

Ch. 6: Test Development

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Reminders

- This week
 - Exercise 3 due
 - Finish Chapter 6
 - Exercise 4 : Strong Interest Inventory
 - Careers in Psychology Lecture (Optional)
- Next Week:
 - Begin Ch7
 - Finish Ch 7, Review for Midterm 2

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Review

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Review

- Reliability
 - kinds
 - r or r^2 - what is “good enough”
- Validity
 - kinds
 - r or r^2 - what is “good enough”
- Chapter 6
 - Writing test items w/good reliability + validity
 - Evaluating test item quality

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4 kinds of Reliability

	Description	Name	Statistic
Time Sampling	1 test given two times	test-retest reliability	correlation between scores at two times
Item Sampling	2 different tests given once	Alternate or Parallel forms	correlation between scores on 2 versions
Internal Consistency	One test, multiple items	Split Half or internal reliability	Cronbach's Alpha
Observer Differences	One test w/ 2+ observers	inter-observer reliability	Kappa

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4 Kinds of Validity

	Description	Notes	Statistic(s)
Face	do items “look” valid?	informal, improper, non-scientific	none
Content	do test questions cover the topic?	logic & judgement - there are no stats to calculate	none
Criterion	does the test predict a specific outcome?	requires a well-defined criterion	Pearson's R (correlation) between Test and Criterion
Construct	does the test measure what it claims	modern theory: all validity is Construct validity	Convergent and Divergent correlations (Pearson's R)

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Ch. 6: Test Development

- Test Items
 - question formats (T/F, Multiple Choice, Likert...)
- Guessing & Correction for guessing formula
- Cognitive Factors: Recall vs. Recognition
- Exercise: from construct to question
- Item Analysis: Difficulty, Discriminability, ICC
- Item Response Theory / Adaptive Testing
- SII (Strong Interest Inventory)

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Writing test items

- Define what you are measuring (theory of the construct)
- Write many items that cover the *content*
- Avoid very long items
- Use appropriate reading level
- Don't mix two concepts in one question.
- Vary the “response set” with both positively and negatively worded items

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Test Item Formats

- Qualitative
 - Fill in the blank
 - Essay
- Quantitative
 - True / False...
 - Multiple Choice...
 - Rating / Category scales...

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Dichotomous Format

- Aka “True/False” or “Yes/No” or “Binary”
- Pros: easy to write, administer, and score, good for basic facts. Avoids ambivalence.
- Cons: rote memorization, high scores due to guessing → increased # of items, black & white thinking: not appropriate for complexity or nuance
- Summary: unsophisticated format - shouldn't be widely used for achievement testing

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Poly[cho]tomous

- AKA “multiple choice”
- Target: correct answer
- Distractor: incorrect answers
- Pros: easy to administer (covers a lot of material quickly), easy to score, can handle shades of gray / nuance
- Cons: difficult to write, susceptible to guessing strategies, susceptible to “over studying”

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Miller's Law

Distractors?

- Too few distractors --> dichotomous
- Too many distractors --> slow, confusing
- Optimal is 3-5 distractors. Thus, most multiple-choice tests should have between 4 and 6 possible answers per question.
- Distractors should cover a wide range of abilities w/o being cute or trite

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Guessing : Probability

- M = # of answer choices per question
- P_{correct} with random guessing = $1/M$
- On a dichotomous (T/F), $P = \underline{\hspace{2cm}}$
- On a multiple choice test with M answers per question, the probability = $\underline{\hspace{2cm}}$
- Total score from guessing:
 - $N_{\text{questions}} \times P_{\text{correct}}$

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Guessing : Expected Score

- Probability of getting any item correct, using a random guessing strategy, p is equal to 1 divided by the # of answers.
- On a dichotomous (T/F) test the probability $P = 1/2 = 50\% = 0.5$
- On a multiple choice test with M answers per question, the probability = $1 / M$. For a 4 item test $P = 1/4 = .25 = 25\%$
- Total score due to guessing = # of questions times average score per item or $N * P$.
- Example: an 100 item test with 4 answers = 25

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Guessing impacts Validity

Correcting for Guessing

- Scores can correct for guessing.
- Goal: person randomly answering should get same score as someone who doesn't answer.
- Expected score of someone who answers no questions = 0
- Expected score of someone who guesses randomly is $N * (1/M)$
- Correction:
 - For every wrong answer, subtract $1/(M-1)$ points.

