E-411 PRMA

LECTURE 14 - EQUATING AND INTELLIGENCE

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EQUATING PROCESS

- The first form that is used to derive scale scores is the base form
- After the raw-to-scale conversion has occurred this form is on scale
- We then equate a new form to a form that is already on scale
- The form already on scale is our reference form and the form that is not yet equated is our new form
- Once our new form is on scale, we can calculate raw scores for the new test takers for the reference form and use the reference form to derive scaled scores
- **An issue** - Can derive reference scores that weren't possible because of discreteness

OUR FIRST DEF'N OF EQUATING

“A score on the new form and a score on the reference form are equivalent in a group of test takers if they represent the same relative position in the group.”

MEAN EQUATING

The simplest form of equating involves adjusting the scores by the difference in means between the reference and new forms

Substraction of values if the new form is easier

Addition of values if the new form is harder

EXAMPLE

Suppose the target population's mean on the reference form was 80 and their mean on the new form was 85.

1. Which form was harder?
2. What should should someone with a 90 on the new form get on the reference form if we were using mean equating?

PROBLEM WITH MEAN EQUATING (LIVINGSTON, 2014)

Table 3. Difficulty of Questions in Two Forms of a Test (Illustrative Example)

Difficulty of questions	Number of questions on new form	Number of questions on reference form
Very difficult	5	2
Difficult	10	8
Medium	20	30
Easy	10	8
Very Easy	5	2

LINEAR EQUATING

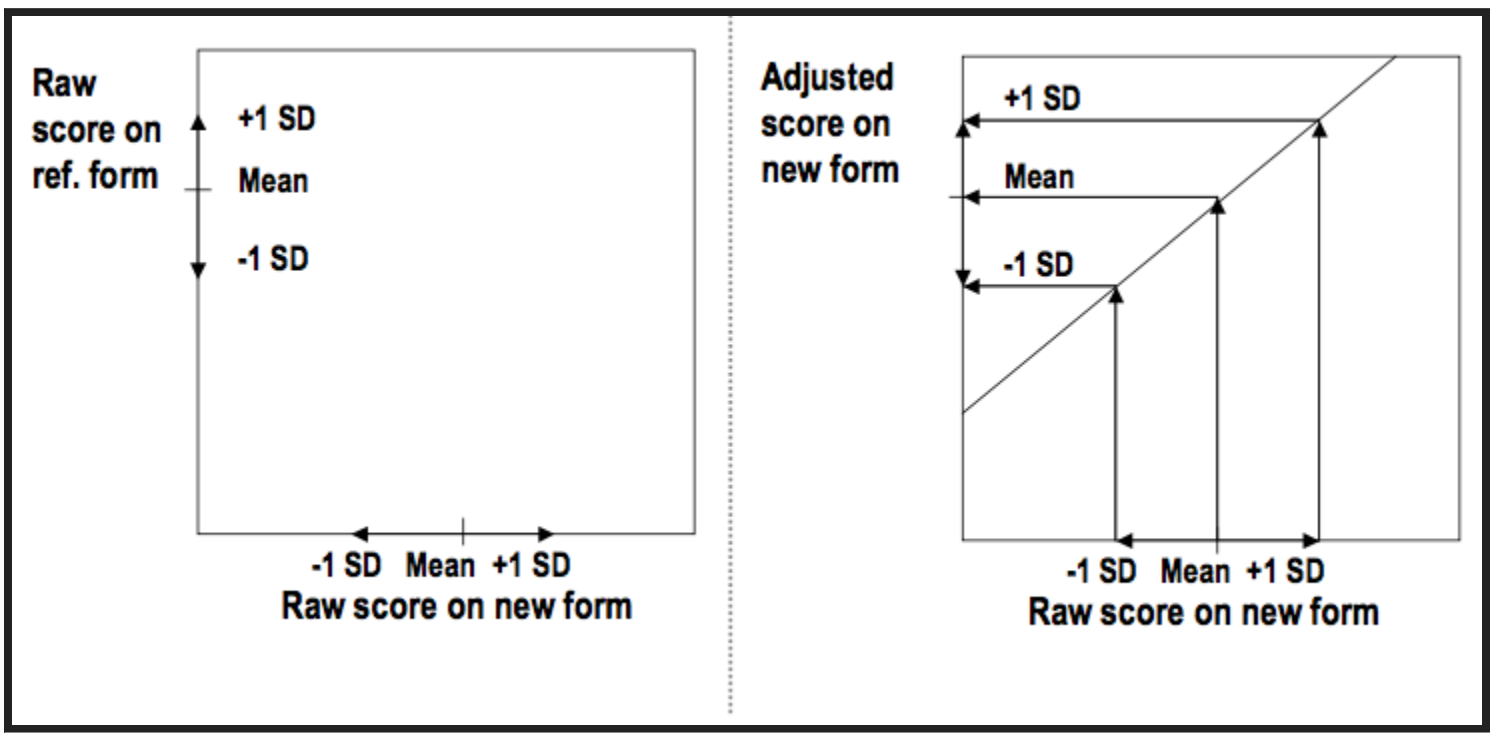
We need to adjust based on how high or low a test taker's score is from the mean

