The University of British Columbia

Misdiagnosis of Cognitive Deficits

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- Cognitive diminishment or impairment can result from a variety of medical, psychiatric, and/or neurological conditions.

- There are very few empirically-established psychometrically-based guidelines for what constitutes mild impairment in cognition.

- Failing to consider fundamental psychometric principles applied to interpreting multiple test scores can readily result in false positive or false negative diagnoses of cognitive impairment.

As Severity Increases, Accuracy Increases

Mild TBI

Depression

ADHD

Mild Cognitive Impairment / Prodromal Dementia

Moderate TBI

Severe TBI

Frank Dementia (e.g., moderate AD)

Images Removed

As severity decreases, the ability to accurately identify TRUE/REAL difficulties decreases

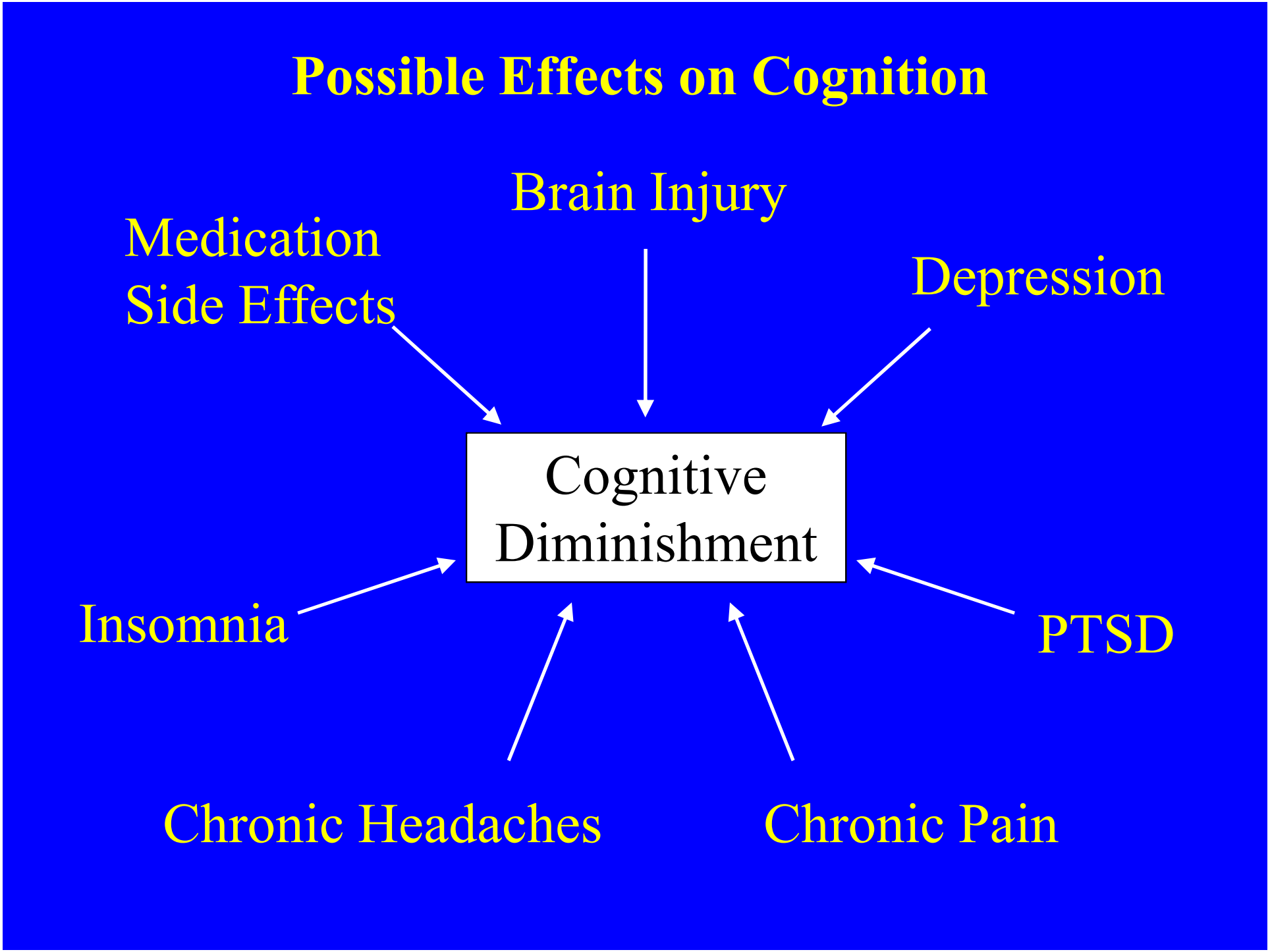
Why?