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Correcting for Guessing : Example

- Example:
 - a 100 item test (N=100)
 - each question has 5 choices (M=5)
 - probability of right answer by guess? ($P = 1/M = 1/5 = 20\%$)
- A student guessing on each item would average 20 correct ($P*N = 0.2 * 100 = 20$)
- Correction: subtract $(1/M-1)$ points for each wrong answer $= 1/(5-1) = 1/4 = 0.25$ points.
- Adjusted score?

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Correcting for Guessing - Real World

- Formula is simplistic
- College Board removed guessing penalty for AP exams in 2010
- SAT revisions in March 2016
 - Removes penalty for Guessing
 - other changes:
 - Essay is optional
 - Vocabulary test changed

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When should you guess?

- Almost always
- Worst case: if a correction formula is in use, and you truly have zero information for a given item, guessing has no effect
- However, it's likely you do have some knowledge. This increases your chances slightly above chance, giving you a positive expected score.

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[di | poly]chotomous Issues

- Pros:
 - neutral, fair scoring
- Types of knowledge:
 - Recall vs. Recognition
 - Receptive vs. Expressive
- Skill =? test taking ability
- Solution: Essay test format

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Accessing Knowledge

- Recalling information is different than Recognizing it
- Neuropsychology suggests different brain systems. Recall can be stronger or weaker than Recognition
- Issues for testing:
 - What type of access is involved in polychotomous testing?
 - Is it fair to test using a method which prefers one type over the other?

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Recall vs. Recognition

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Recall vs. Recognition

- Remember these numbers:
 - 134592618
 - 214577131

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The magical number

- What is the magical number?
 - 1, 2, 3, 4, 5, 6, 7, 8, 9 ?
- Answer:
 - this slide is here to flush your short term working memory

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Recall vs. Recognition

- Recall both numbers now

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Recall vs. Recognition

- Which of these numbers were you asked to remember?
 - 021418321
 - 134592618
 - 214577131
 - 213011764
 - 138363732

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Facts vs Opinions?

- Polychotomous : good for assessing factual information
- What about measuring opinions, preferences, styles?

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Other question formats

- Likert Scale
- Category Rating Scale
- Visual Analogue Scale
- Q-Sorts
- Checklists

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Rensis Likert

American social psychologist

Pronounced “LICK-ert”



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Likert Format

- Asked to rate statements on an ordinal scale with a short list of answer choices
- Example:
I am afraid of heights:
1 strongly disagree
2 disagree
3 undecided
4 agree
5 strongly agree
- Numbers : sometimes shown, sometimes not shown.

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Likert : Neutral?

- Sometimes, want to avoid the middle (neutral, undecided) answer
- Example:
- I am afraid of heights:
1 strongly disagree
2 somewhat disagree
3 somewhat agree
4 strongly agree
- Like T/F, forces subject to take a position

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Likert : Balance & Symmetry

- Answers should be balanced & symmetrical
- Example:
- I am afraid of heights:
1 strongly disagree
2 somewhat disagree
3 neutral
4 somewhat agree
- Poor design
 - Answers will be biased towards 3 or 4

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Category (Rating Scale) Format

- Similar to Likert format, but #s are used instead
- Pros -- responses are more precise than with Likert scales (10 vs. 5 or 6)
- Cons -- context effects stronger
 - Solution: clearly define endpoints
- Precision vs. Accuracy?

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Category Example

- On a 1 to 10 scale how much do you like your partner?
 - 1 Planning to break up
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7
 - 8
 - 9
 - 10 Planning to get Married soon
- Issues:
 - Unbalanced (is 5 or 6 the middle?)
 - Hard to interpret : what does a “2” or “3” really mean?

