Computerized Neuropsychological Assessment: The Good, the Bad, and the Ugly

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Disclosures

- None
Objectives

- Neuropsychological Evaluation
- Bases of Assessment
- “Traditional” Neuropsychological Assessment
  - Measures
  - Benefits/Strengths (the good)
  - Problems/Weakness (the bad and ugly)
- Computerized Cognitive Assessment
  - Measures
  - Benefits (The good)
  - Problems (The bad and ugly)
- Conclusions
- Future Directions

Neuropsychological Evaluation: Fundamentals

- Study of Brain-Behavior Relationships
  - Identifies presence (or absence) of neuropsychological Deficits
- Assumptions for Evaluation
  - Brain dysfunction affects behavior
  - Behavior changes can be associated with particular brain processes/areas/neurological syndromes
  - Assessment can be reliable
  - Assessment can be valid
  - Assessment affects diagnosis/treatment
Neuropsychological Evaluation: Traditional

- Assessment versus Evaluation
  - Assessment
    - Collection of historical data
    - Collection of cognitive data
    - Collection of mood data
  - Evaluation
    - Interpretation of data for diagnosis/treatment planning

Purpose of Assessment

- Screen for presence/absence of potential problem or change
  - Is performance above or below threshold to identify possible problem?
    - Common example is MMSE or Clock Drawing task
  - Screening data, in and of itself, typically not diagnostic nor used for treatment planning

- Diagnosis of problem (etiology) and plan treatment
  - Is data suggestive of known syndromes/diagnostic entities?
  - Interpretation of data for diagnosis/treatment planning
Neuropsychological Evaluation: Assessment Methods

- Historical information
  - Referral question(s)
  - Presenting problems
  - Historical information
    - Other laboratory tests
    - Comorbid conditions
    - Other historical data
- Clinical Interview
- Behavioral observations
  - Neurobehavioral tests/sensory/perceptual/cranial nerves/etc.
- Neuropsychological test administration
  - Paper and pencil based cognitive tests
  - Computer assisted tests
- Psychological test administration
- Assessment of effort/Task engagement

Assessment: The Basics

- Assessment measures must be:
  - Reliable
  - Valid
  - Efficient
  - Sensitive (and specific)
Assessment: The Basics

Reliability:
- Reliability typically refers to consistency in measuring a construct
  - A test is only as valid as it is reliable
- Reliability includes internal consistency, test-retest reliability, alternate forms, etc.
  - Internal consistent is how consistent items within a test are to measuring the construct
  - Test-retest reliability how consistent across time. Assumes construct does not change over time.

Validity
- Extent test measures what it intends to measure
  - Criterion Related validity
    - Predictive (criterion) Validity
      - High score predict behavior/deficit (dementia)
    - Concurrent validity
      - Does shorter test measure same construct as validated longer test?
  - Construct related validity
    - Convergent/discriminant validity
      - do scores differ between groups with syndromes/dx in which test scores should theoretically differ
  - Ecological validity
    - Extent test predicts a “real world” behavior or problem thought to be associated with construct (e.g., good driving)
Sources of Assessment Error

- **Measurement error**
  - Assessment a “picture in time”
    - Variation in CNS pathology
  - Test not perfectly valid
    - Some error in tests
  - Sampling error
    - Selection of tests and test items
  - Scoring/Administration errors
    - Intra-rater reliability
    - Inter-rater reliability
  - Patient variables
    - Task engagement/motivation to perform well
    - Educational/occupational/cultural/language/age factors

- **Test score = syndrome + measurement error + premorbid ability + drugs + effort + practice**

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### Diagnostic Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Test YES</th>
<th>Test NO</th>
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<tbody>
<tr>
<td>Disease: YES</td>
<td>(a) True +</td>
<td>(b) False –</td>
</tr>
<tr>
<td></td>
<td>SENS</td>
<td></td>
</tr>
<tr>
<td>Disease: NO</td>
<td>(c) False +</td>
<td>(d) True –</td>
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<tr>
<td></td>
<td>SPEC</td>
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<td></td>
<td>PPP</td>
<td>NPP</td>
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<td></td>
<td>Hit Rate</td>
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</table>

Sensitivity: $a/[a + b]$. It’s there, and you see it

Specificity: $d/[c + d]$. It’s not there, and you don’t see it

Positive Predictive Value: $a/[a+c]$. Your test says it’s there, and it is

Negative Predictive Value: $d/[b+d]$. Your test says it’s not there, and it’s not
Neuropsychological Evaluation

- Important shift in Neuropsychological Assessment
  - NOT can a cognitive test discriminate abnormal from healthy?
  - Rather, can cognitive test/battery discriminate subtypes of diseases or phases of single disease.
  - MMSE is highly sensitive, not specific
    - That is, if you score low on a test, suggestive something is wrong, but don’t know what.

