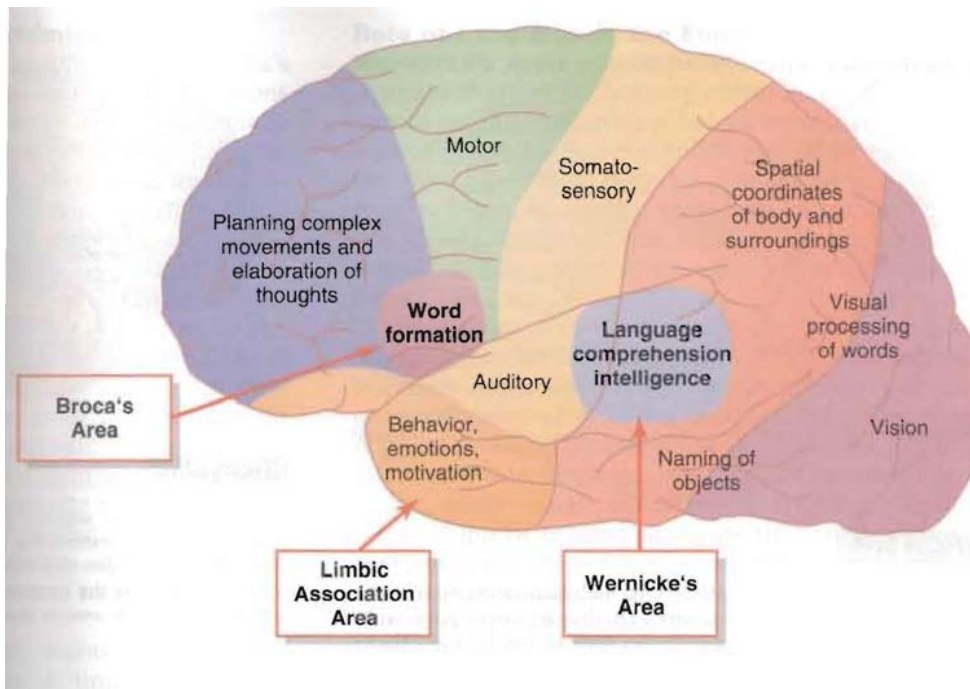


Creativity on the Brain (and its psychometrics)

Linda S. Gottfredson
University of Delaware
Newark, DE

Discussion of Rex E. Jung's presentation, "Neuroimaging of Creativity and Intelligence"
New Voices in Creativity and Intelligence Conference
University of Kansas
Lawrence, KS, November 2, 2009

Exciting interdisciplinary research



Big advances, quickly:

- More imaging methods
- Lower cost
- Larger samples
- More collaboration
- More theory testing
- More psychometric traits
- Etc.

Psychometric (Interpretive) Challenges

- Construct validity

IQ = score

g = theoretical construct

Treating
scores as constructs
badly muddled
intelligence debates

- Restriction in range

- Reliability of measurement

- Sampling error

3 statistical artifacts
misled personnel
selection psychology
for many decades

Your assessment of your field's needs?
Questions of experts here today?

Constructs vs. Measurements

	Construct (empirical phenomenon)	Measurement (score)
“Intelligence”	g—general proficiency at learning, reasoning (“catching on”)	IQ score
“Creativity”	?	?

Hierarchical model of cognitive abilities—

The empirical relatedness of differences across individuals

(factor analyses of scores)

Where is “intelligence”?
It’s just a label that can be applied to different layers of traits in—or outside—the hierarchical model