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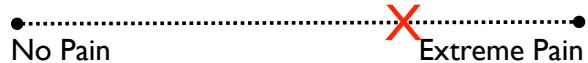
How many choices?

- Research suggests optimal # of choices is between 4 and 7
 - consistent with Miller's 7 ± 2
- Using up to 10 choices is OK if
 - raters are motivated
 - good anchors & examples are provided
 - Otherwise, 10 choices leads to random responding

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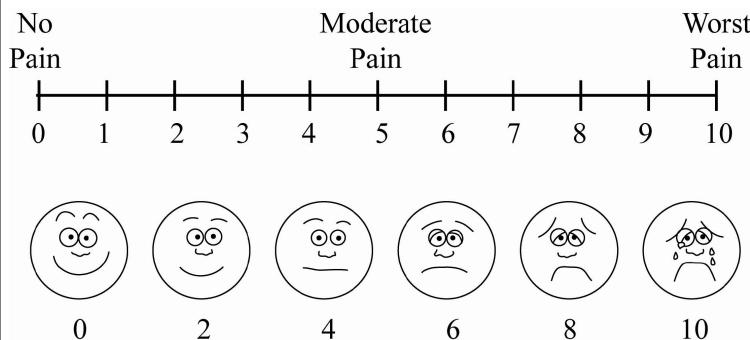
Visual Analogue Scale

- Similar to Category format, except use of a visual stimulus & graphical measurement
- Example:
How much pain are you in right now?

- Pros: allows a precise, finely detailed response
Cons: hard to score, precision vs. accuracy?

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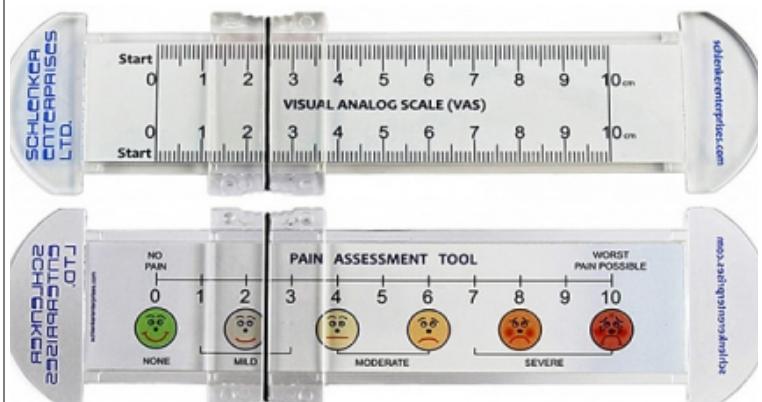
Visual Analogue Scale



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Visual Analogue Scale



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Checklists

- Checklists:
 - Agree/disagree with large # of statements
 - Example
 - "I am currently having trouble with..."
- Money
 Relationships
 Appetite
 Sleep
 ...

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Q sorts

- Q sort:
 - sort large # of statements into piles depending on how much you agree/disagree (like Likert format)
 - Responses follow bell-shaped curve, extreme responses are most interesting

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Advice from Textbooks

Advice	% endorsing
Don't use "All of the above"	80%
Don't use "None of the Above"	75%
All choices should be plausible	70%
Negative wording shouldn't not be un-used	55%

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Intermission

- 2 day/week format

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Ch. 6 - Part 2

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Review

- Reliability and Validity of entire Test
- Individual Test Items
 - dichotomous / polychotomous
 - recall vs. recognition
 - Likert
 - neutral, balanced
 - Category
 - anchors, context effects
- Ideal # of answers per question?

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Item Analysis

- In Ch 5 we discussed the reliability and validity of *the entire test*.
- Now we look at psychometrics of *individual test items*.
- Item Difficulty
- Item Discriminability

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Item Difficulty

- How hard is this item?
- % who get the item correct (item easiness)

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Too hard / Too easy

- Floor effect: many scores near the bottom range of possible scores
- Ceiling effect: many scores near the top range of possible scores

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Item Difficulty

- How hard is this item?
- % who get the item correct (item easiness)
- Ideal= halfway between chance and perfect
 - for a 4-item multiple choice, chance = 25%, so optimum would be 62.5%
- typical range is 30% to 70%
- Tests should contain wide variety of item difficulties, because people are different

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Item Difficulty 2

- Mathematically, 30%-70% is optimum
- What about human / emotional issues?
 - Tests or items that are too hard?
 - Tests or items that are too easy?

