

The Validity of Logic- Based Tests

Robert Simpson
Mary Anne Nester
Eric Palmer

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Logic-Based Measurement

- System for measuring reasoning skills
- Test-takers read a passage and draw an inference
- Questions based on schemas, which
 - are logical formulas
 - comprise the content domain of reasoning

Sample Question

Police officers were led to believe that many weapons sold at a certain gun store were sold illegally. Upon investigating the lead, the officers learned that all of the weapons sold by the store that were made by Precision Arms were sold legally. **They also found that none of the illegally sold weapons were .45 caliber.**

From the information given above, it can be validly concluded that, concerning the weapons sold at the store,

- A) all of the .45 caliber weapons were made by Precision Arms
- B) none of the .45 caliber weapons were made by Precision Arms
- C) some of the weapons made by Precision Arms were .45 caliber weapons
- D) all of the .45 caliber weapons that were sold were sold legally**
- E) some of the weapons made by Precision Arms were sold illegally

Use of Schemas

- Objective measurement of job-related thinking skills
- Thorough sampling from content domain of reasoning
- Reliable tests
- Efficient item writing technology

History

- Colberg (1984, 1985)
- Federal Contract Specialist test (1986)
- Administrative Careers with America exam (1990)
- Research
 - deduction vs. induction
 - negation & linguistic complexity
 - illogical biases

LBM Taxonomies

- Define the content domain of reasoning
 - Colberg, 1983, first taxonomy
 - Colberg, 1987, added illogical biases
 - Nester, Reilly, & Colberg, 1996, added inductive schemas
 - Colberg & Varon Cobos, 2000, for economists
 - Simpson and Nester, 2001, first “public” taxonomy
 - <http://www.ipmaac.org/mapac/meetings/2001/fall2001.htm>

Taxonomy

<i>Logic of Two Sets</i>	<i>Logic of Three Sets</i>	<i>Logic of Connectives</i>
13 Valid Schemas	79 Valid Schemas	17 Valid Schemas
26 Invalid Schemas	125 Invalid Schemas	28 Invalid Schemas

Logic of Two Sets

- Premise: all persons must be treated fairly
- Valid Conclusion: no persons must be treated unfairly (schema A1)
- Invalid Conclusion: no persons must be treated fairly (schema A5)

Taxonomy: Logic of Three Sets

- Premise: all representatives of the U.S. Government are obligated to conduct themselves in a dignified manner
- Premise: all Border Patrol Agents are representatives of the U.S. Government
- Valid Conclusion: all Border Patrol Agents are obligated to conduct themselves in a dignified manner (schema 1AA1)
- Invalid Conclusion: everyone who is obligated to conduct him or herself in a dignified manner is a Border Patrol Agent (schema 1AA9)

Taxonomy: Logic of Connectives

- Premise: a private person may arrest an individual when the individual commits a crime in the presence of the private person
- Valid Conclusion: if a private person may not arrest an individual, then the individual did not commit a crime in the presence of the private person (schema S1)
- Invalid Conclusion: a private person may arrest an individual only if the individual committed a crime in the presence of the private person (schema S5)

Taxonomy: Induction

- Premise: Of all the weapons sold illegally by this gun store, one-fifth were .45 caliber.
- Valid Conclusion: There is a 20% chance that a randomly selected weapon that was sold illegally by this gun store is .45 caliber.
- Invalid Conclusion: There is an 80% chance that a randomly selected .45 caliber weapon that was sold by this store was sold legally.