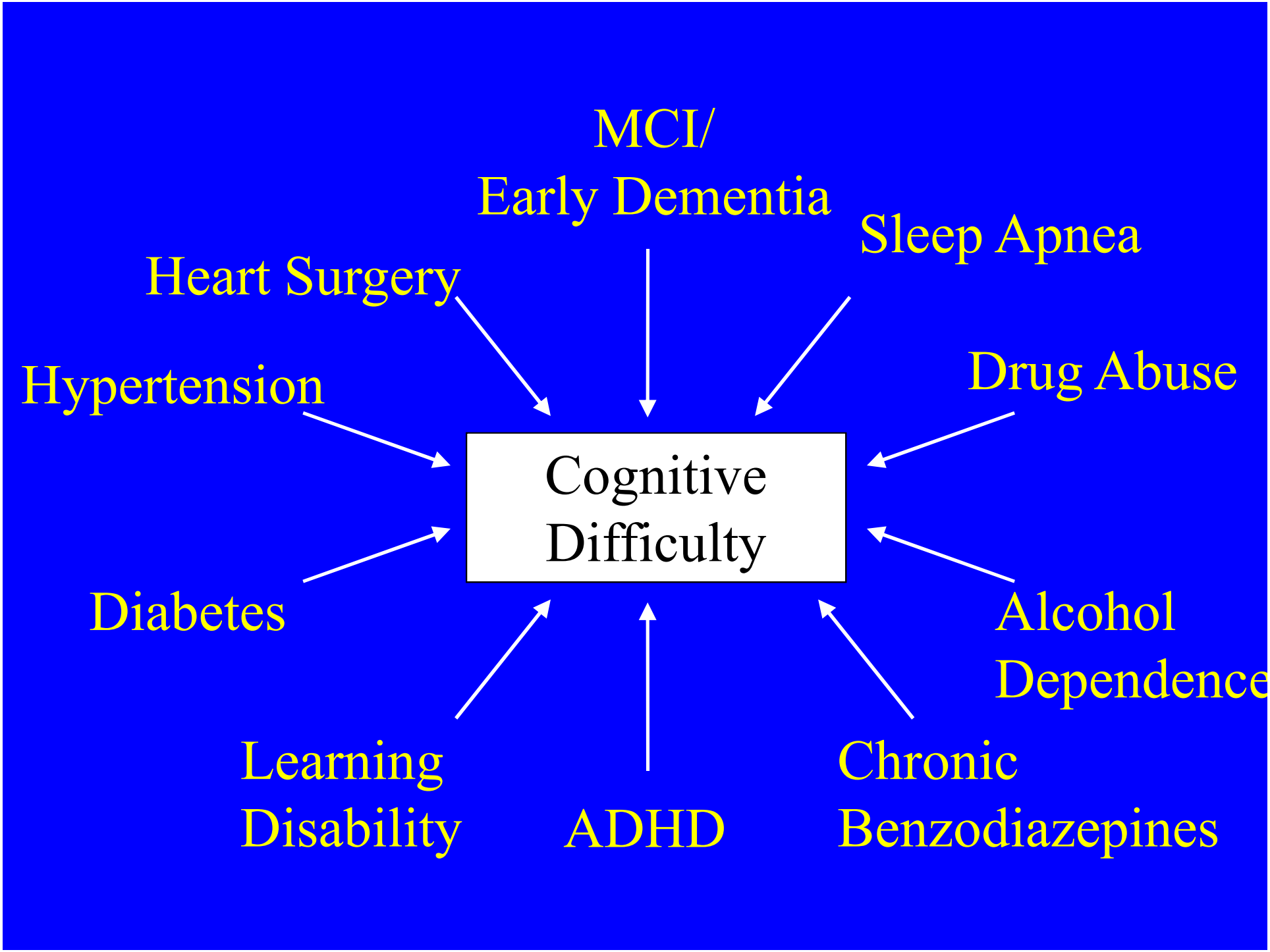
Signal-Noise Problem

Psychometrics

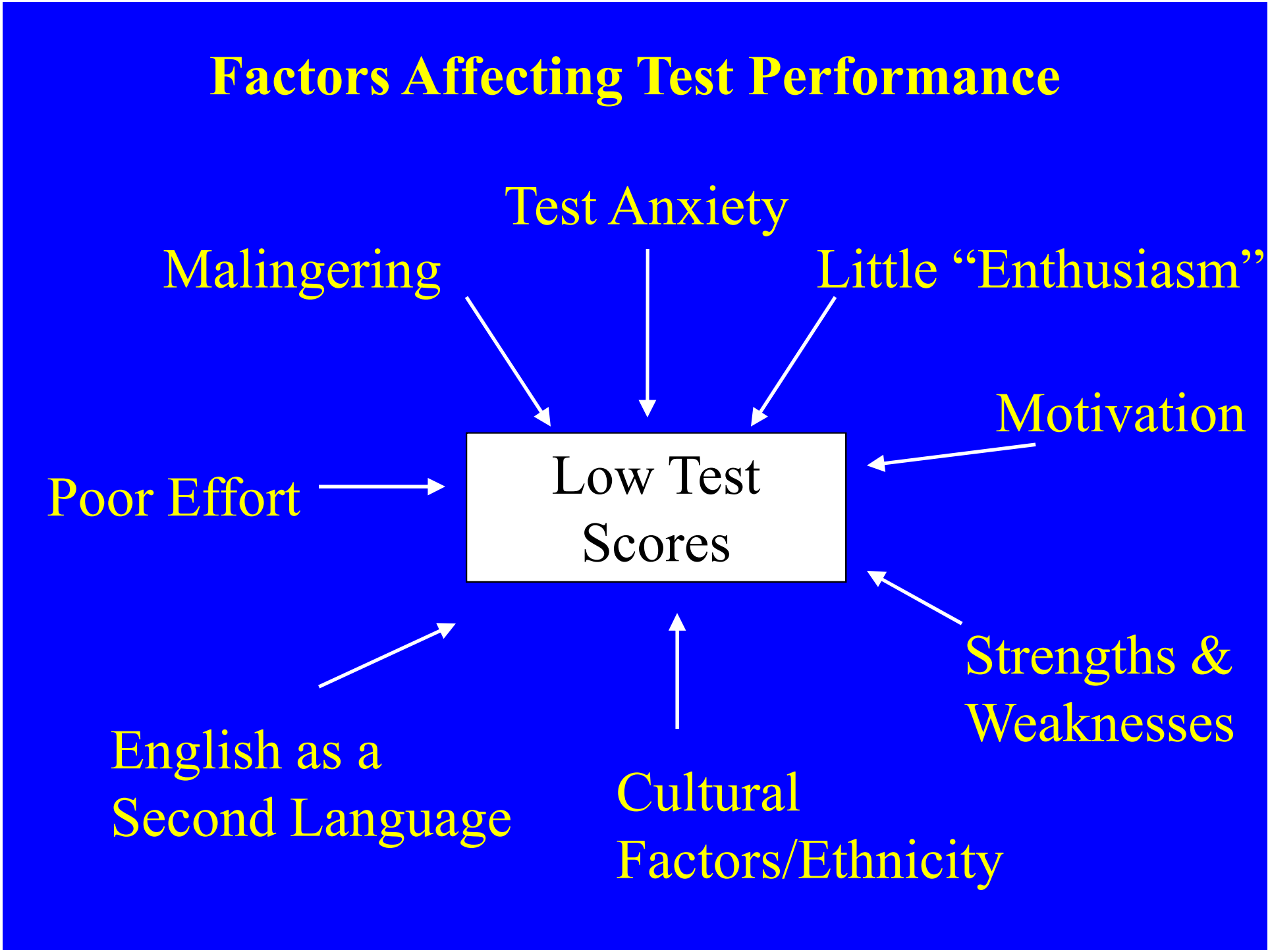
Confounds

Expertise

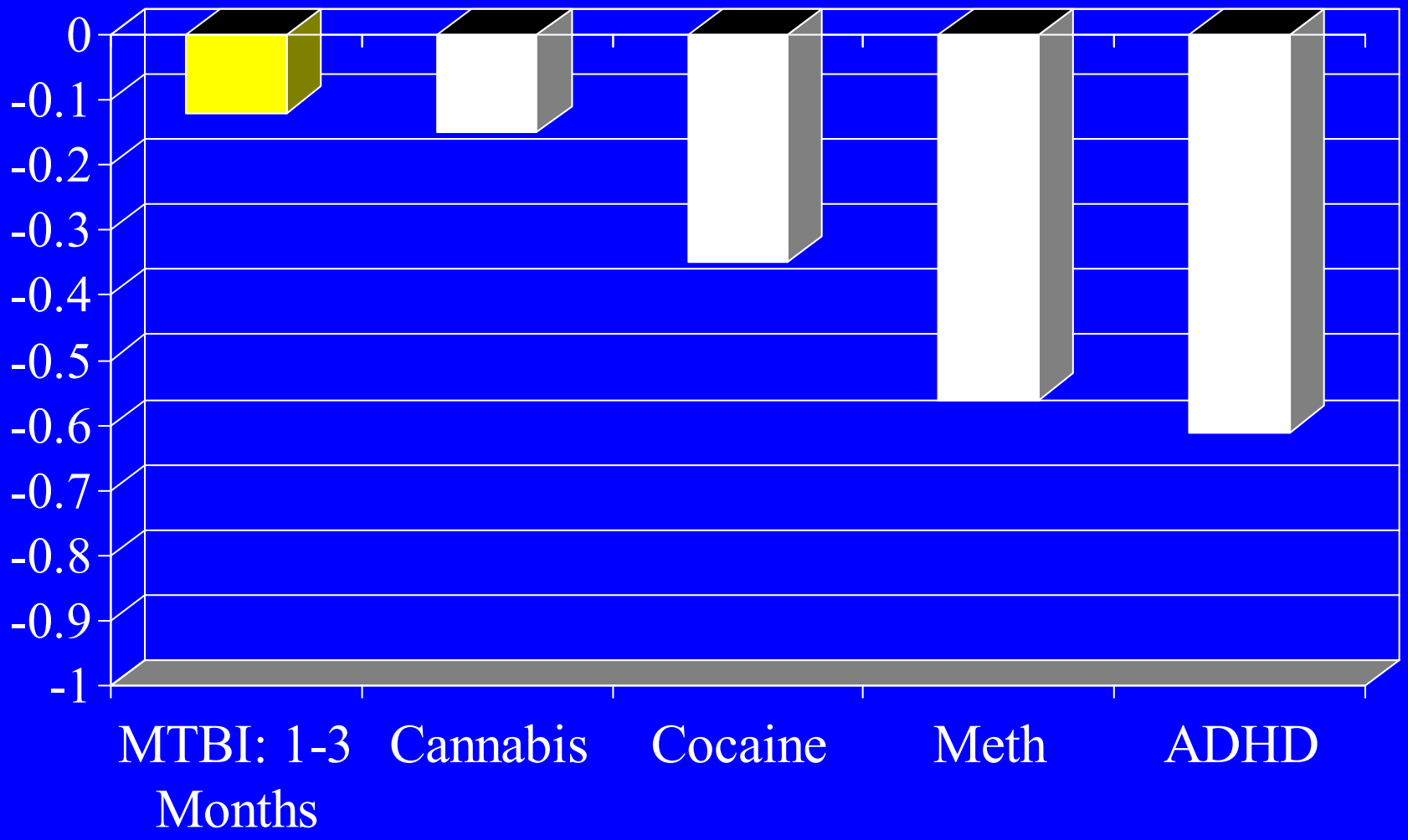

Possible Effects on Cognition
Brain Injury
Medication Side Effects
Depression
Cognitive Diminishment
Insomnia
PTSD
Chronic Headaches
Chronic Pain


MCI/
Early Dementia
Sleep Apnea
Heart Surgery
Hypertension
Drug Abuse
Cognitive
Difficulty
Diabetes
Alcohol
Dependence
Learning
Disability
ADHD
Chronic
Benzodiazepines