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Discriminability

- Difficulty = how many people answer correctly?
- Discriminability = who answers correctly?
- Does performance on one item correlate with overall test performance?
- Two ways
 - statistical
 - graphical

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Discriminability - Statistical

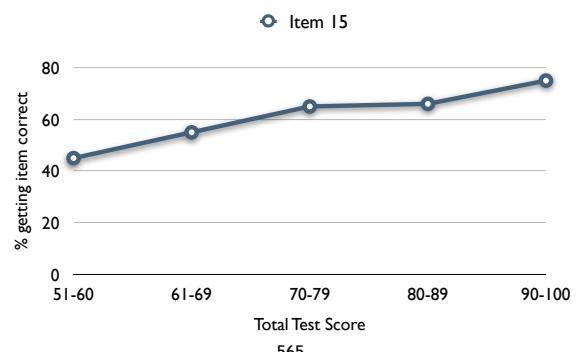
- Extreme Group:
 - divide test takers into thirds
 - % correct : top third vs. bottom third
- Point Biserial
 - p.b. correlation between item and test score
 - low or negative values represent “bad” items

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Discriminability - Graphical

- Item Characteristic Curve
- Graph % correct vs. total test score for one test item

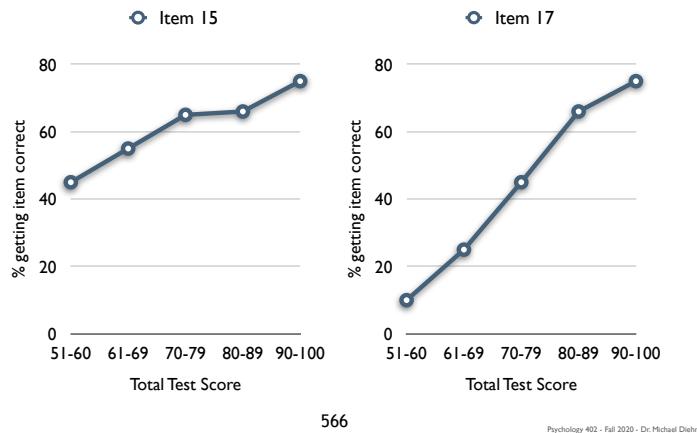


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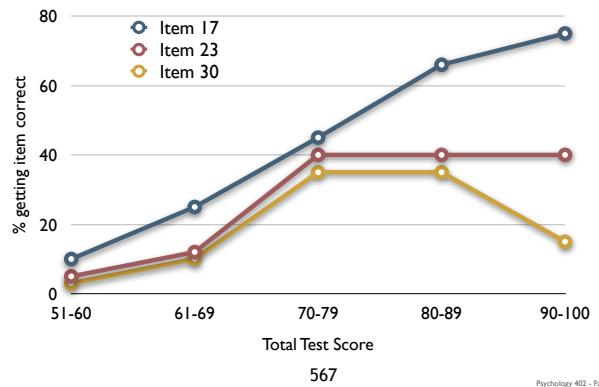
Item Characteristic Curve

- Different test items have different ICCs



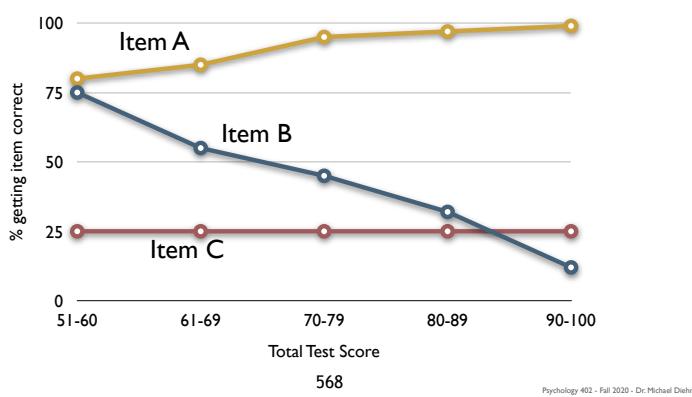
Item Characteristic Curve

- Good items show steady increase
- Bad items show decreases or flat spots



ICC Example

- Diagnose these problems:



