

Development of a Computer Adaptive Test of Health Numeracy: The CAT NUMi

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Health Numeracy

- *The ability to understand and use numbers, tables & graphs, probability, and statistics in making decisions and caring for one's health*
- Health numeracy variable and impacts MDM
 - » Accuracy in risk perceptions
 - » Use of deliberative reasoning
 - » Susceptibility to framing bias
 - » Affective response to numbers
- Screening for health numeracy in the clinical setting could lead to tailored, more effective communication strategies

Schwartz L, 1997, Ann Intern Med
Peters E, 2011, Med Decis Making
Hamm RM, 2007, Med Decis Making

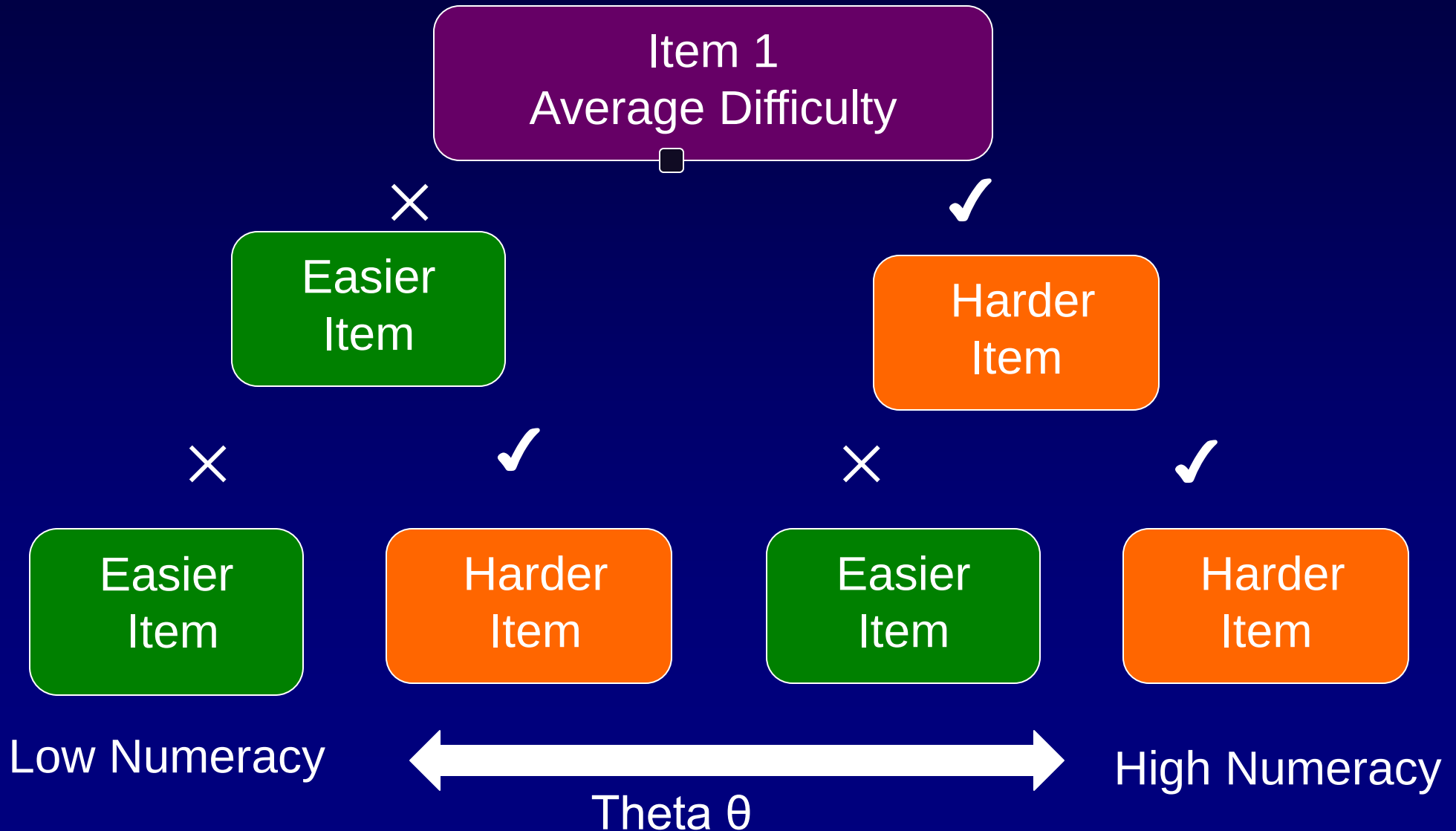
Numeracy Understanding in Medicine Instrument (NUMi)