What might we consider doing?

EQUATING BETTER DEF'N

“ A score on the new form and a score on the reference form are equivalent in a group of test takers if they are the same number of standard deviations above or below the mean of the group. ”

Linear equating a harder new form (Livingston, 2014)



LINEAR EQUATING CONCEPTUALLY

- Make the adjusted new form mean equal to the reference score mean
- Same with standard deviations above and below the mean
- Do this for every possible value
- This results in a linear relationship between the new form raw and the new form adjusted scores

DOING THE MATHS!

Let *NF* stand for a score on the new form and *RF* a score on the reference form

$$\frac{RF - \bar{RF}}{sd(RF)} = \frac{NF - \bar{NF}}{sd(NF)}$$

OUR NEW ADJUSTED SCORE

$$RF = \frac{sd(RF)}{sd(NF)}NF + R\bar{F} - \frac{sd(RF)}{sd(NF)}N\bar{F} = \text{adjusted } NF$$

Note, the adjusted *NF* score is very unlikely to ever be a whole number

EXAMPLE

Form	Mean	Standard Deviation
Reference	82	15
New	79	14

If someone scored an 80 on the new form, what should there reference form score be?

$$RF = \frac{15}{14}80 + 82 - \frac{15}{14}79$$

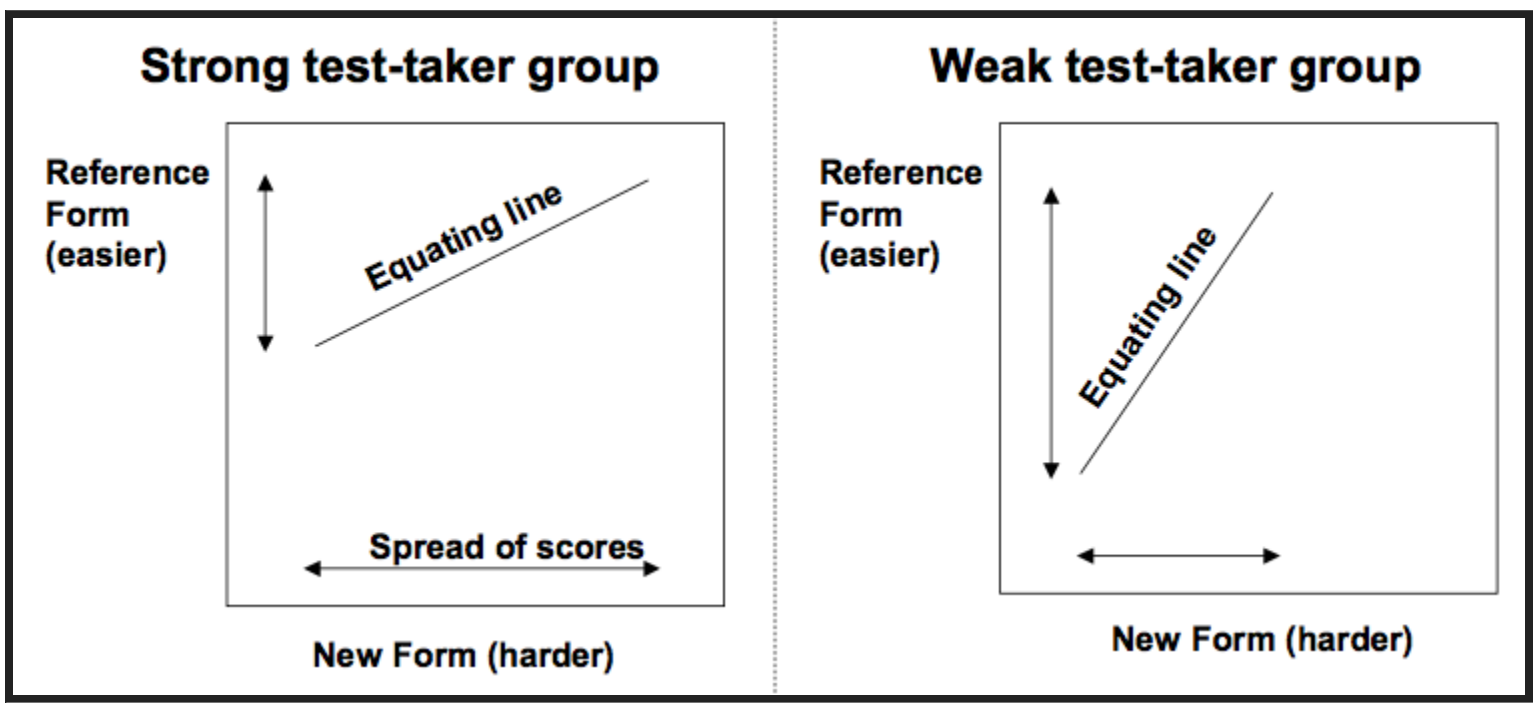
```
# Do the math in R and save it as RF
RF <- (15 / 14) * 80 + 82 - (15 / 14) * 79

# Print RF
RF
[1] 83.07143
```