Construct Validity

- reasoning is a well-established factor in human cognitive performance
- reasoning skills are among most important job skills
- logical formulas define the content domain of reasoning

Construct Validity

- Carroll (1993) reanalyzed and reevaluated decades of factor analytic research
- reasoning factors identified in 176 datasets
- sequential reasoning is a key facet
 - “operates in tasks or tests that require subjects to start from stated premises, rules, or conditions and engage in one or more steps of reasoning to reach a conclusion that properly and logically follows from the given premises”

Construct Validity

- Pollack, Simons, and Patel (1999) study of 105 professional and administrative occupations
- Importance of competencies for performing 317 specific job tasks
 - Reasoning was linked to 144 of tasks, second only to Attention to Detail
- 42 "core" job tasks had high Importance and Frequency ratings for all jobs in the study
 - Reasoning was linked to 16 of these core job tasks, more than any other competency
 - Example of core task: Interprets and applies laws, regulations, policies, standards, or procedures to specific issues

Construct and Content Validity

DHS employees use their reasoning skills in countless decisions, determinations, and investigations:

- A Border Patrol Agent deciding whether an impending confrontation involves dangerous individuals
- a Customs and Border Protection Officer determining if an alien should be admitted
- a supervisory Special Agent deciding whether to open a case based on certain evidence

Reasoning skills are used in:

- applying rules, making determinations, making predictions, and in problem solving, on-the-spot decision making, and complex, deliberate decision making.

Content Validity

REASONING CONSTRUCT

Taxonomy = Content Domain

x x x x x (schemas) x x x x x x

Content Validity

Simpson (1999) studied logical content of tests and job materials

- Compared test content and job content to see if there is convergence in logical schemas used

Content Validity

REASONING CONSTRUCT

Taxonomy = Content Domain

x x x x x (schemas) x x x x x x

USBP Reasoning Test

***Sample from the
Schemas***

x x x x x x x x

Content Validity

REASONING CONSTRUCT

Taxonomy = Content Domain

x x x x x (schemas) x x x x x x

USBP Reasoning Test

**Sample from the
Schemas**

x x x x x x x x

**USBP Job-Content
Materials**

Includes all the Schemas

**x x x x x x x x x x x x x x x x
x x x x x**

Content Validity

● Definitions

- makes extensive use of statements about sets
- As representatives of the [Immigration and Naturalization] Service, patrol agents should attempt to project a very positive image both on and off duty

● Operations

- makes extensive use of connective statements
- Illegal establishments and places held in disrepute should be entered only when official business requires it

Content Validity

Summary of Content Validity Evidence

- Taxonomy displays the content domain of the reasoning construct
- USBP Logical Reasoning Test Samples from Taxonomy
- USBP Handbook contains numerous schemas from all parts of the content domain
- The convergence is one-to-one
- Proves that the reasoning tasks that U.S. Border Patrol Agents are required to master are the same reasoning tasks that are assessed in the instrument used to select entry-level U.S. Border Patrol Agents

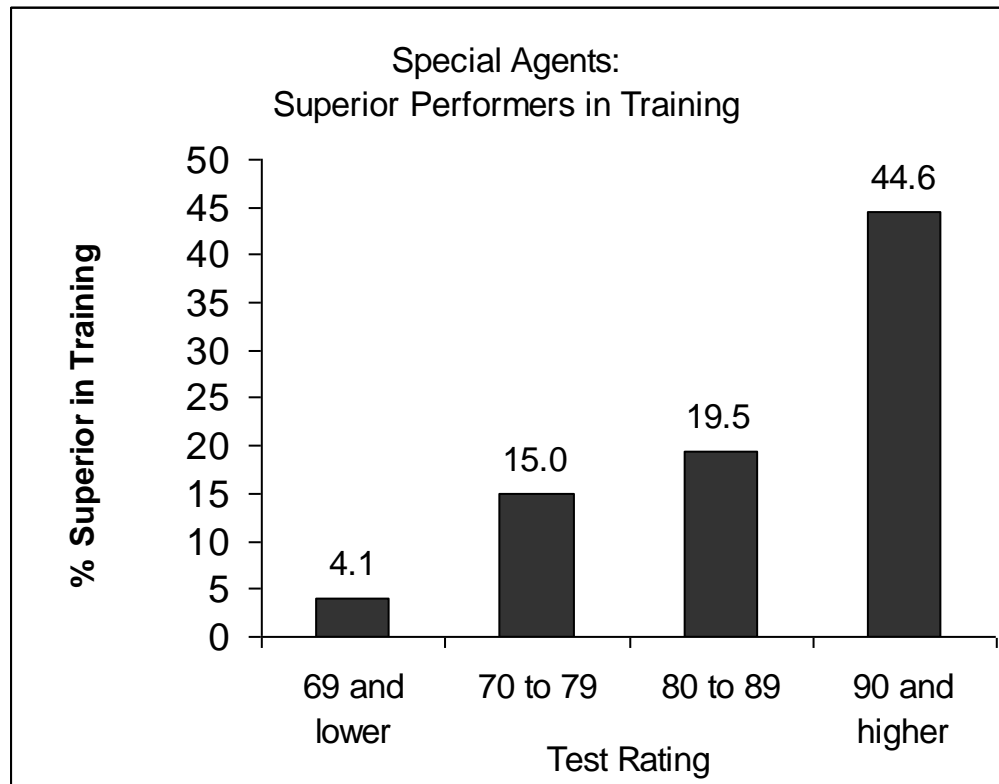
Criterion-Related Validity of Logic-Based Reasoning Tests