- 20-item written test based on Item Response Theory
 - » Item level analysis
 - » Test formed from an bank of developed items
- NUMi developed using a broad conceptual model
 - » Number Sense
 - » Tables & Graphs
 - » Probability
 - » Statistics
- Item Bank (n=108)
 - » Multiple choice
 - » True false

Objectives

- To develop a Computer Adaptive Test of the NUMi
- Goals of CAT NUMi
 - » Increase precision of measurement
 - » Decrease respondent burden
 - » Create a feasible modality for the clinical setting

Methods: CAT Schema



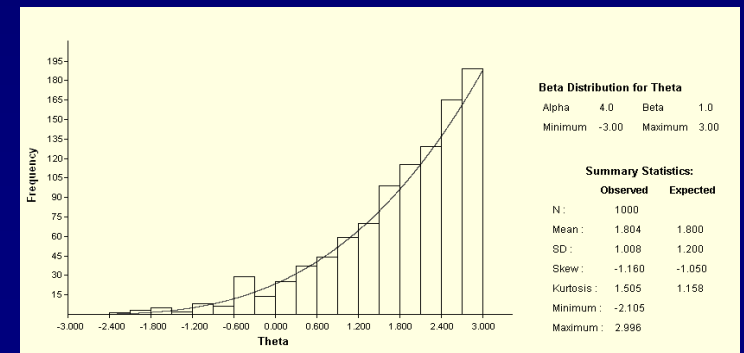
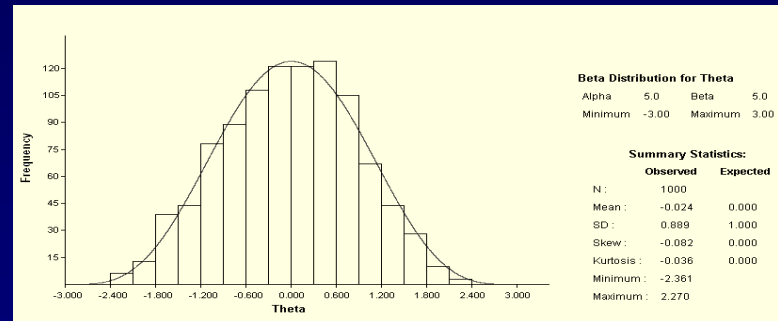
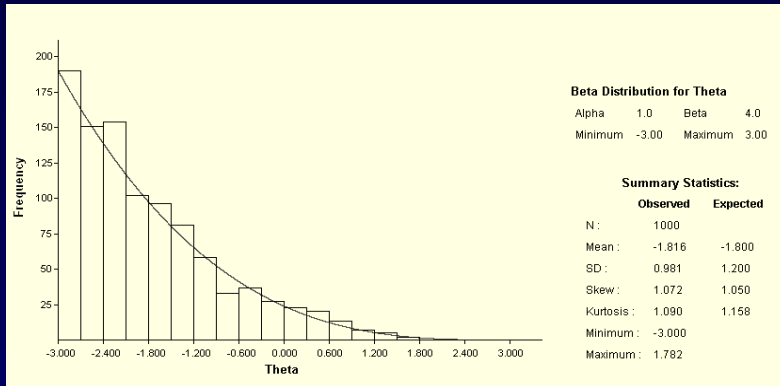
Methods: Algorithm Specification