Does 83.07413 seem sensible?

PROBLEMS WITH LINEAR EQUATING

A very high or very low score can equate to a score outside of the range on the reference form

Depends heavily on the group of test takers (e.g. are they strong test takers? weak test takers?)

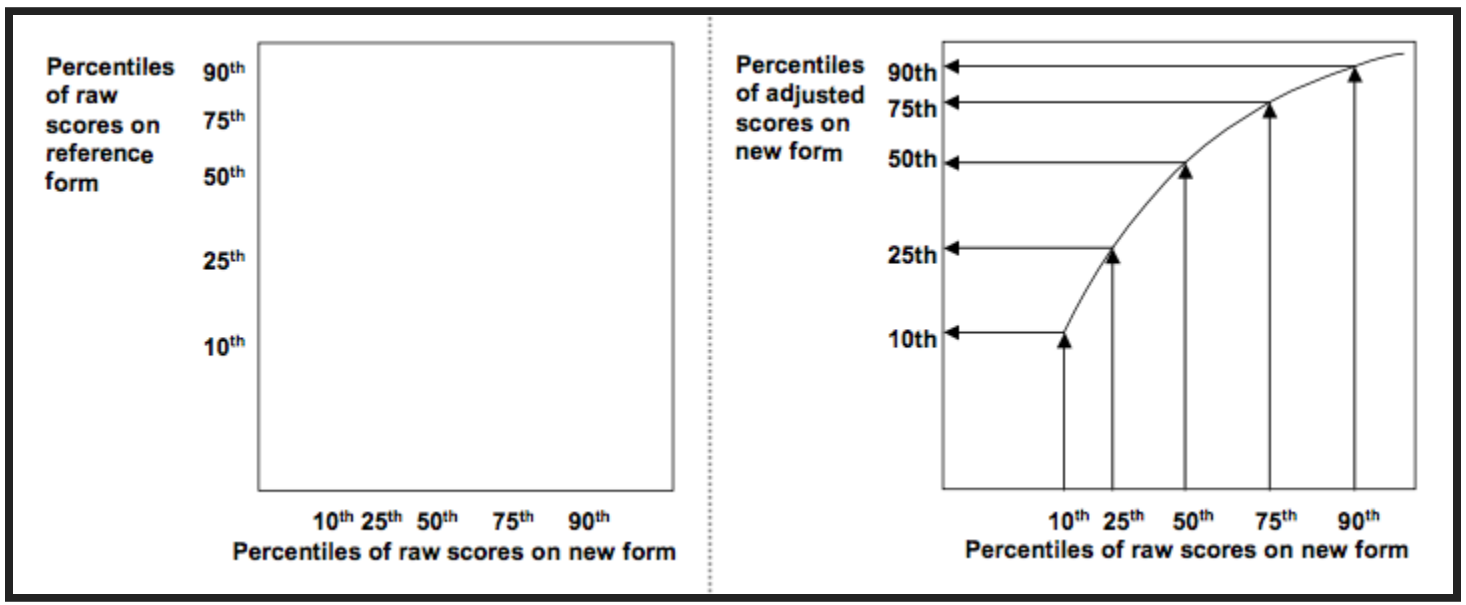


We need an equating that can be shallow for the strong test takers and steep for the weaker ones

EQUIPERCENTILE EQUATING

“To equate scores on the new form to scores on the reference form in a group of test takers, transform each score on the new form to the score on the reference form that has the same percentile rank in that group.”