MOST GENERAL

Domain general

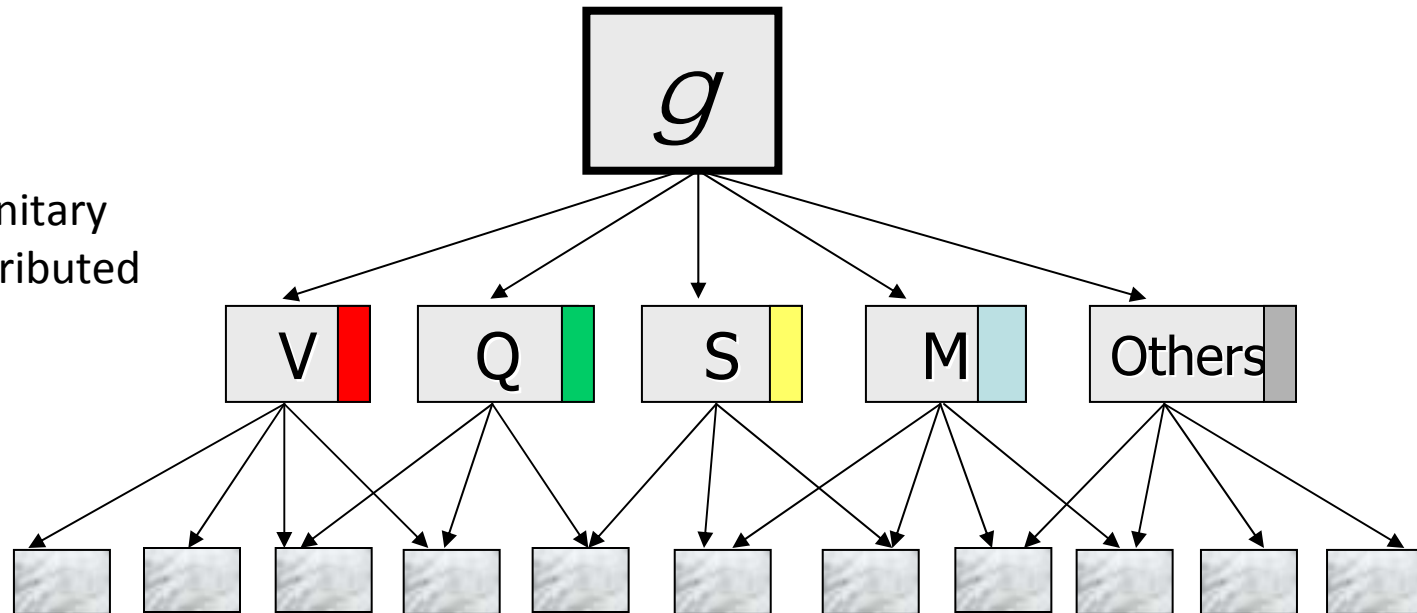
More heritable

Psychometrically unitary

Physiologically distributed

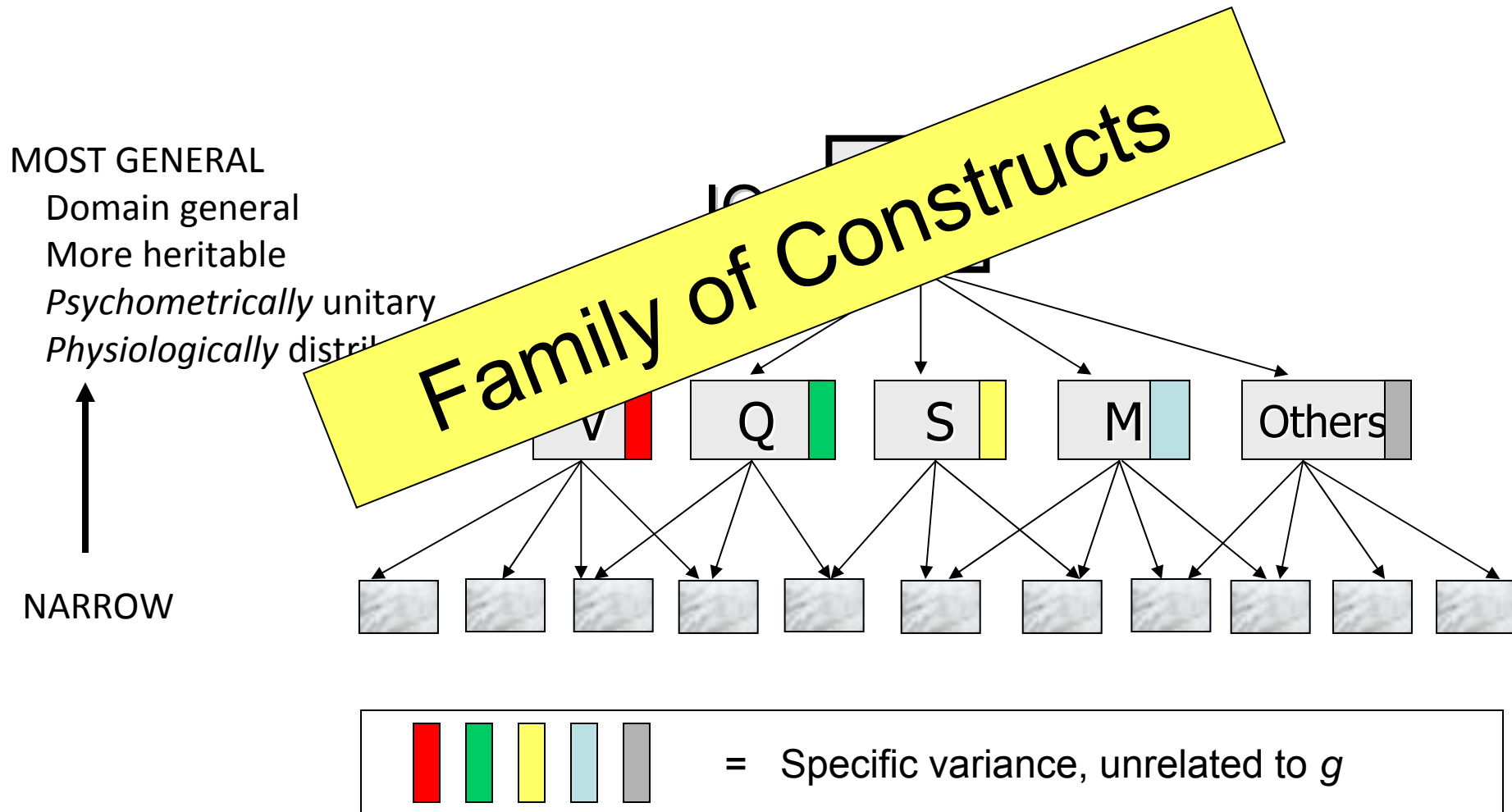


NARROW



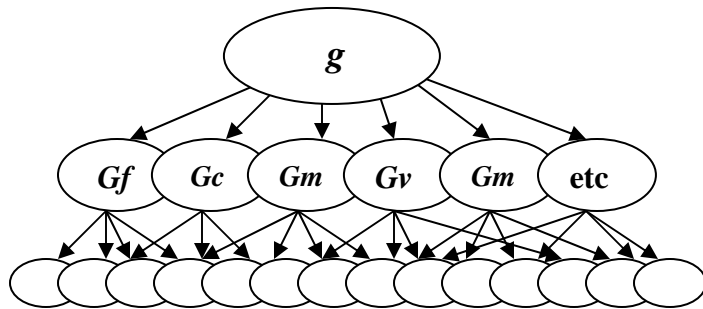
 = Specific variance, unrelated to g

Hierarchical model of cognitive abilities— The empirical relatedness of differences across individuals (factor analyses of scores)