- Choose initial item at Theta=0 (Range -3 to 3)
- Subsequent item selection: maximum information
- Termination criteria
 - » Precision: SE of Theta ≤ 0.315
 - » Added information ≤ 0.100
 - » Maximum length of test

Methods: Simulation of CAT

- Conduct Monte-Carlo simulations of CAT algorithm
 - » Assumptions of numeracy distribution
 - » Length of test (5, 10, 15, 20 items)
- Simulations outcomes
 - » Full item bank and CAT Theta (θ)
 - » SE of Theta (θ)

Simulated Distributions of Theta (θ)



Results of Simulation Data

CAT Length	Lower Numeracy		Normal Distribution		Higher Numeracy	
	SE of Theta Mean (SD)	Corr.*	SE of Theta Mean (SD)	Corr.*	SE of Theta Mean (SD)	Corr.*
5	1.14 (1.12)	0.86	0.56 (0.40)	0.86	1.36 (0.93)	0.77
10	0.66 (0.84)	0.92	0.39 (0.19)	0.93	0.88 (0.55)	0.87
15	0.48 (0.65)	0.95	0.33 (0.16)	0.97	0.72 (0.43)	0.92
20	0.40 (0.53)	0.97	0.29 (0.12)	0.96	0.65 (0.38)	0.95

*Correlation of full bank Theta and CAT Theta

Interpretation of Simulation Study

- The 10-item CAT performed favorably and approached performance of 15 or 20 item CAT
- Highest performance when numeracy was normally distributed in the population
 - » Followed a population with higher proportions of low numerate persons

Limitations

- CAT NUMi requires IRT software and web access
- Need for clinician reports that explain test findings and suggest communication strategies

Conclusions

- CAT NUMi has strong psychometric performance
- Length decreased from 20 to 10 items
- Performs well in populations with a range of numeric ability, a general goal of ability tests
- Provides a robust assessment of health numeracy: number sense, table/graphs, probability, statistics

Implications/Next Steps

- This is the first CAT of health numeracy designed for assessment in a general population
 - » Berlin Numeracy Test designed for Ph.D. level ability
- Potential Applications
 - » Guide clinician communication strategies
 - » Create cross-culturally equivalent assessments
- Next steps
 - » Development of physician reports/guidance
 - » Web availability in English and Spanish
 - » Evaluation of screening strategy in the clinical setting

NUMi Website

<http://www.med.upenn.edu/numi/>



Numeracy Understanding in Medicine Instrument

[What is the NUMi?](#)

[Access the Written NUMi](#)

[Scoring the Written NUMi](#)

[Research Team](#)

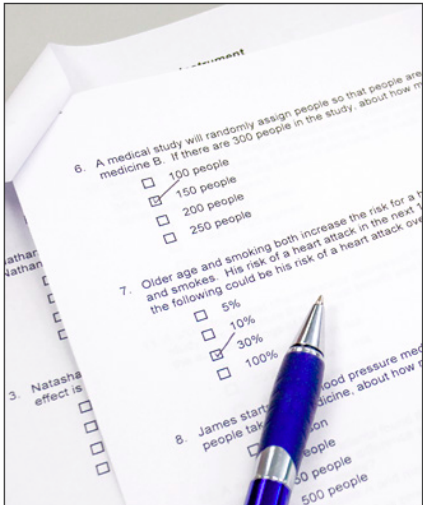
[Development/Future Plans](#)

[Validation Paper](#)

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What is the NUMi?

NUMi stands for Numeracy Understanding in Medicine Insstrument, an objective test of health numeracy that is appropriate for both research and clinical settings. The NUMi will indicate how well a person will understand education materials, instructions, or other forms of communication that involve numbers, tables, & graphs, probability or statistics. The NUMi was developed and validated using item response theory (*Med Decis Making* 2012;32:851-865)



Health Numeracy Definition

The ability to understand medical information presented with numbers, tables and graphs, probability, and statistics and to use that information to communicate with your health care provider, take care of your health, and participate in medical decisions.

Research Team

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