Factors Affecting Test Performance



Adverse Neuropsychological Effects



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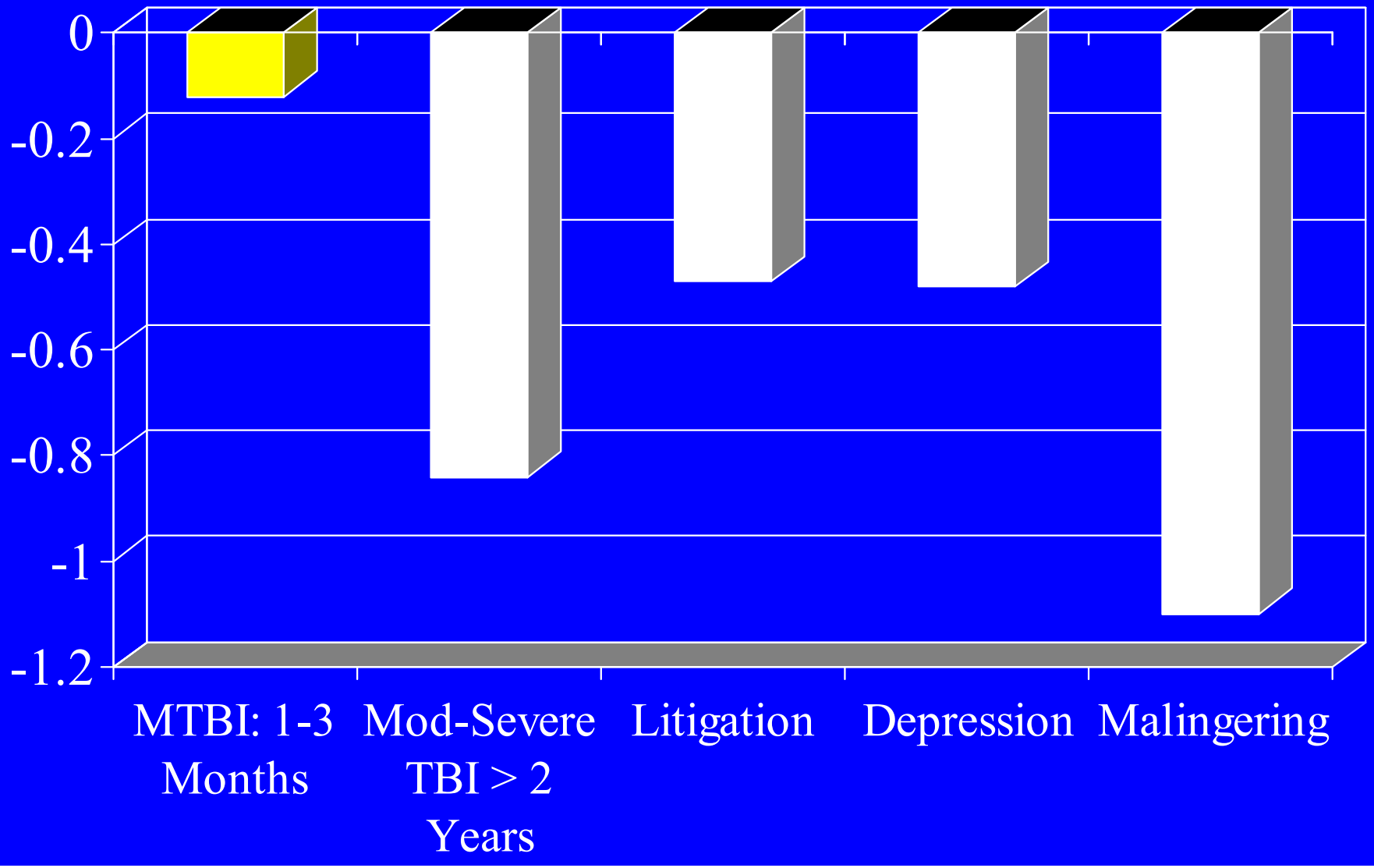
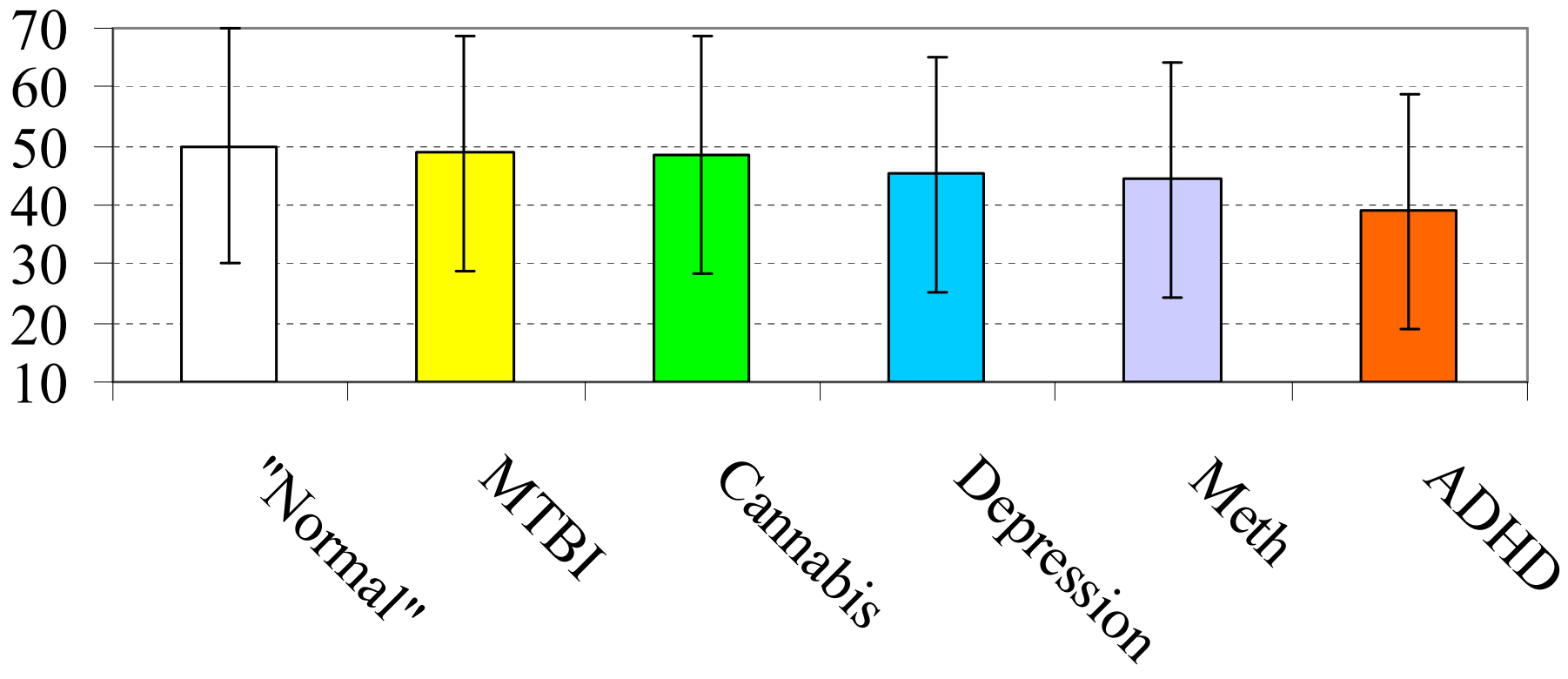


Signal? Overall Effect on Cognition



Psychometrics

- LEAST sensitive tests are MOST reliable
- Many of the MOST sensitive tests have large “margins of error”

Less Obvious Problem: Diagnosis Threat

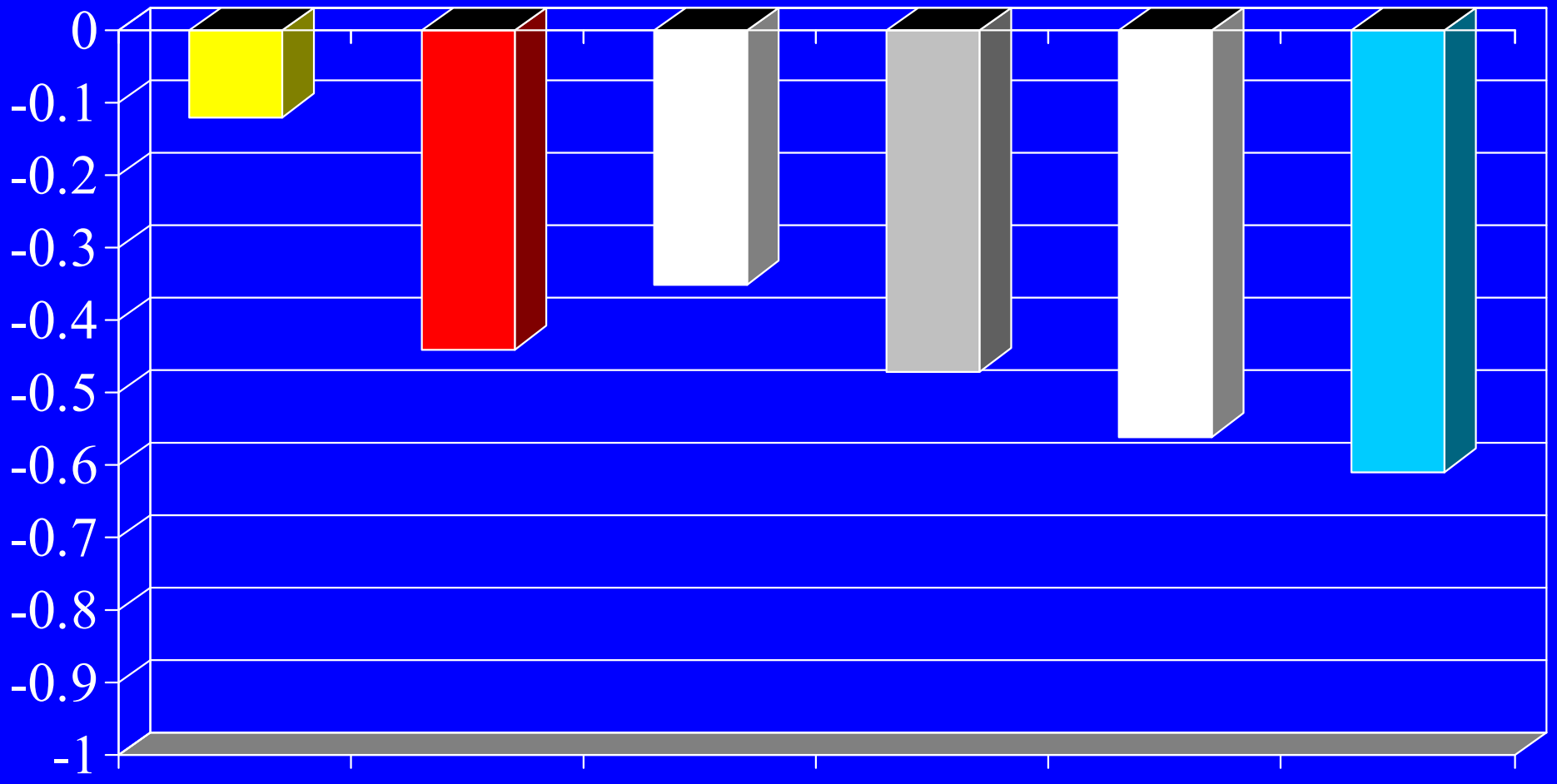
- Negative expectations and neuropsychological test performance
- University Students
- Diagnosis Threat = 17
- Neutral = 19

Suhr & Gunstad (2002)

Results

- Those in diagnosis threat condition performed more poorly on neuropsychological testing
- Examples: Rey Auditory Verbal Learning Test and Block Design (Suhr & Gunstad, 2002)
- Replication study (Suhr & Gunstad 2005)