- Diagnostic Characteristics dependent upon prevalence of disorder

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### Diagnostic Characteristics

N = 100. Prevalence rate = 11%

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<thead>
<tr>
<th></th>
<th>Test YES</th>
<th>Test NO</th>
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</thead>
<tbody>
<tr>
<td>Disease: YES</td>
<td>10 (a)</td>
<td>1 (b)</td>
</tr>
<tr>
<td>Disease: NO</td>
<td>14 (c)</td>
<td>75 (d)</td>
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<td>24</td>
<td>76</td>
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</table>

Sensitivity (SENS): $\frac{a}{a + b} = 91\%$

Specificity (SPEC): $\frac{d}{c + d} = 84\%$

Positive Predictive Value (PPV): $\frac{a}{a+c} = 42\%$

Negative Predictive Value (PPV): $\frac{d}{b+d} = 99\%$

Hit Rate (HR) = 85%
Diagnostic Characteristics

N = 100. Prevalence rate = 50%

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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Disease: YES</td>
<td>46 (a)</td>
<td>4 (b)</td>
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<td></td>
<td>8 (c)</td>
<td>42 (d)</td>
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<td>54</td>
<td>44</td>
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</table>

Sensitivity: $a/[a + b] = 92\%$
Specificity: $d/[c + d] = 84\%$

PPV: $a/[a+c] = 85\%$

NPV: $d/[b+d] = 95\%$

Hit Rate = 90\%

Variables that effect diagnostic test characteristics

- Prevalence rate affects PPV and NPV.
  - Screening for a syndrome better with higher prevalence rate
    - Positive Predictive Value (power) of test increases with higher prevalence
- Need to balance adverse affect of making false positive error versus a false negative error
  - Screening ideal when consequence of false positive is low while consequence of making a false negative error is bad
Brain Function Organization

- Output
- Organization
  - Verbal Skills
  - Non-verbal skills
- Learning and memory
- Attention and concentration
- Senses

Neuropsychological Evaluation: Diagnostic Assessment Measures

- Measurement of cognitive constructs
  - General Cognitive Ability (IQ)
  - Achievement (academic development)
  - Processing Speed/psychomotor speed
  - Attention/Concentration
  - Memory
  - Language
  - Visuoperceptual/Visuoconstructional
  - Executive functions (problem solving, insight, judgment, etc.)

- Psychological Function
# Traditional Neuropsychology Battery: Diagnosis

<table>
<thead>
<tr>
<th>DOMAINS</th>
<th>TESTS</th>
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<tbody>
<tr>
<td>General Cognitive (IQ)</td>
<td>Intelligence Test (e.g., Wechsler Adult Intelligence tests)</td>
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<td></td>
<td>Achievement Tests</td>
</tr>
<tr>
<td>Psychomotor Speed</td>
<td>Finger Tapping, Grooved Pegboard, Continuous Performance Tasks (reaction time)</td>
</tr>
<tr>
<td>Attention/Executive Function</td>
<td>Trail Making Test A &amp; B</td>
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<tr>
<td></td>
<td>Coding Tasks (e.g., symbol digit substitution)</td>
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<td></td>
<td>Letter-number sequencing (working memory)</td>
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<td></td>
<td>Stroop color-word tasks (inhibition/interference)</td>
</tr>
<tr>
<td></td>
<td>Wisconsin Card Sorting Test</td>
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<tr>
<td>Learning &amp; Memory</td>
<td>Wechsler Memory Scales</td>
</tr>
<tr>
<td>Immediate (short-term)</td>
<td>Auditory Verbal Learning Tasks</td>
</tr>
<tr>
<td>Delayed (long-term)</td>
<td>Rey-Osterreith Complex Figure memory</td>
</tr>
<tr>
<td>Language</td>
<td>Boston Diagnostic Aphasia Exam</td>
</tr>
<tr>
<td>Receptive, Expressive, &amp;</td>
<td>Verbal Fluency Tests (semantic and phonemic)</td>
</tr>
<tr>
<td>repetition</td>
<td>Token Test</td>
</tr>
<tr>
<td>Visuoperceptual/construction</td>
<td>Complex figure tasks, block design tasks</td>
</tr>
<tr>
<td>Mood</td>
<td>MMPI, Beck Depression Inventory</td>
</tr>
</tbody>
</table>