Graph the ICC

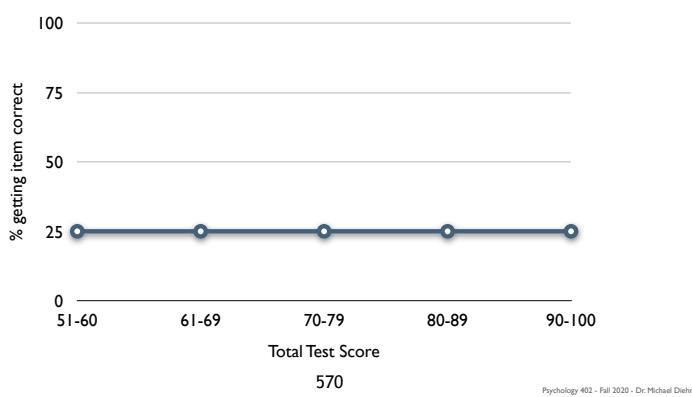
- Item 1: What was the exact population of the town Bodie, California, in 1879?
 - (A) 6142
 - (B) 6143
 - (C) 6144
 - (D) 6145
- Correct answer = A

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ICC Example

- Random guessing



Graph the ICC

- Item 1: What is 0.34×0.27
 - (A) 9.18
 - (B) 0.61
 - (C) 0.0918
 - (D) 91.8
- “Correct Answer” = B

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ICC Example

- Answer key is wrong



Graph the ICC

- Item 1: What is $1 + 2$
(A) 11
(B) 21
(C) 3
(D) 0.3

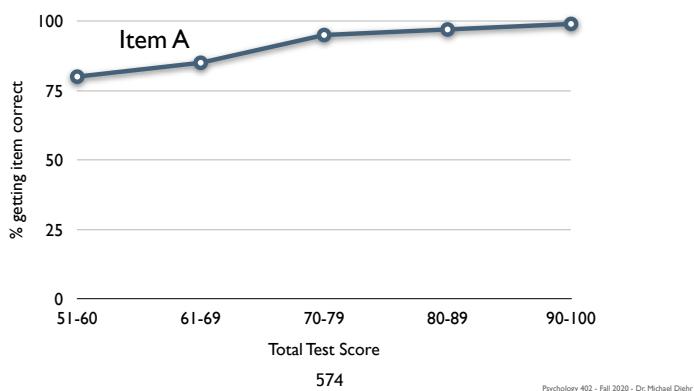
- Correct answer = C

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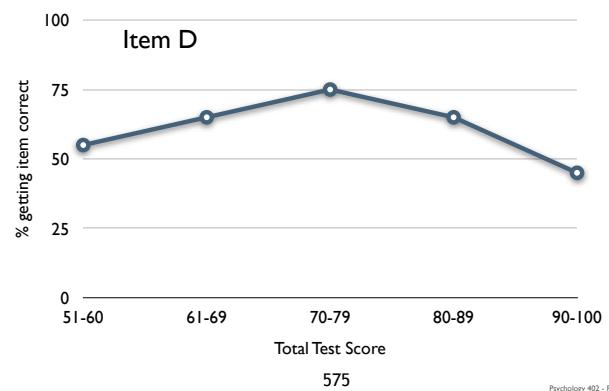
ICC Example

- Item is too easy



ICC Example

- The “Overstudying” problem:



Q: How many Human Genders are there?

