized intervals, percentiles as variably sized

Emphasis Upon Level of Performance: The Use of Percentiles

- Bowman's conclusion "Thus, it seems wise to avoid using percentiles in neuropsychological assessment reports, oral feedback, and in expert testimony."
- Alternatives
 - Use ordinary language based upon ranges of scores (e.g., Wechsler)
 - Use graphs with equal sized intervals
 - Use customary scores (including raw scores) for each test placed on a score sheet

Factors Often Contaminating Level of Performance Scores

- Psychological but non-cognitive
 - Emotional disturbance
 - Personal/interpersonal
 - Motivational
- Physical, nutritional
- Environmental
- Other

“Effort”--Example of Contaminating Factor

- Has received a great deal of attention recently
- Tests devised said to measure this construct
- Word Memory Test (Green et al., 1996)
 - Recent seizure impact (Drane et al., 2005)
 - 63 epilepsy patients with EEG monitoring
 - 75% of WMT failures: seizure(s) in last 24h
 - CPS: 8/16 with seizures failed; 0/16 no seiz.
 - Useful in epileptic vs. non-epileptic seizures (Drane et al., in press)

Notes Concerning the Word Memory Test as a Measure of “Effort”

- It is at least a measure of mental abilities
- Performances are reduced by recent seizures
- More failures after epilepsy surgery on left or speech-related side (Drane, personal commun.)
- Failures associated with LH seizures
- Failures associated with diminished education
- Failures associated with lowered performances on verbal tests generally

Frequencies of Methods of Inference Used in the General Neuropsychological Deficit Scale

- Level of performance: 19 variables (45%)
- Right-left: 9 variables (21%)
- Pathognomic sign: 12 variables (29%)
- Pattern: 2 variables (5%)

Reitan RM, Wolfson D. (1993) The H-R Neuropsychological Test Battery. Tucson: Neuropsychology Press.

Mean Scores: GNDS Level of Performance vs. LNDS/RNDS

Patient group	GNDS	LNDS	RNDS
Bilateral (n=53)	32.34	11.55	8.36
Left damage (n=55)	32.53	20.24	4.13
Right damage (n=61)	32.90	3.89	16.41

Reitan RM, Wolfson D. (1993) The H-R Neuropsychological Test Battery. Tucson: Neuropsychology Press.

Summary: Current Trend #3

Heavy Emphasis Upon Level of Performance in Evaluation of Test Data

- Level of performance
 - By far the most commonly used method of inference (about 80% of tests given)
 - Often used almost exclusively
 - Easily contaminated with non-cognitive factors
 - Misses lateralized lesions
 - Does not do justice to the complexity of brain functions

Current Trend #4

“Impairment” Frequently Concluded But with Unclear Basis

- A compromise in brain functions is commonly implied, but the basis for this is unclear
- “Impairment” commonly appears to be psychometrically based
- A lowered performance seems to equal impairment in a manner such as follows:
 - 2-5%-ile “Mild impairment”
 - 1-2%-ile “Moderate impairment”
 - <1%-ile “Severe impairment”

Critical Questions

- Does “impairment” imply that something is wrong? (Webster: To impair is “to make worse, damage, or injure”)
- Can we say that our test results indicate a compromise in brain functions if our tests have not been shown to be sensitive to the condition of the brain?
- If we do not have the tools to say that a compromise in brain functions has occurred, are we any longer truly neuropsychologists?

Additional Important Questions Beyond the Scope of the Talk

- If scores are lower on some tests, how do we know if these scores are indications of brain impairment or if they are normal variants?
Note: Most neuropsychologists are not trained in the neuropsychology of normals
- If some scores are lowered, does it mean anything from an ecological viewpoint?

Current Trend #5

Little Emphasis Upon an Overall Index of Functioning

- Previously valued, now used much less
- Used less significantly because it requires normative studies across tests
- Also, it does not give information about specific functions
- Is it useful clinically?
- Is it useful in research?

Overall Index: Clinically Useful?

- Provides an overall indication of the degree of concerns (if any) which may be present
- Especially useful in forensic settings as
 - It is the best single indicator of presence vs. absence of neurological difficulties
 - It helps to ballpark the damages
 - It is readily understood by attorneys, judges, and juries
- Gives a basis for analysis of individual tests

Overall Index: Useful in Research?

Some Dodrill et al. Studies

- Vocational
 - Employment status and level of employment
 - Predicting employment in adulthood
- Emotional/psychosocial adjustment in life including marital status and independent living
- Lifetime number of generalized TC seizures
- Neuropsychological effects of formaldehyde
- Studies of cognitive functions in the elderly
- Performance of neurological vs. normal cases

Conclusions

- Cognitive domains represent an approach to test selection which lacks rigor and definition
- Casually composed batteries of tests (tests not meeting empirical requirements and not studied together) lack in rigor and have major limitations
- Used alone, level of performance is an inadequate method of inference of brain status
- If “impairment” is to be inferred, the basis for this inference needs to be established
- An overall index of functioning is useful