# Standard Neuropsychological Battery: The Good

- **Empirical support for use of Neuropsychological tests to identify brain dysfunction**
  - Test Measures are Reliable
    - Inter-rater reliability
    - Intra-rater reliability
    - Test – Retest (some better than others)
    - Internal reliability
  - Test Measures have validity
    - Criterion Validity - Associated with known brain damage
      - Poor validity for some known lesions (e.g., frontal)
      - Used for diagnosis of brain dysfunction
    - Construct validity - Associated with theories of cognitive function
    - Discriminant validity – Test scores differ between diagnostic groups test scores should differ (some better than others)
    - Predictive validity - Predictor of cognitive/surgical outcome
      - Epilepsy surgery (primarily for non-lesional)
      - Deep Brain Stimulator (DBS) surgery (?)
Standard Neuropsychological Battery: Strengths

- **Diagnostic value**
  - Good to discriminate Neurological disorder from normal (old news)
  - Required for dx of Mild Cognitive Impairment (MCI)
    - Memory impairment = <10th %ile of normal
  - Required for HIV-associated cognitive impairment
  - Good for Dementia
  - Fair to Good for effect of medications (AEDs) on cognition
  - Fair (even good) discriminating BETWEEN neurological disorders
    - Distinct (relatively) neuropsychological profiles can distinguish
      - Alzheimer’s dementia from Frontotemporal dementia vs. vascular dementia
      - Dementia from Pseudodementia
      - Parkinson’s dementia from Lewy Body Dementia

- **Ecological validity**
  - Independent predictor of cognitive outcome (and sz freedom) from temporal lobectomy for intractable epilepsy
  - Poor (p > 0.05) for criterion of self-reported cognitive problems
  - Fair to Good for criterion of ADLs (67%)
  - Poor to Fair for safe driving

Standard Neuropsychological Battery: The Bad

- **Benefit versus Cost?**
  - Time intensive
    - Typical Assessment period ranges from 2 - 8 hours
  - Special equipment/training needed
    - Professional/training component demand is high
    - Equipment must be secured/Testing areas needed.
  - Moderate expense
    - Typical Neuropsychological evaluation cost [2,000-3,000].
    - Typical charge for MRI [2,500 - 4,000]
    - Typical charge for ambulatory EEG [1,400 - 2,500]

- **Limited Accessibility**
  - Access to quality neuropsychological services limited
  - Because time intensive difficult to do many evaluations in short time
  - Patient time intensive.
  - Practice effects are present
    - Limited availability of alternate forms
  - Ecological validity limited
    - Poor for criterion of self-reported cognitive problems
    - Fair to poor for criterion of safe driving
### Neuropsych: Diagnostic Accuracy

<table>
<thead>
<tr>
<th></th>
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<th>PPV</th>
<th>NPV</th>
<th>Hit Rate</th>
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</thead>
<tbody>
<tr>
<td><strong>DAT versus Normal</strong></td>
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</tr>
<tr>
<td>MMSE</td>
<td>71-92 (82)</td>
<td>56-96 (98)</td>
<td>15-72^ (68)</td>
<td>64-99 (99)</td>
<td>(84)</td>
</tr>
<tr>
<td>Neuropsychologic</td>
<td>83-100 75!</td>
<td>84-100 74!</td>
<td>83-100 90!</td>
<td>73-100 50!</td>
<td>81 – 100 75!</td>
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<tr>
<td>Function Activity Q</td>
<td>90</td>
<td>90</td>
<td></td>
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<tr>
<td>MRI</td>
<td>80-82#</td>
<td>87#- 90</td>
<td>89—90#</td>
<td>77#- 82</td>
<td>85-92#</td>
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<tr>
<td><strong>DAT from Depressed</strong></td>
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<tr>
<td>MMSE</td>
<td>80</td>
<td>100</td>
<td>100</td>
<td>83</td>
<td>90</td>
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<tr>
<td>Neuropsychologic</td>
<td>83*</td>
<td>83*-100</td>
<td>86*-100</td>
<td>79*-90</td>
<td>83*-95</td>
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<tr>
<td>Pocket smell test</td>
<td>95</td>
<td>100</td>
<td>100</td>
<td>90</td>
<td>97.5</td>
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</table>

Note: ^10% prevalence of dementia; # 59% prevalence rate of pathologically confirmed AD (Gosche et al., 2002); *RAVLT only, 56% prevalence rate of dementia; ! = Neuropsych. testing predicting 6 year post-mortem pathologic diagnosis of DAT.