- A : One (Human)
- B : Two (Male, Female)
- C : Three (Male, Female, Neuter)
- D : Four (Male Adult, Male Child, Female Adult, Female Child)
- E : None of the above

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Item Response Theory (IRT)

- Classical Test theory
 - your ability = *number of items correct*
- IRT
 - your ability = *level of difficulty* at which you can perform
- IRT Model : probability of correct answer is modeled using several variables (for the test and the test-taker)
- IRT Procedures: computer-based *adaptive testing*

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IRT / Adaptive Testing

- To cover a range of ability levels, tests must have a range of item difficulties
- For one individual, therefore many items are much too easy and much too hard
- “old fashioned” solution = have several tests (easy...medium...hard) and pick a test based on pre-existing knowledge of person.
- IRT solution = one test that automatically detects person’s level and gives questions mainly in that difficulty level.

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IRT in the real world

- IRT is theoretically better
- Adoption in curriculum is slow
- some tests use it but vast majority do not
- Continuing research

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External Criteria

- Internal Criteria = total test score
- External Criteria = thing that actually matters (e.g. “do you crash the plane”)
- Most Item Analysis still uses Internal criteria rather than the more correct External Criteria
- Why?

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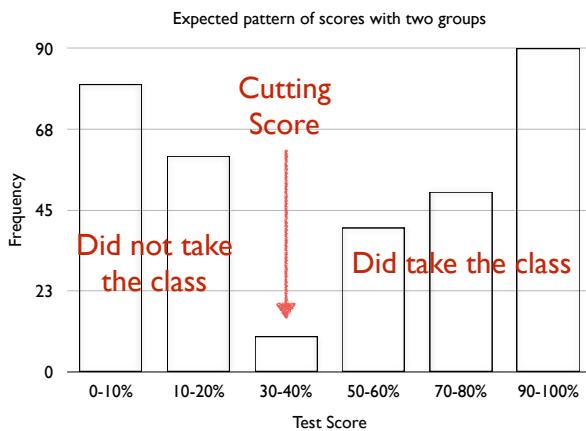
Criterion-referenced Test

- Instead of arbitrary criteria such as “70% = pass” use one with more validity.
- Criteria = the learning outcome(s) desired
- Method:
 - create a good test
 - give it to two groups of students
 - those who have had the material
 - those who have not
 - Determine cut-point score from histogram

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Criterion-referenced Test



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Limitations of Item Analysis

- Tests discriminate between levels of performance
- Statistics (difficulty and discriminability) don’t tell why a person missed an item
- Items might discriminate well (statistically) but for the wrong reasons (educationally)
- Tests don’t directly help people learn
- Tests can harm, if they dramatically change learning behavior (e.g. study for the test rather than the subject)

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Example of a poor test item?

- What is 0.4 plus 0.3
 - (A) 0.3
 - (B) 0.4
 - (C) 0.7
 - (D) .07
- Is answering (A) better or worse than answering (D)?

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Strong Interest Inventory (SII)

There will not be any questions about the SII on the midterm

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About the SII

- 291 multiple choice questions (polychotomous)
- Likert-style questions
- Takes about 25 minutes to take
- Developed in 1927 by E.K. Strong, Jr.
- Vocational placement upon leaving military
- Based partly on “Holland Codes”

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Holland Typology

- Theory: personality and vocations share six main *factors*

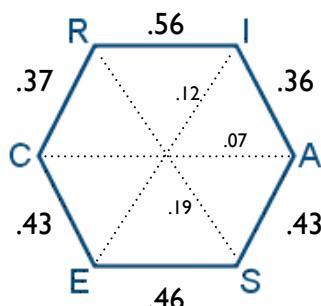
Type	Description
Realistic	practical, physical, hands-on, tool-oriented
Investigative	analytical, intellectual, scientific, explorative
Artistic	creative, original, independent, chaotic
Social	cooperative, supporting, helping, healing/nurturing
Enterprising	competitive environments, leadership, persuading
Conventional	detail-oriented, organizing, clerical

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Holland Typology

- Type : usually expressed as top 3 factors
- Hexagon indicates correlation between factors



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SII uses T-Scores

	Z scores	IQ scores	T scores	Scaled Scores
Mean	0	100	50	10
SD	1	15	10	3

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The Structure of the SII

- Section 1 : General Occupational Themes
- Section 2 : Basic Interest Scales
- Section 3 : Occupational Scales
- Section 4 : Personal Style Scales
- Section 5 : Profile Summary
- Section 6 : Response Summary

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1 : General Occupational Themes (GIS)

Describes your interests, work activities, potential skills, and personal values in six broad areas: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C).