Effect Size for Diagnosis Threat



Norms Matter

California Verbal Learning Test

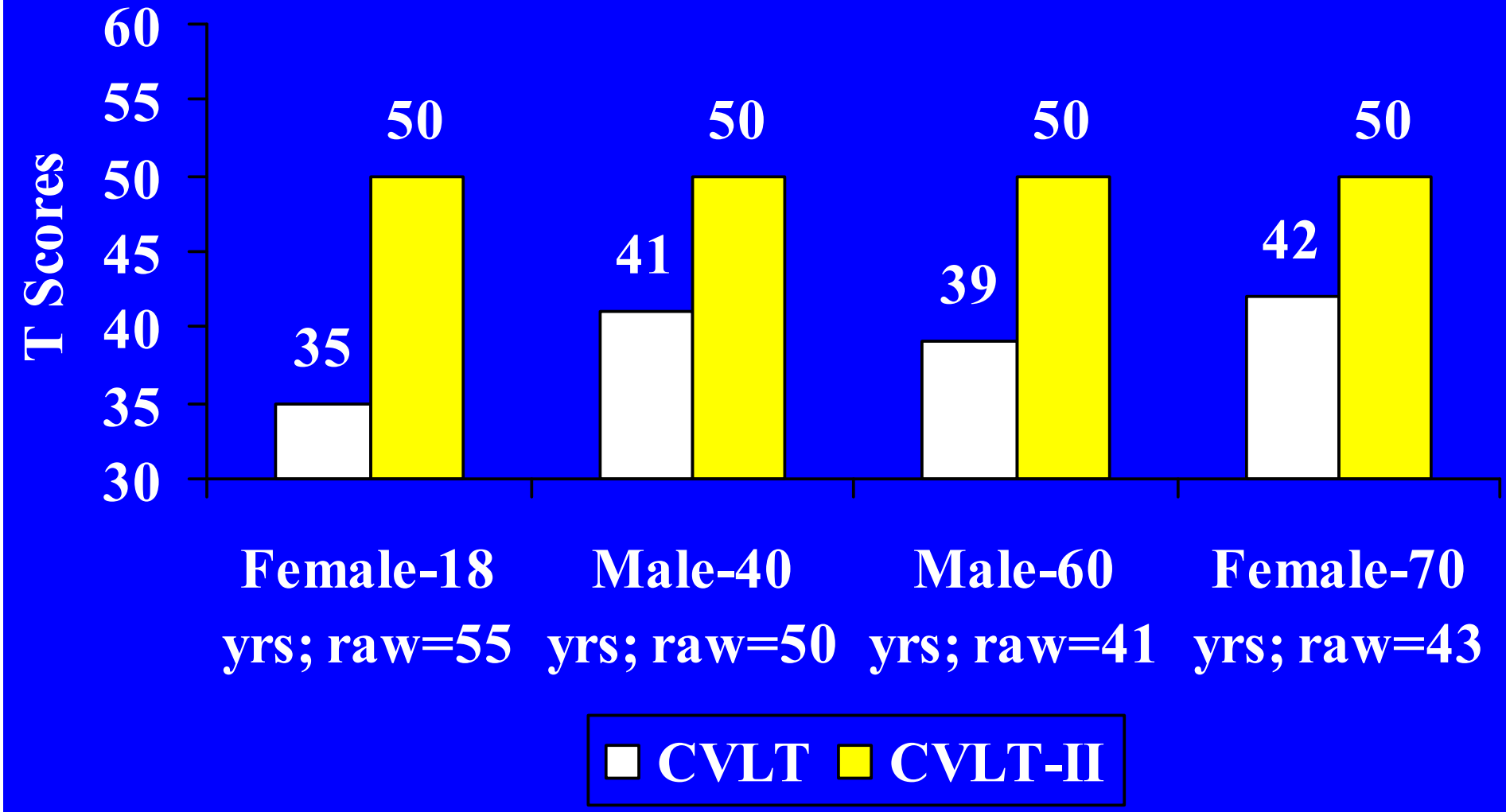
- Healthy adults (N = 62) took both versions in counter-balanced order.
- The raw scores derived from the two tests were remarkably similar.
- Examples are as follows: Trials 1-5 Recall
  58.76 (SD=8.94; Original CVLT)
  58.47 (SD=9.98; CVLT-II)

Raw Scores Similar, Normative Scores Different

- Although the raw scores are similar, the *normative scores* are different.

- Why? Because the original CVLT norms were based on a research sample that was well educated (mean education level = 13.8 years, SD = 2.7) and less representative of healthy adults in the community than the CVLT-II.

CVLT versus CVLT-II Trials 1-5 Total Score: Normative Comparisons (T-scores)



How Do You Define Impairment?

- Scores below the 16th percentile (1 SD)?
- Scores below the 10th percentile?
- 5th percentile?
- 2nd percentile (2 SDs)?

Prevalence of Low Scores in Healthy Adults?

- Most neuropsychologists don't know
- Higher the cut-off, greater the number of low scores
- More tests you give, the more likely you are to get low scores

Neuropsychological Assessment Battery (NAB)

- Takes approximately 3.5 hours to administer
- 24 tests
- 36 Primary Test Scores
- MANY additional test scores

Impairment = 5th Percentile

- What percentage of healthy adults have one or more low scores?

70%

- 3 or more? 31%

- 5 or more? 16%

Impairment < 1 SD (16^{th} percentile)

- What percentage of healthy adults have one or more low scores?

92%

- 3 or more? 66%

- 5 or more? 44%

Age-Adjusted Normative Scores

- People with less education have more low scores
- African Americans have more low scores than Caucasians
- Many tests are culturally biased
- Some tests have sex effects

Mild Cognitive Impairment/ Prodromal Dementia

- Diagnosis of Amnestic Mild Cognitive Impairment (MCI) requires, in part, objective evidence of memory impairment

- Many clinicians and researchers consider an age- and education-adjusted score that is at least 1.5 standard deviations (*SD*s) below the mean to be sufficient to meet psychometric criteria for amnestic MCI

Revert to Normal on Retesting

Authors	Retest	Percentage
Loewenstein et al., 2007	1 year	7.7%
Fischer et al., 2007	2.6 years	16.2%
Perri et al., 2007	2 years	17.2%
Fisk et al., 2003	5 years	31.2%
Alexopoulos et al., 2006	3.5 years	40%
Larrieu et al., 2002	2 years	41.4%
Kryscio et al., 2006	1.1 years	52.5%
Ganguli et al., 2004	4 years	55%

Were some misdiagnosed?

WMS-III: "Accidental MCI"

- WMS-III Older Adults Study
- N = 550
- 8 Age-Corrected Scaled Scores
  - Logical Memory I & II
  - Verbal Paired Associates I & II
  - Faces I & II
  - Family Pictures I & II
- Base rates of low scores

Brooks, Iverson, Holdnack, & Feldman (2008)

5th Percentile Cut-Off (MCI)

- Total Sample = 26%

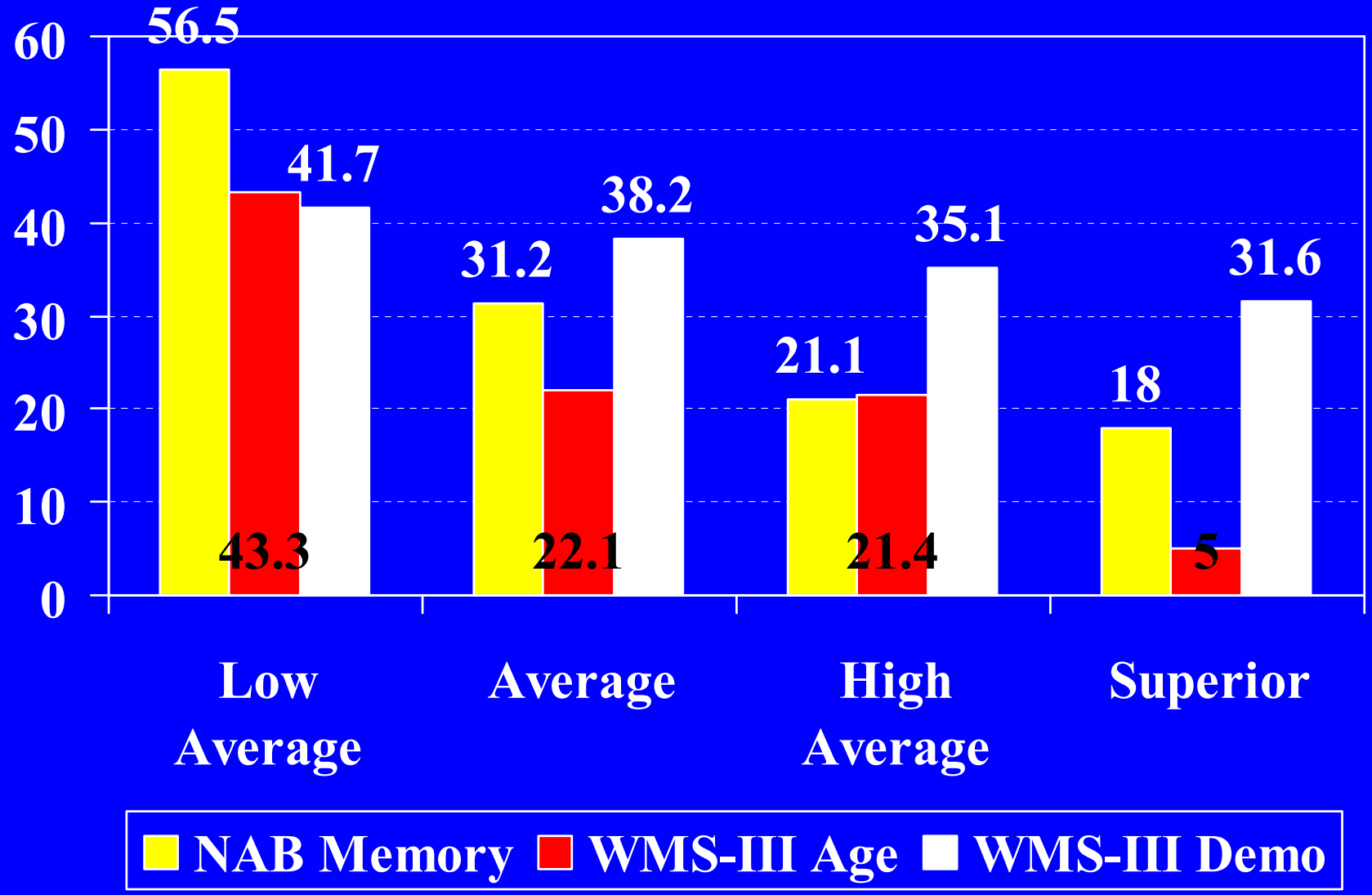
WTAR-Demographics Predicted FSIQ

- Low Average = 43%
- High Average = 21%

Memory Batteries: Wechsler Memory Scale – Third Edition NAB Memory Module

- WMS-III: 4 tests, 8 scores (immediate and delayed)
- NAB: 4 tests, 10 scores (immediate and delayed)

Percentage of healthy older adults with one or more low memory scores (≤ 5th percentile)