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<td>MMSE</td>
<td>64</td>
<td>98</td>
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<tr>
<td>Neuropsychologic</td>
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<td><strong>Computer Battery</strong></td>
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<tr>
<td>MRI</td>
<td>49-80</td>
<td>90</td>
<td>70</td>
<td>82</td>
<td>79</td>
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<tr>
<td><strong>HIV-Dementia vs. Normal</strong></td>
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<tr>
<td>HIV Dementia Scale</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td></td>
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<tr>
<td>Neuropsychologic</td>
<td>43-100</td>
<td>91</td>
<td>83-100</td>
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Note: *Prevalence of FTD = 16%, AD prevalence = 43%; Walker et al., 2005;
### Neuropsychological: Diagnostic Accuracy

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<tr>
<td>AD vs. Vasc. Dementia</td>
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<tr>
<td>MMSE</td>
<td>51</td>
<td>48</td>
<td>51</td>
<td>48</td>
<td>51</td>
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<tr>
<td>Neuropsych. Battery</td>
<td>75</td>
<td>93</td>
<td>-</td>
<td>-</td>
<td>89</td>
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<tr>
<td>FTD vs. AD vs. Normals*</td>
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<tr>
<td>MMSE</td>
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<td>69</td>
<td>93</td>
<td>64</td>
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<td>90</td>
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<tr>
<td>SPECT^</td>
<td>90</td>
<td>100</td>
<td>100</td>
<td>91</td>
<td>95</td>
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<tr>
<td>MRI volumetrics</td>
<td>49-80</td>
<td>-</td>
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Note: * FTD Prevalence = 16%, AD prevalence = 43%, Walker et al., 2005; ^ prevalence = 50%

### Neuropsychological: Diagnostic Accuracy

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<tr>
<td>Predict Sz. Free outcome from ATL</td>
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<tr>
<td>Left ATL</td>
<td>-</td>
<td>-</td>
<td>92</td>
<td>80</td>
</tr>
<tr>
<td>Right ATL</td>
<td>-</td>
<td>-</td>
<td>90</td>
<td>83</td>
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<tr>
<td>Adult ADHD</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Neuropsychologic</td>
<td>40-80</td>
<td>83-100</td>
<td>70-90</td>
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Note: *10% prevalence of dementia; Lovejoy et al., 1999
Objectives

- Neuropsychological Evaluation
- Bases of Assessment
- “Traditional” Neuropsychological Assessment
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  - Benefits/Strengths (the good)
  - Problems/Weakness (the bad and ugly)
- Computerized Cognitive Assessment
  - Measures
  - Benefits (The good)
  - Problems (The bad and ugly)
- Conclusions
- Future Directions

Computerized Cognitive Assessment: Why

- Increasing need for fast and efficient cognitive testing
  - 58% of PCP physicians reported MMSE was too time intensive (Tangalos et al., 1996)
  - MMSE ineffective at screening unselected cases
    - Positive Predictive power = 32% (1.7% prevalence rate)
- Neuropsychological testing time intensive
- Neuropsychological resources limited
- Neuropsychological assessment difficult to apply in varied environments
  - Expensive or impractical to have trained person in environment
- Development of computer assisted administered neuropsychological/cognitive tests
- Need re-training to maintain collection of good data
Computer Cognitive Measures: Historical Development

- Historical Tests
  - Adaptation of paper/pencil neuropsychological tests to computer
    - Wisconsin Card Sorting Test
  - Development of novel computer administered tests to measure unique cognitive functions
    - Reaction time/attention tests
    - N-Back tests for working memory/application to fMRI
- Novel automated Computerized assessment
  - Department of Defense (DoD) cognitive test applications