EQUIPERCENTILE EQUATING WITH A HARDER NEW FORM



EQUIPERCENTILE EQUATING

15th percentile of the adjusted test form corresponds (as much as possible) to 15th percentile on the reference form and so on

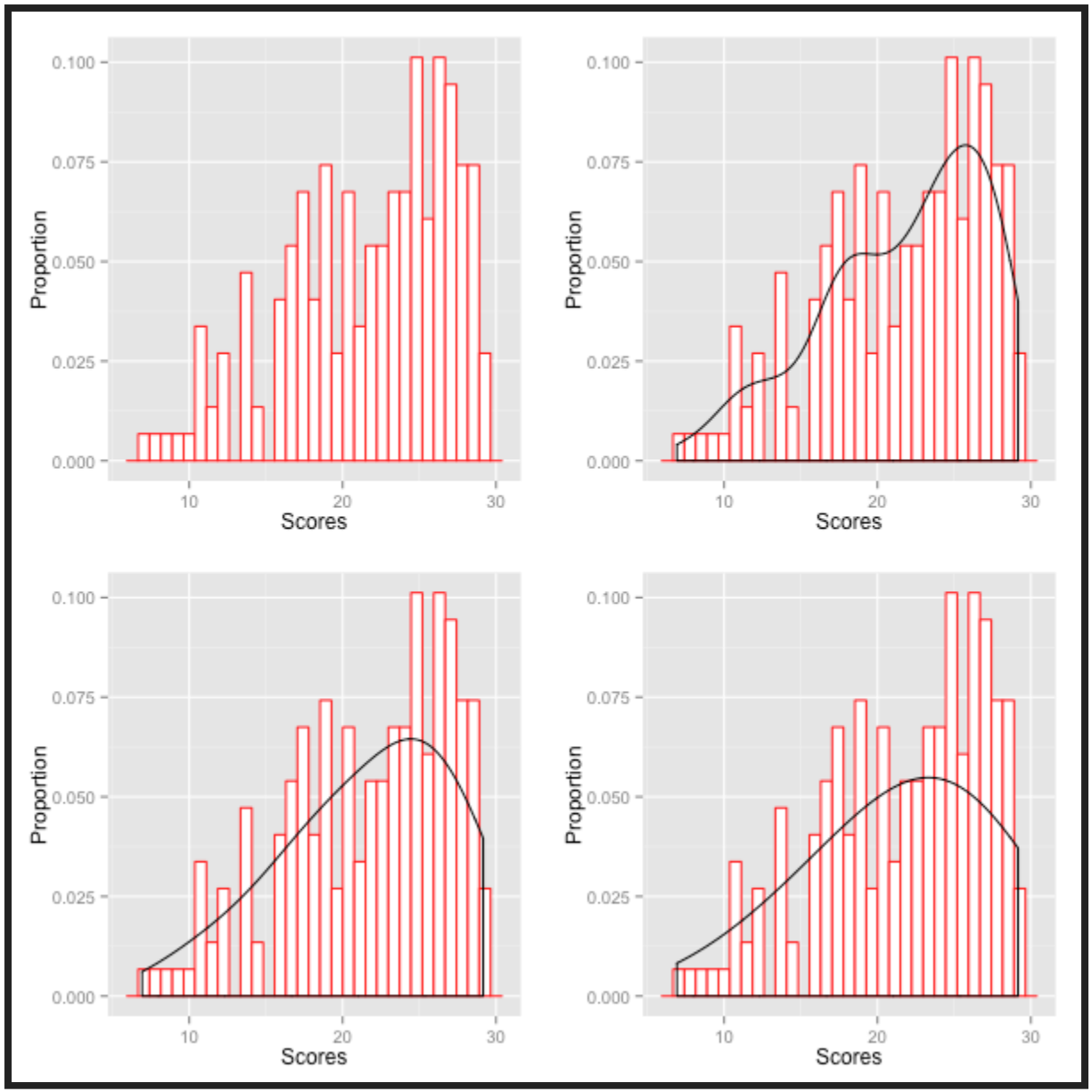
Adjusted scores will all fall within the range of possible scores on the reference form