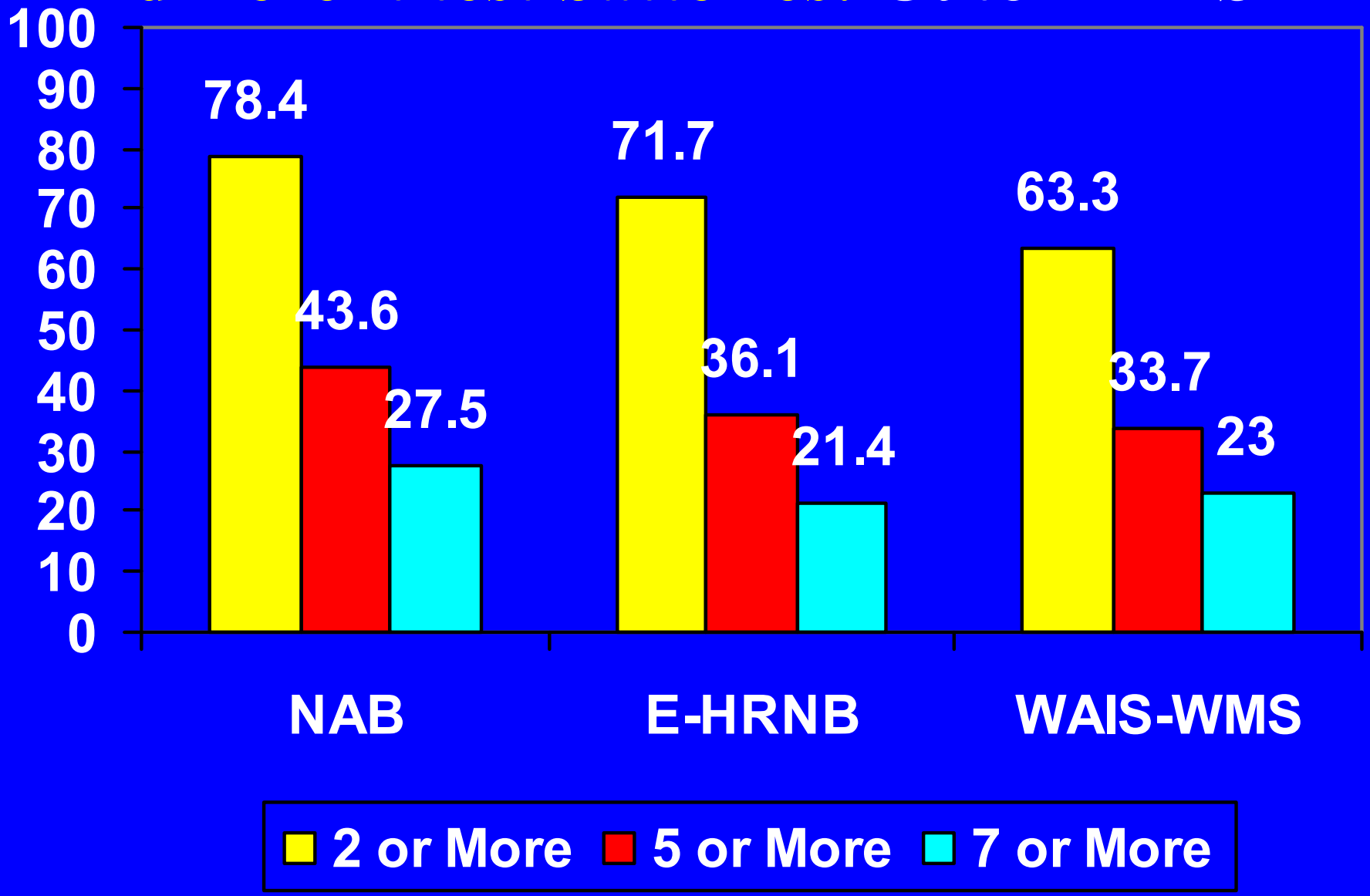


Five psychometric principles for interpreting scores

- Low scores are relatively common across all test batteries
- Low scores depend on where you set your cutoff score
- Low scores vary by number of tests administered
- Low scores vary by demographic characteristics of the examinee
- Low scores vary by level of intelligence.

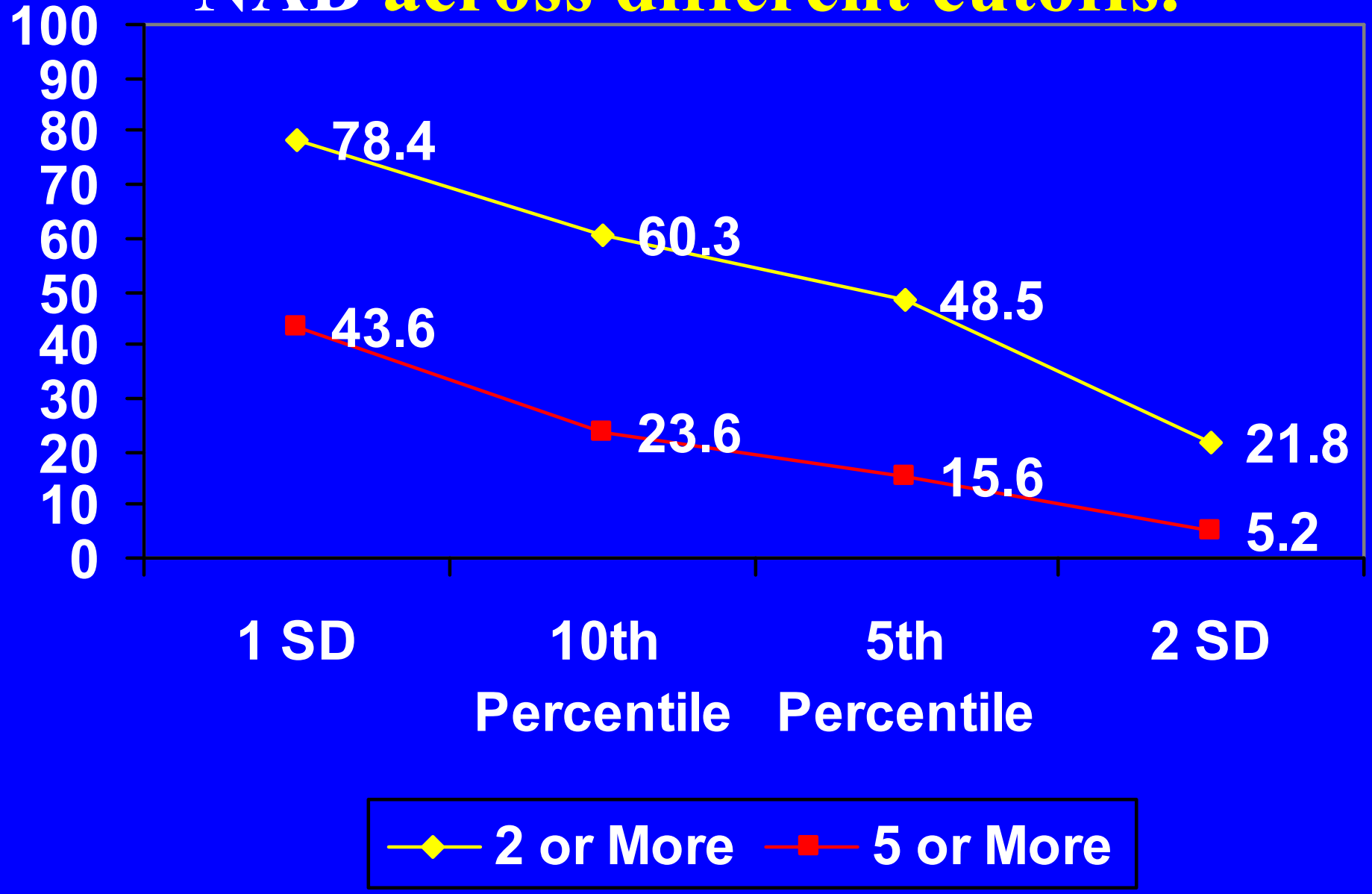
Principle #1
Low scores are relatively common across all test batteries

Base rates of low scores across different test batteries: Cutoff < 1 SD

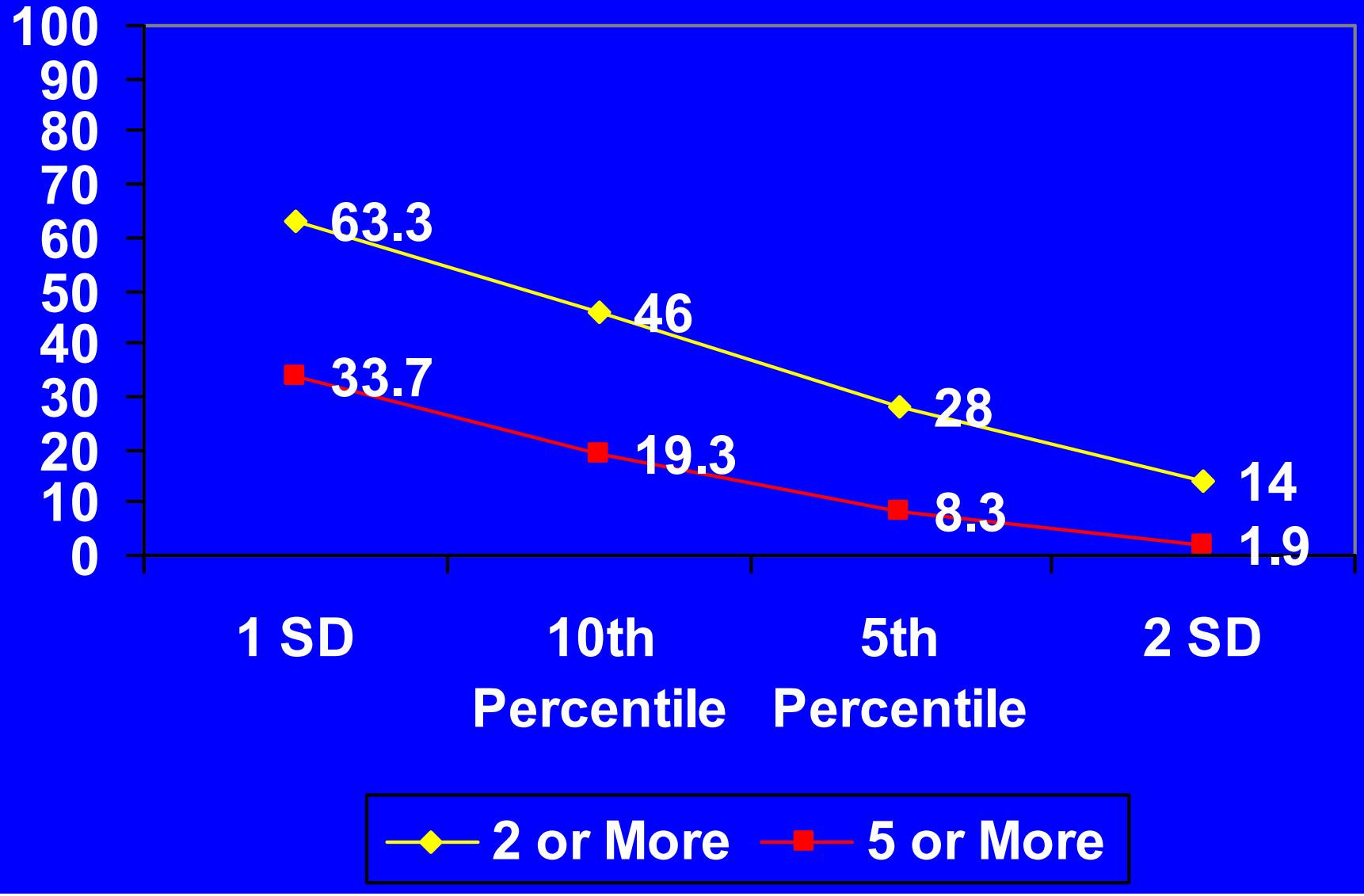


Principle #2
Low scores depend on where you set your cutoff score

Prevalence of low scores on the NAB across different cutoffs.