Computer Cognitive Measures: Whom

- Department of Defense
- Federal Aviation
- Private commercial enterprises
  - Dementia
  - Concussion/sports medicine
- Psychological Test Publishers
  - Adaptations of current tests
- Pharma/National Institute of Health
Computer Cognitive Measures:
What

- Current “stand alone” computerized cognitive batteries
  - Many (13) independent developers.
  - Some developers have multiple “models”

Automated Neuropsychological Assessment Metrics (ANAM)®
CNS Vital Signs ®
CANS-MCI
(Computer administered neuropsychological screen)

Cambridge Neuropsychological Test Automated Battery (CANTAB)®
CNT
CogSport®
Headminder ®

ImPACT ®
MicroCog®
NeuroTrax – Mindstreams®
Neurobehavioral Evaluation System – 3 (NES-3) ®
Specialty Automated Systems®

Computerized Cognitive Assessment: Benefits

- Easy to administer and score
- Relatively fast (.25-2 hours)
- Relatively inexpensive
- Readily available
- Applicable to many “real world” settings
  - Adaptation to PDAs or multi-function cell phones
  - Testing can occur in variety of environments
    - Battlefield, Schools, Churches, hospitals/clinics
- Can provide accurate assessment of cognitive functions
  - Information proc. speed, reaction time, working memory, etc.
- Administration procedure can be held constant
- Alternate versions can be easily developed
- Conclusion:
  - Particularly suited for screening instrument and/or monitoring change in cognitive function(s) over time
Computerized Assessment: Advantages and drawbacks

- **Drawbacks**
  - Reliability has been fair to poor. Much improved recently.
  - Validity is often questionable
  - Generalizability may be poor
  - High potential for abuse
    - Effect of False Positive on person/system
    - Effect of use without adequate training in neuropsychology and psychometrics
  - Few include measures of task engagement/motivation
  - With increasing sophistication comes increasing time
    - Time for some full batteries not inconsequential (1-2 hours)
  - Computer/software error
    - Losing data/Data corruption
    - Effects of different screens on reliability/validity

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<tr>
<td>MCI vs. Normals</td>
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<td>Computer battery</td>
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<td>Concussion</td>
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<td>Brief Neuropsych.</td>
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Neuropsychological: Diagnostic Accuracy

Warden et al., 2003

Computerized Assessment: Conclusions

- Reliability is poor to good
- Validity is poor to clinically adequate (80%)
  - Detailed (independent) studies limited to military applications
  - Independent testing is otherwise generally lacking
  - Studies limited to distinguishing abnormal from healthy
- Adaptable and flexible for rapid development
  - Easy to administer and scoring is automated
  - Relative short test batteries
  - Alternate test forms readily developed
  - Can be adaptable to person during testing
- Appears best suited for:
  - Screening large numbers of individuals
  - Best for discriminating normal from abnormal
    - NOT for differential diagnosis
  - Evaluation of change in populations with risk or in treatment groups
    - Military applications
    - Application to Phase III trials
      - Evaluate for change in cognitive function with intervention
    - Sports medicine/concussion management
Neuropsychology: Extinction or Growth?

- Automated cognitive tests reflect an extension of traditional neuropsychological tests
  - Application in screening situations should “trigger” an in-depth evaluation to assess for etiology for abnormal finding
    - Dementia screening
    - Concussion management
    - Cognitive impairment in neurological/psychiatric syndromes
    - Cognitive impairment after surgical procedures
    - Cognitive impairment in other medical conditions/therapeutics
      - Lupus, Chronic Fatigue syndrome, Hep C, Chemotherapy, HIV
  - Application in monitoring for change with treatment can document + and – of medical therapies on cognition
  - Use as baseline against which to compare changes following known or suspected brain injury

- Does not replace need for trained professional in neuropsychology!