YOUR HIGHEST THEMES		YOUR THEME CODE	
Artistic, Investigative, Social		AIS	
THEME	CODE	STANDARD SCORE & INTEREST LEVEL	STD SCORE
Artistic	A	< 30 40 50 60 70 >	VERY HIGH 71
Investigative	I		56
Social	S		51
Enterprising	E		48
Conventional	C		43
Realistic	R		37

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2: Basic Interest Scales (BIS)

Identifies specific interest areas within the six General Occupational Themes, indicating areas likely to be most motivating and rewarding for you.

YOUR TOP FIVE INTEREST AREAS	
1. Writing & Mass Communication (A)	
2. Performing Arts (A)	
3. Visual Arts & Design (A)	
4. Culinary Arts (A)	
5. Law (E)	

Areas of Least Interest	
Management (E)	
Computer Hardware & Electronics (R)	
Military (R)	

ARTISTIC — Very High

BASIC INTEREST SCALE	STD SCORE & INTEREST LEVEL	STD SCORE
Writing & Mass Communication	VH	71
Performing Arts	VH	71
Visual Arts & Design	VH	70
Culinary Arts	VH	67

INVESTIGATIVE — Moderate

BASIC INTEREST SCALE	STD SCORE & INTEREST LEVEL	STD SCORE
Law	VH	66
Marketing & Advertising	VH	65
Politics & Public Speaking	H	58
Entrepreneurship	M	48
Sales	L	41
Management	VL	33

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ENTERPRISING — Moderate

BASIC INTEREST SCALE	STD SCORE & INTEREST LEVEL	STD SCORE
Law	VH	66
Marketing & Advertising	VH	65
Politics & Public Speaking	H	58
Entrepreneurship	M	48
Sales	L	41
Management	VL	33

3 : Occupational Scales (OS)

Compares your likes and dislikes with those of people who are satisfied working in various occupations, indicating your likely compatibility of interests.

YOUR TOP TEN STRONG OCCUPATIONS

1. Librarian (A)
2. Technical Writer (AIR)
3. Broadcast Journalist (AE)
4. Graphic Designer (ARI)
5. Photographer (ARE)
6. Reporter (A)
7. Chef (ERA)
8. Attorney (A)
9. Editor (AI)
10. Translator (A)

Occupations of Dissimilar Interest

- Physical Education Teacher (SRC)
- Physicist (IRA)
- Athletic Trainer (RIS)
- Mathematician (IRC)
- Mathematics Teacher (CIR)

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4 : Personal Style Scales (PSS)

Describes preferences related to work style, learning, leadership, risk taking, and teamwork, providing insight into work and education environments most likely to fit you best.

PERSONAL STYLE SCALE		CLEAR < 75	MIDRANGE 75 - 85	CLEAR 85 - 75 >	STD SCORE
Work Style	Prefers working alone; enjoys data, ideas, or things; reserved		◆		47
Learning Environment	Prefers practical learning environments; learns by doing; prefers short-term training to achieve a specific goal or skill		◆		65
Leadership Style	Is not comfortable taking charge of others; prefers to do the job rather than		◆		54

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5 : Profile Summary

Provides a graphic snapshot of Profile results for immediate, easy reference.