Prevalence of low scores on the WAIS-III/WMS-III across different cutoffs



Principle #3

Low scores vary by number of tests administered

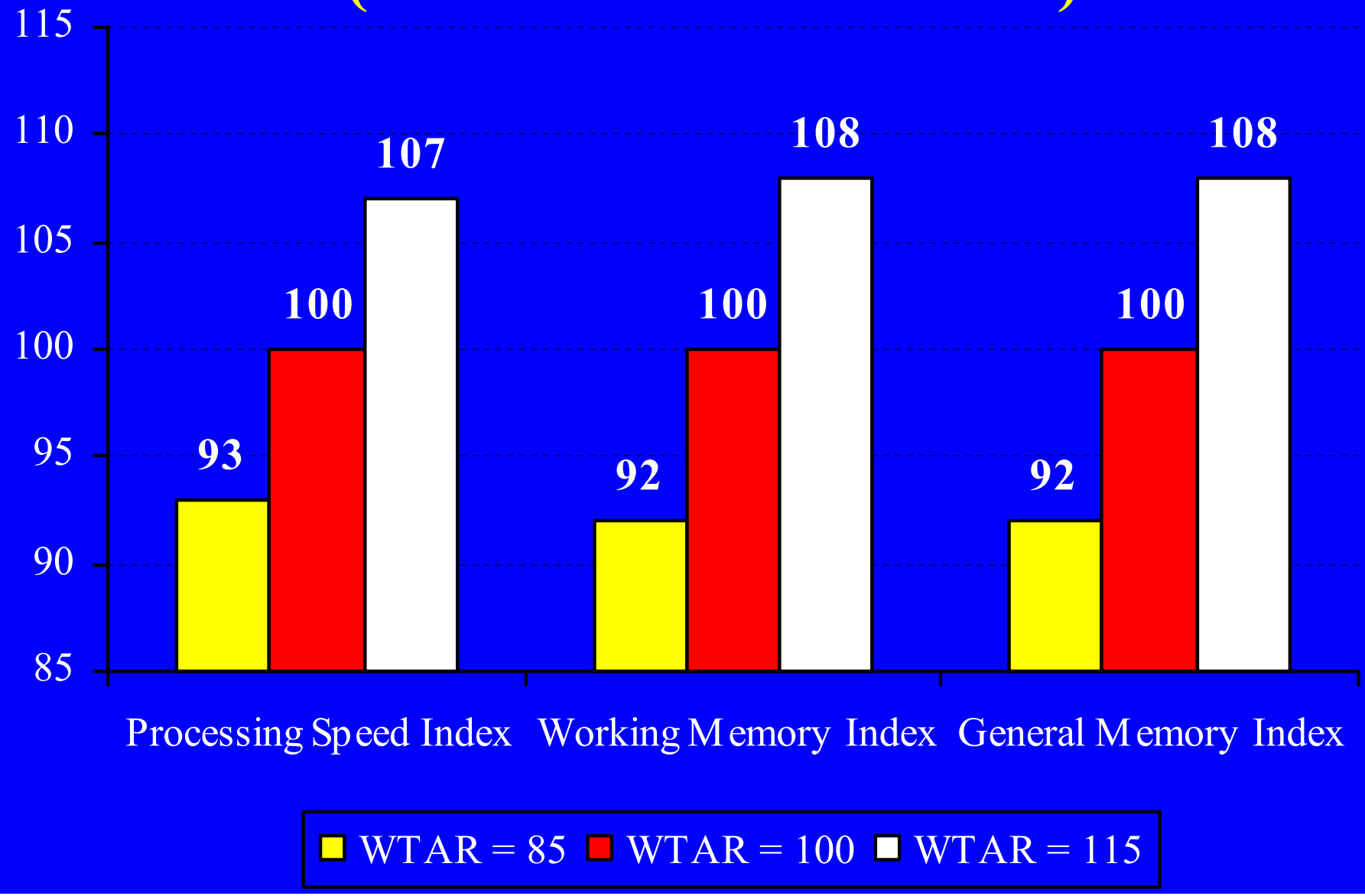
Principle #4

Low scores vary by demographic characteristics of the examinee

Reading Ability

- Wechsler Test of Adult Reading (WTAR)
- WAIS-III Processing Speed Index
- WMS-III Working Memory Index
- WMS-III General Memory Index

Relation between reading test scores and cognitive functioning in healthy adults (WTAR-Predicted Scores)



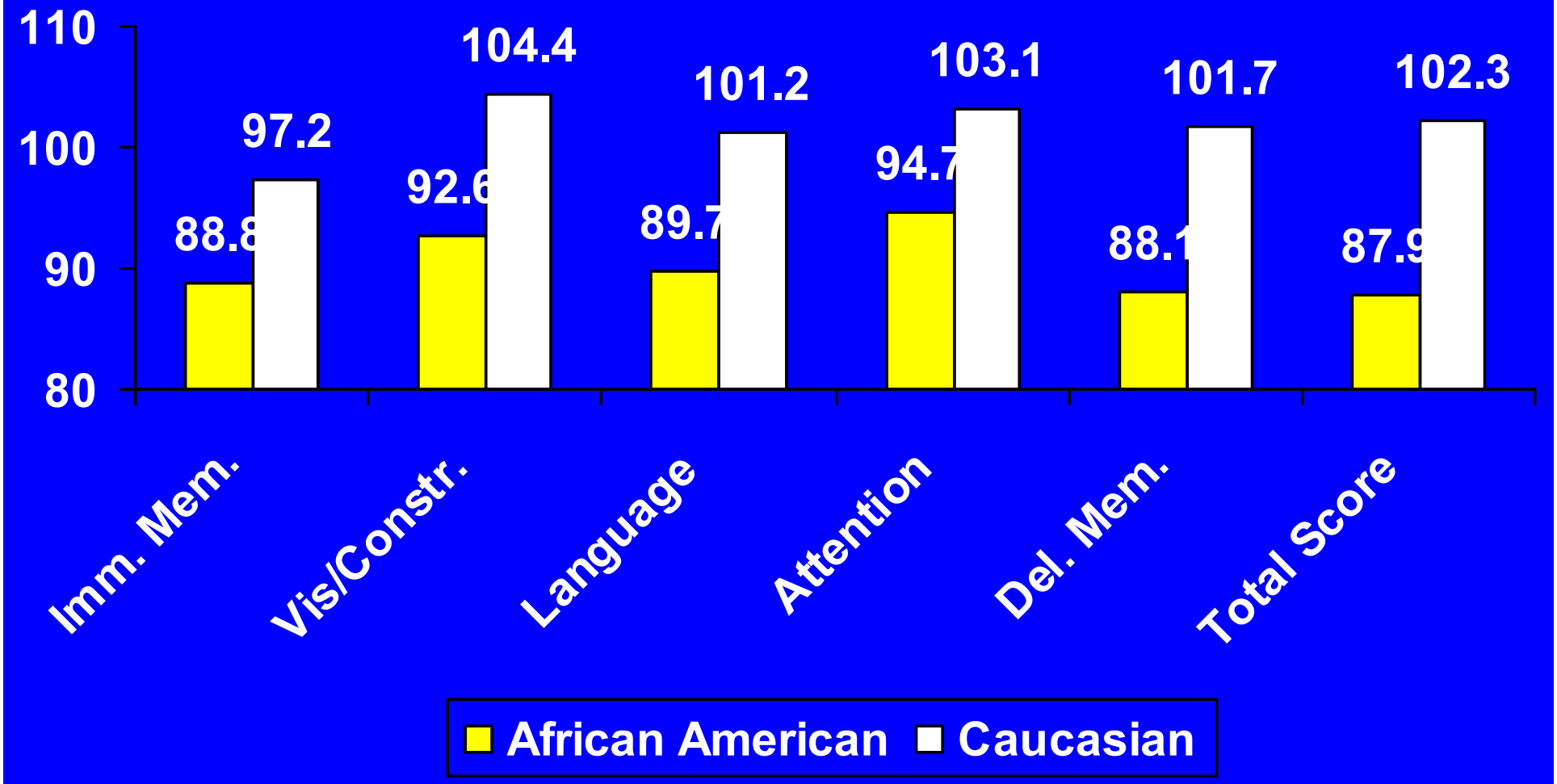
African Americans, Hispanics, & the Effects of Language and Culture

Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)

- Attention Index
- Visuospatial/Constructional Index
- Language Index
- Immediate Memory Index
- Delayed Memory Index
- Mean = 100, SD = 15

Comparison data derived from Patton, Duff, Schoenberg, Mold, Scott, & Adams (2003).

Comparison of healthy African Americans to healthy Caucasians on the RBANS



Principle #5
Low scores vary by level of intelligence.