To Screen asymptomatic persons or not? Cost versus Benefit

- Automated cognitive screening may identify subtle problems before appreciated. BUT-
- No empirical evidence to support routine screening for dementia in primary care settings for asymptomatic individuals (American Academy of Neurology, Canadian Task Force on Preventive Health Care, U.S. Preventive Services Task Force).
- Impact of False Positive errors in diagnosis not established
  - Case reports of suicide in early diagnosed patients with Alzheimer’s disease
Other Developments

- “Traditional” neuropsychological evaluations are
  - Getting shorter
  - New tests developed to better measure
    - Frontal lobe dysfunction
    - Non-verbal Memory
  - Combining neuropsychological measures with neurophysiological assessment (SAM).
  - Developing “screening” paper and pencil based neuropsychological batteries for specific populations
    - Alzheimer’s dementia (CERAD)
    - Multiple Sclerosis
    - Parkinson’s disease
    - Epilepsy (EpiTrax)
    - Schizophrenia (MATRICS)
    - HIV – dementia
    - Sports Concussion (SAC)
      - $22-27 per athlete versus $669-677 per athlete for computer

Neurophysiological Measures

- EEG and Event-Related Potentials (ERPs)
  - More sensitive to medications (and sleep deprivation) than neuropsychological measures
- Sustained Attention and Memory (SAM) test
  - Combined assessment of cognitive performance with EEG/ERPs
    - Computerized cognitive battery with working memory and episodic memory tasks.
    - Working memory assessed with spatial n-back tasks
      - Easy task, which is a 1-back test (compare spatial location of a stimulus to location of previous trial)
      - Harder task, a 2-back task.
    - Episodic memory task (24 word memory recognition task)
    - EEG recording during cognitive tasks
Neurophysiological Measures

- Measures (dependent variables)
  - Cognitive errors
  - EEG power in delta and theta ranges along with peak alpha
  - ERPs
    - Working Memory - parietal P300 peak
    - Word recognition – frontal slow wave
- Cost versus benefit?
  - Administration Time is ≤ 1 hour
  - Specialized equipment needed
  - Training and equipment relatively expensive
- Sensitivity and specificity excellent
  - Sensitivity 75 – 100%
- Ecological validity
  - ?

### Neuropsychological vs. Neurophysiological (ERPs)

<table>
<thead>
<tr>
<th>Measure</th>
<th>SENS</th>
<th>SPEC</th>
<th>ROC Area under curve</th>
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</table>

Meador et al., 2007
Drawbacks to Neurophysiologic and Neuropsychologic

- Neurophysiological assessment
  - Training and equipment costs higher than neuropsychological
  - Very high professional technical component
  - Administration time can be shorter than neuropsychological

- Increase in patient discomfort
  - Requires EEG placement on participant

Bottom Line

- Automated Cognitive Batteries here to stay
- Many options
- Little reliability and validity data to date
- Application possibilities is large
  - Screening purposes
  - Application to clinical trials (Phase III)
- Complements “traditional” neuropsychological measures
- Because dx of cognitive disorder is a medical dx, it has legal implications
  - Document methods for determing dx meticulously.
    - Other possibilities (neurological/medical) must be ruled-out
    - Should NOT be based on automated test alone
Bottom Line

- High potential for abuse, but some clear advantages
  - Enables rapid, efficient, and cost-effective screening for cognitive disorder
- Interpretation of results must be made by qualified physician or psychologist
  - Knowledge of psychometrics
    - Reliability and Validity of Measure. Sources of Error.
    - Knowledge of neurological/psychiatric syndromes
    - Cause of abnormal result may not be brain dysfunction
- Limitations of billing and practice implications
  - Doctors limited to use professional neuropsychological procedure codes
    - Most document time
  - Automated computer based neuropsychological testing procedure code available.
    - Must document time
    - Reimbursement lower than professional procedure codes

Questions
Diagnostic Value: Shifting Priorities

- Old priorities
  - Test needed to distinguish abnormal from healthy
    - Experimental designs compared individuals with known diagnosis to healthy individuals
  - Test need to be valid for criterion (brain injury)
    - Does test localize/lateralize brain dysfunction?

- New priorities
  - Test need to distinguish between abnormal syndromes (e.g., distinguish DAT from VaD from LBD)
  - Test need to have ecological validity
  - Test need to be efficient and cost effective
  - Need to affect patient outcome

Neuropsychological Evaluation: Diagnostic Evaluation

- Assessment for Purpose of diagnosis and plan treatment
  - Interpretation of data for diagnosis/treatment planning
  - Is data suggestive of known syndromes/diagnostic entities?
Neuropsychological Evaluation: The Evaluation

Methods of Evaluation
- Integration and interpretation of historical data, observations, and neuropsychological test scores based on the:
  - Association with known syndromes (diagnosis), and
  - Association with functional neuroanatomy, and from this:
    - Associate conclusions with interventions