PROFILE SUMMARY

SECTION 5

YOUR HIGHEST THEMES

- Artistic, Investigative, Social

YOUR THEME CODE

AIS

YOUR TOP FIVE INTEREST AREAS

1. Writing & Mass Communication (A)
2. Performing Arts (A)
3. Visual Arts & Design (A)
4. Culinary Arts (A)
5. Law (E)

Areas of Least Interest

- Management (E)
- Computer Hardware & Electronics (R)
- Military (R)

YOUR TOP TEN STRONG OCCUPATIONS

1. Librarian (A)
2. Technical Writer (AIR)
3. Broadcast Journalist (AE)
4. Graphic Designer (ARI)
5. Photographer (ARE)
6. Reporter (A)
7. Chef (ERA)
8. Attorney (A)
9. Editor (AI)
10. Translator (A)

Occupations of Dissimilar Interest

- Physical Education Teacher (SRC)
- Physicist (IRA)
- Athletic Trainer (RIS)
- Mathematician (IRC)
- Mathematics Teacher (CIR)

YOUR PERSONAL STYLE SCALES PREFERENCES

1. You are likely to prefer a balance of working alone and working with people
2. You seem to prefer to learn through lectures and books
3. You probably are comfortable both leading by example and taking charge
4. You may dislike taking risks
5. You probably enjoy both team roles and independent roles

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6 : Response Summary

Summarizes your responses within each category of Strong items, providing interpretive data useful to your career professional.

RESPONSE SUMMARY

SECTION 6

This section provides a summary of your responses to the different sections of the inventory for use in interpretation by your career professional.

ITEM RESPONSE PERCENTAGES					
Section Title	Strongly Like	Like	Indifferent	Dislike	Strongly Dislike
Occupations	23	9	17	8	42
Subject Areas	30	13	22	15	20
Activities	18	19	25	12	26
Leisure Activities	54	14	7	11	14
People	44	0	19	19	19
Characteristics	56	11	11	22	0
TOTAL PERCENTAGE	28	13	19	12	29

Total possible responses: 291 Your response total: 290 Items omitted: 1 Typicality index: 19—Combination of item responses appears consistent

Note: Due to rounding, total percentage may not add up to 100%.

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How good is the SII

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SII Reliability

- Generally good Reliability

Type	Cronbach's Alpha	Test-Retest
GOTs	.91 - .95	.84 - .92
BIS	0.87	
Occupational Scales		.82 - .89

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SII Validity

- Concurrent Validity
 - measured % Hit Rate for using Occupational Scale to predict College Major
 - Excellent or Moderate hit:
 - 82% for females, 92% men
 - Predictive Validity
 - % hit rate for major Senior for tests taken as Freshmen (3.5 years)
 - 69% females, 70% for males

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SII Validity - Donnay & Borgen (1996)

- Methods: 55000 subjects took the SII at their current job. Mean age 42, 50 occupations
 - Selected subjects who had:
 - “typical” job duties
 - “very” or “somewhat” satisfied
 - N= 10000 men + 10000 women
 - Goal:
 - Using SII factors, predict their occupation

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SII Validity - Donnay & Borgen (1996)

- Results:
 - predictions depended on scale used
 - 9% hit rate (personal style scales)
 - 10% hit rate (GOTs)
 - 22% hit rate (Basic Interest Scales)

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Does it work?

Strong Interest Inventory® College Profile

USING YOUR OCCUPATIONAL SCALES

These scales identify jobs held by people with whom you share common interests, arranged in order of similarity of interests. Some occupations require specific training; however, many do not require a particular college major. Explore classes relevant to these occupations and consider related careers as well.

YOUR TOP STRONG OCCUPATIONS

OCCUPATIONAL SCALE	THEME CODE	EDUCATIONAL PREPARATION	COLLEGE COURSES	RELATED CAREERS
University Professor	IAS	PhD	Varies by academic discipline	Academic Dean College Instructor Research Scientist
Biologist	IA	MA or PhD in biological sciences	Biology Botany Biochemistry	Biochemist Geneticist Oceanographer
Mathematician	ICA	MA or PhD	Math Statistics Computer Science	Actuary Statistician Engineer Analyst
Psychologist	IA	PhD	Psychology Statistics Social Sciences	Psychiatrist Counselor Psychometrist
Software Developer	IAR	BA, preferably in computer science	Computer Science Engineering Mathematics	Computer Consultant Database Manager Information Officer

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Intermission

- 2 day/week format

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