- LBM questions have proven to be excellent predictors of training success and job performance.
- Average validities (Hayes et al., 2003):

training	$r = .60$, $lcv = .6$
work simulation	$r = .60$, $lcv = .6$
supervisory ratings	$r = .27$, $lcv = .2$

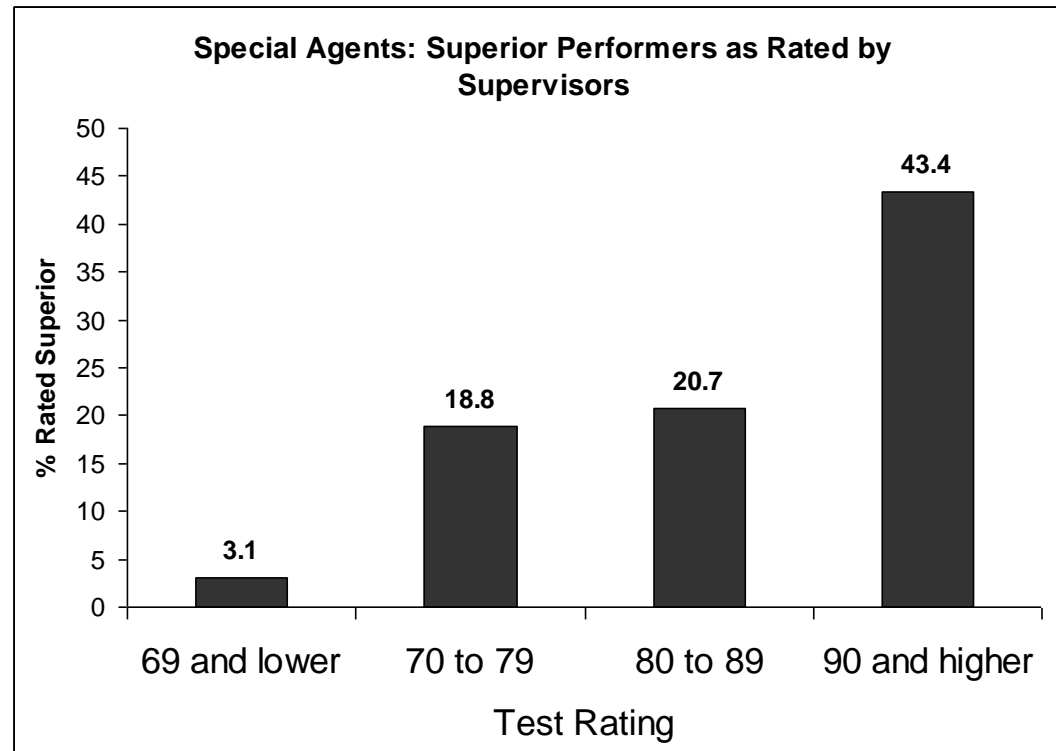
Validity For Decision-Makers

High Scorers Excel in Training



Validity For Decision-Makers

High Scorers Excel on the Job



Practical Benefits from Psychometric Characteristics

- LBM questions always have excellent psychometric statistics (item analysis)
- Because questions almost always “work,” you do not need to write lots of extra items.