Low NAB Scores: 5th Percentile

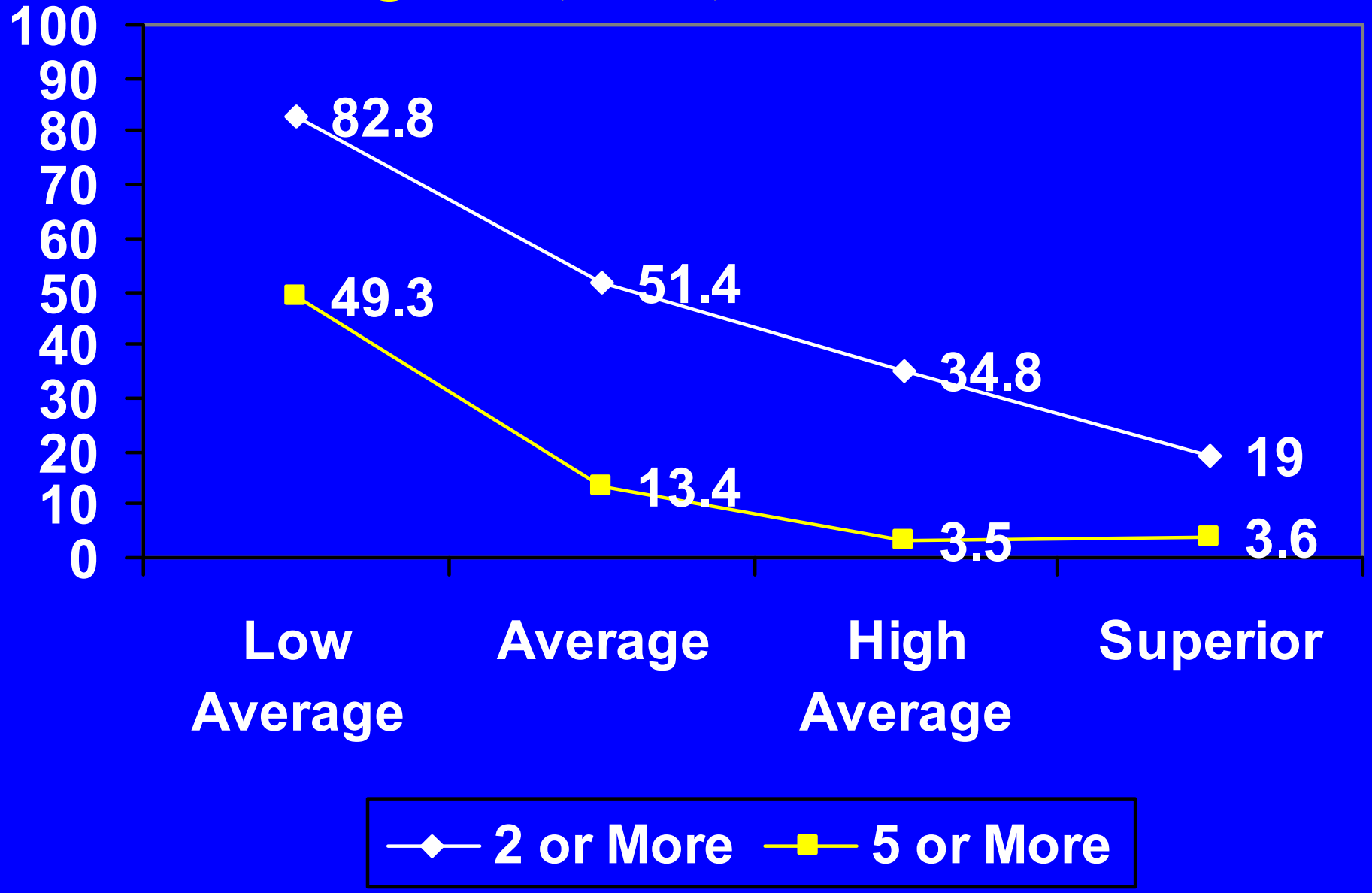
- 1 or more low scores

Below Average Intelligence	90%
Above Average Intelligence	58%

- 5 or more low Scores

Below Average Intelligence	49%
Above Average Intelligence	4%

Prevalence of low NAB scores stratified by intelligence (RIST): ≤ 5th Percentile



Clinical Implications?

- Misdiagnosis of cognitive impairment (false positive)
- "Missed" diagnosis of cognitive impairment (false negative)

Methodological Issues

- Choice of tests
- Quality normative data
- Number of tests used
- Cutoff score selected for “impairment”

Factors That Can Confound, Mimic, or Obscure

- Race/Ethnicity
- ESL / Acculturation
- Level Intelligence
- Longstanding strengths and weaknesses
- Pre-Existing Conditions
- Co-Occurring Conditions
- Fatigue, level of effort, enthusiasm
- Malingering

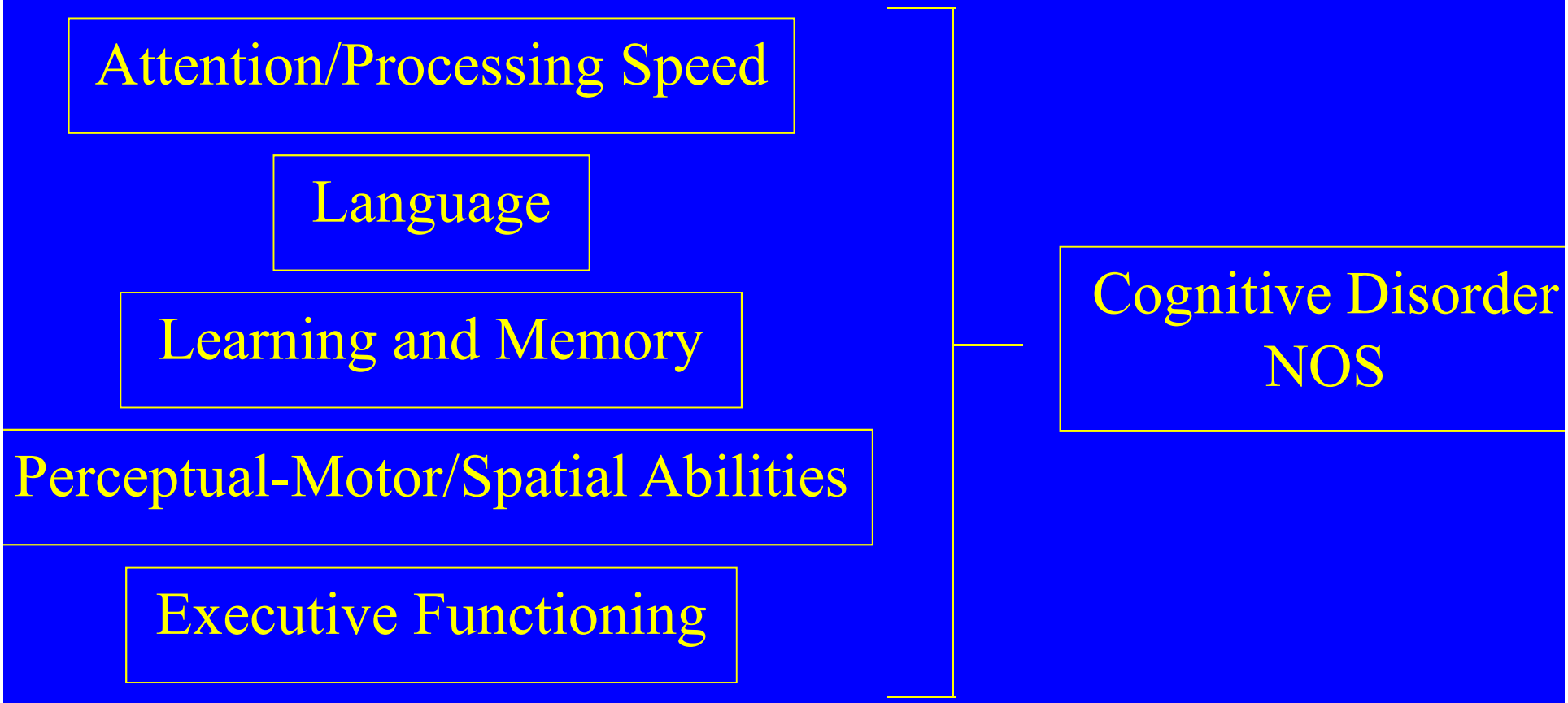
Misdiagnosis of Cognitive Deficits

- Longstanding strengths and limitations
- Pre-existing conditions
- Co-occurring conditions
- Confounds (e.g., effort, fatigue, or cultural factors)
- Low scores are common in healthy adults
- Capitalizing on chance findings

Ongoing, Multi-Year Research Program

To develop and evaluate evidence-based, psychometric criteria for the DSM-IV Axis I Diagnosis: Cognitive Disorder NOS (i.e., Mild Neurocognitive Disorder)

DSM-IV Cognitive Disorder NOS: "Mild Neurocognitive Disorder"