The steepness of the slope of the curve can vary

Will result in the adjusted test scores having a similar distribution to the reference form

Will be identical to linear equating when the distribution of scores on the new form has the same shape as the distribution of the scores on the reference form

SMOOTHING



LIMITATIONS OF EQUIPERCENTILE

Equating relationship is bound by the highest and lowest observed score

On a difficult test, the highest possible raw score might not be observed

Future administration could result in a higher score being observed

Smoothing may help with this

AGAIN, THE DISCRETENESS PROBLEM (LIVINGSTON, 2014)

New form		Reference form	
Raw score	Percentile rank	Raw score	Percentile rank
52	78.07	52	68.96
51	74.95	51	65.09
50	71.64	50	61.12
49	68.18	49	57.07
48	64.60	48	52.99
47	60.92	47	48.93
46	57.18	46	44.93
45	53.41	45	41.01
44	49.65	44	37.23
43	45.93	43	33.60
42	42.28	42	30.15

Where should the Raw Score of 49 on the New form go on the Reference form?

Can use interpolation to calculate unobserved raw score

CONCLUDING REMARKS ON EQUATING

- Lots of other equating methods exist beyond these three
- Lots of other equating design exist beyond these introduced (briefly)
- Non-equivalent group designs are tricky
- The equate package in R does all of this (and more)

INTELLIGENCE

INTELLIGENCE

What is intelligence?

What makes someone intelligent?

Write one item that you measures intelligence

INTELLIGENCE IS ...

- There is no consensus on what intelligence is
- There is no single instrument to measure intelligence
- To Sternberg's public, intelligence means
  - "Reasons logically and well"
  - "Reads widely"
  - "Displays common sense"
  - "Keeps an open mind"
  - "Reads with high comprehension"

INTELLIGENCE COULD INVOLVE (STERNBERG'S FINDINGS)

- Problem-solving ability
- Verbal ability
- Social competence
- + academic behaviors (Academic intelligence)
- + interest learning & culture (Everyday intelligence)

INTERACTIONIST VIEWS OF INTELLIGENCE

Galton - heritable; possessing great sensory (hearing, visual) abilities; measured sensorimotor and perception task

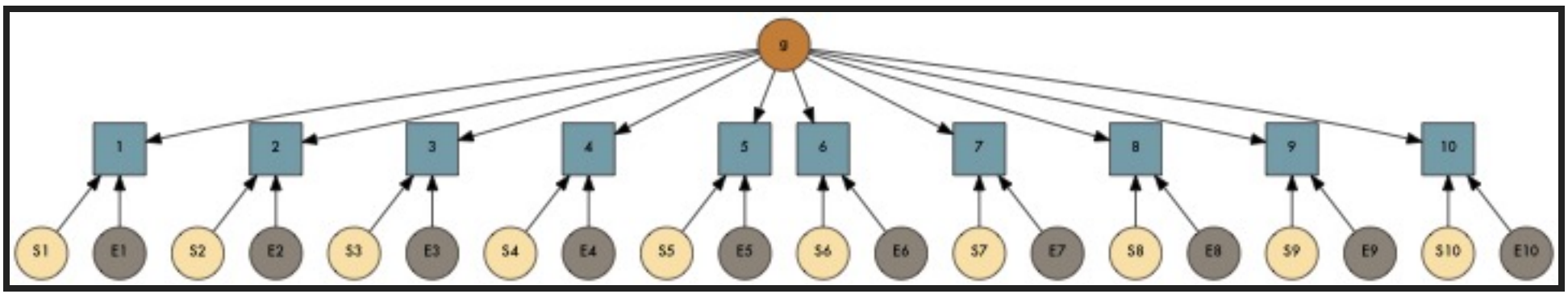
Binet - involves reasoning, judgment, memory, and abstraction and these cannot be assessed seperately

Wechsler - aggregate capacity made of measurable, qualitatively different abilities that interact in a complex, non-additive ways; affected by nonintellective factors (e.g. personality traits); verbal and performance abilities (historical?)

Piaget - evolving biological adaption to the world; assimilation and accomodation

FACTOR ANALYSIS AND INTELLIGENCE

- Structure of intelligence exmamined thoroughly using factor analysis to explore relationships between abilities measured on tests
- Spearman (1927), two-factor theory of intelligence
- Existence of a general ability factor, *g* and specific factors, *s*, and unexplained factor variability (*e*)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INTEMEDIATE GROUP FACTORS