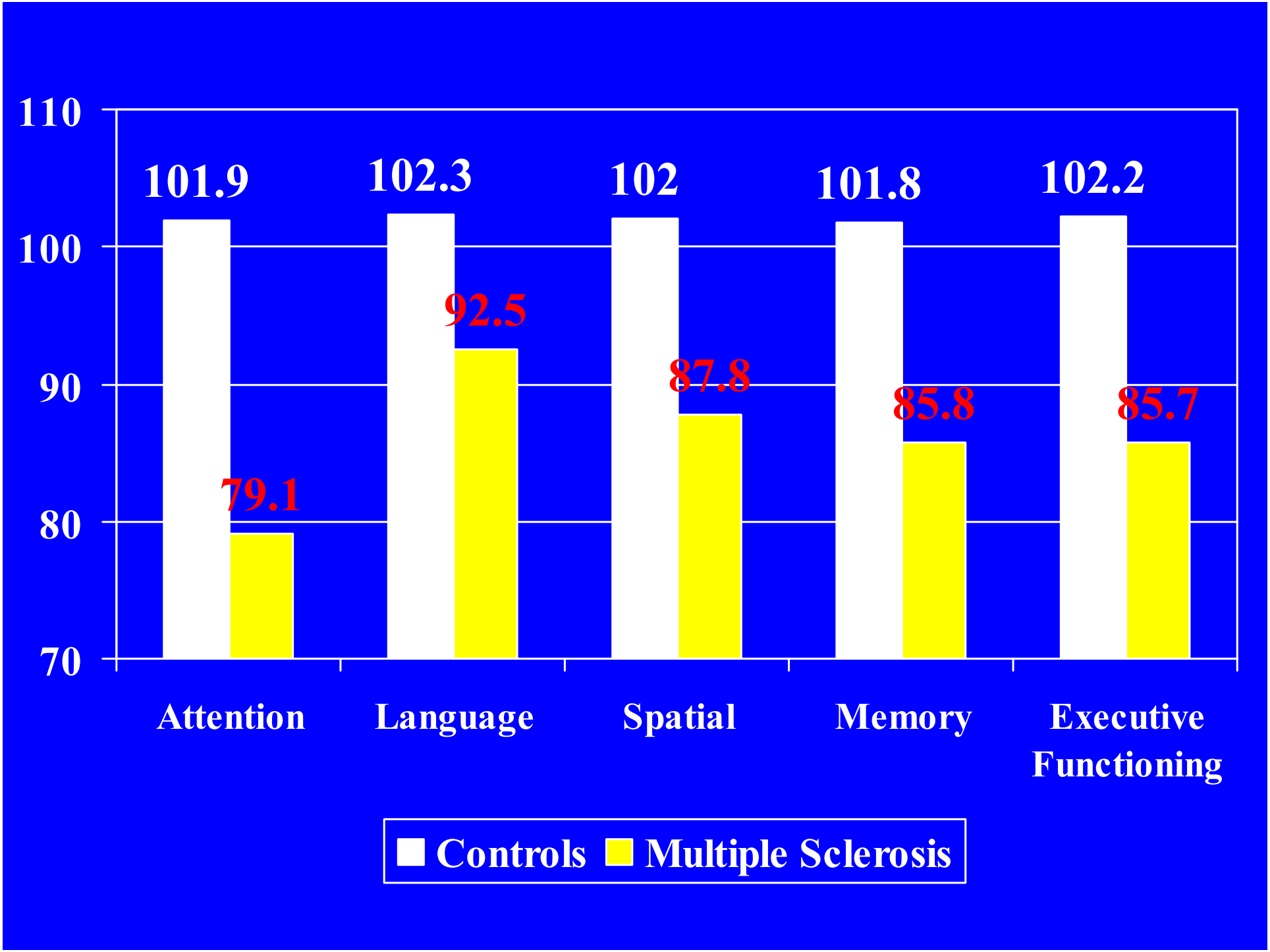


Multiple Sclerosis

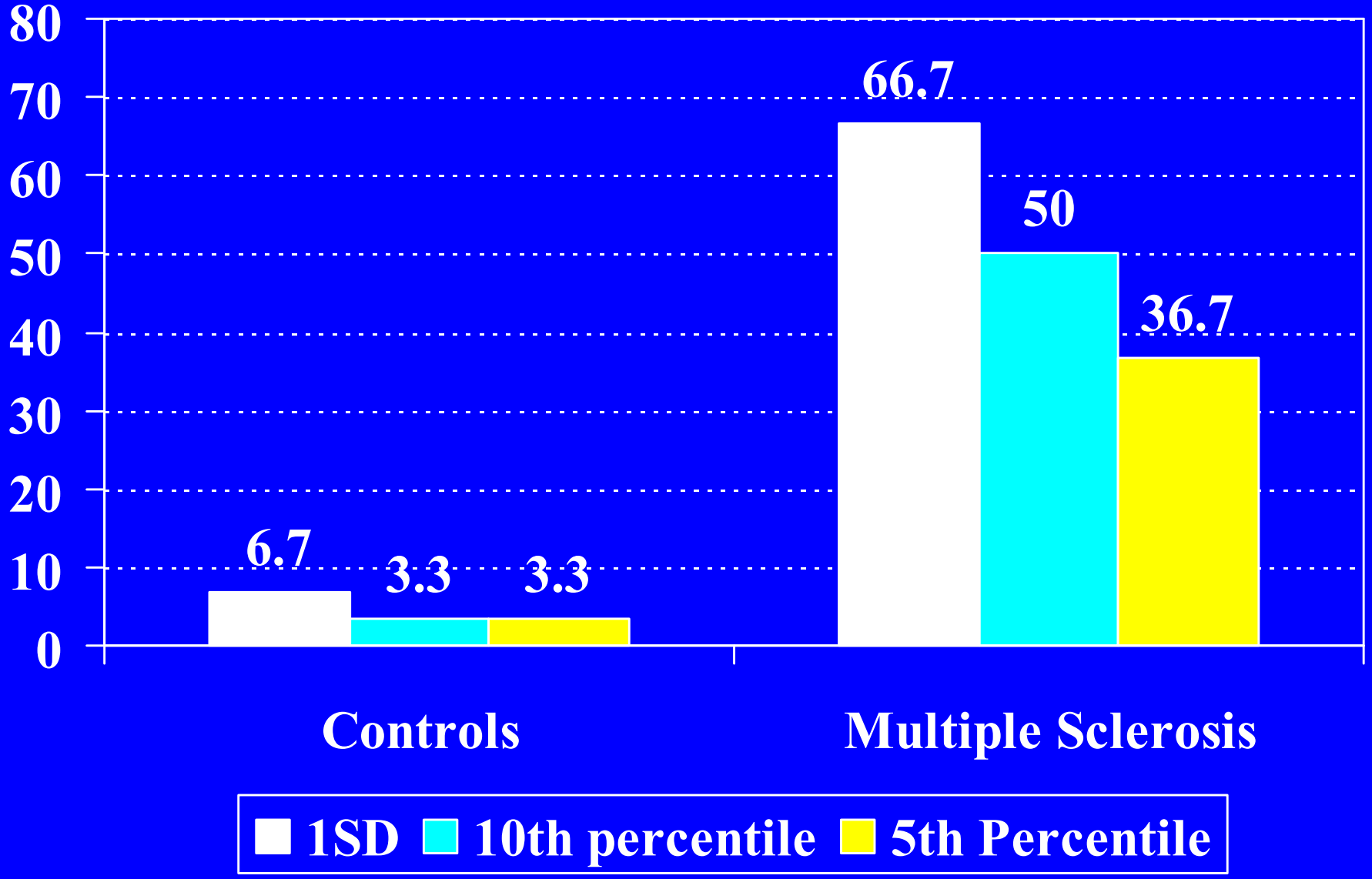
Participants

- 30 patients with MS
- 30 healthy controls from the NAB standardization sample were individually matched on sex, age, education, and ethnicity

- Battery: Neuropsychological Assessment Battery (NAB): 5 Index Scores


110
100
90
80
70
101.9
102.3
102
101.8
102.2
79.1
92.5
87.8
85.8
85.7
Attention
Language
Spatial
Memory
Executive Functioning
Controls
Multiple Sclerosis

Percentage with 2 or More Low NAB Index Scores



New Psychometric Criteria for DSM-IV Cognitive Disorder NOS

- An abbreviated version of the NAB, comprised of 15 of the 24 tests, was used. This abbreviated battery requires approximately 2 hours to administer.
  - NAB Attention Module: 5 tests
  - NAB Language Module: 2 tests
  - NAB Spatial Module: 2 tests
  - NAB Memory Module: 3 tests
  - NAB Executive Functions Module: 3 tests

Development Sample

- 1,269 healthy adults selected from the NAB standardization sample.
- Age from 18 and 79 years (mean = 55.1 years, standard deviation = 17.8)
- Education between 5 and 23 years (mean = 13.6 years, standard deviation = 2.8)
- Normative Data: Age-, Education-, and Sex-Adjusted

“Impairment” By Domain

- *Possible* impairment: fewer than 20% of healthy adults.
- *Probable* impairment: fewer than 10% of healthy adults obtaining the number of low scores below the given cutoff.
- All criteria stratified by level of intelligence

Average Intelligence: Psychometric Criteria

Attention & Speed

- Possible Impairment: 5 scores < 25th%;
  3 scores < 1SD; 2 scores < 10th% ;
  1 score <2nd%

- Probable Impairment: 6 scores < 25th%;
  4 scores < 1SD; 3 scores < 10th%;
  2 scores <2nd%

Average Intelligence: Psychometric Criteria

Learning & Memory

- Possible Impairment: 3-4 scores < 25th%;
  2 scores < 1SD; 1 score < 10th%

- Probable Impairment: 5 scores < 25th%;
  3 scores < 1SD; 2 scores < 10th%

Executive Functioning

- Possible Impairment: 2 scores < 25th%;
  1 score < 10th%

- Probable Impairment: 3 scores < 25th%;
  2 scores < 1SD

High Average Intelligence: Psychometric Criteria: Probable Impairment

Attention & Speed

- 5 scores < 25th%; 4 scores < 1SD; 3 scores < 10th%; 2 scores ≤ 5th%; 1 score <2nd%

Learning & Memory

- 4 scores < 25th%; 2 scores < 1SD

Executive Functioning

- 2 scores < 25th%; 1 score < 10th%

Application of New CD-NOS Criteria: Brain Tumor Study

- N = 35
- Age: 46.6 (SD=12.5) years
- Education: 13.8 (SD=2.8) years
- Primary Brain Tumor: 60%
- Metastatic Brain Tumor: 40%
- Currently working: 25.7%

Cognitive Outcomes: Brain Tumor Study (N = 35)

- Broadly Normal 3/35 (8.6%)
- Mild Diminishment 14/35 (40.0%)

- Cognitive Disorder NOS 14/35 (40%)
- Dementia 4/35 (11.4%)

Conclusions

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Moving Forward

- Try to use neuropsychological testing descriptively
- Use testing in situations where it is most useful (e.g., assessing effects of serious brain injuries or diseases)
- Be clear about the limitations of the data
- Conduct research designed to improve the sensitivity, specificity, and predictive accuracy of specific test batteries for identifying cognitive impairment

Thank You