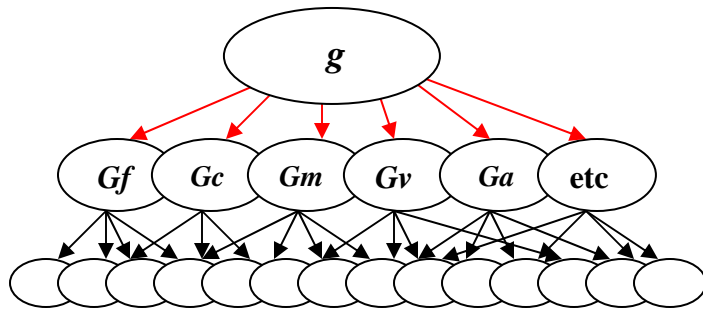
A closer look at constructs vs. measures

Constructs



An often misunderstood point

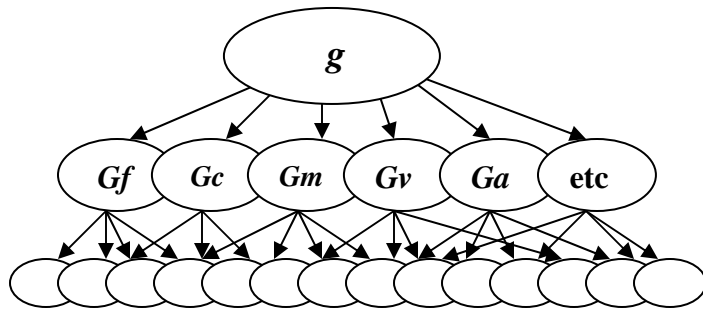
Constructs



g is core ingredient of
all more specific abilities

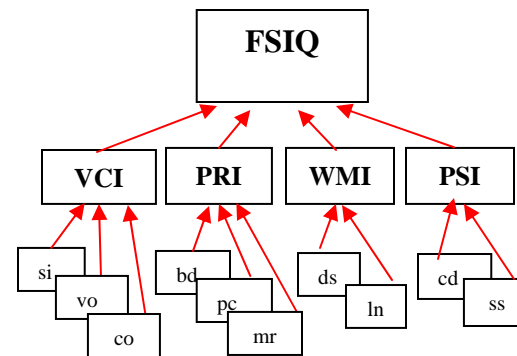
Scores \neq Constructs

Constructs



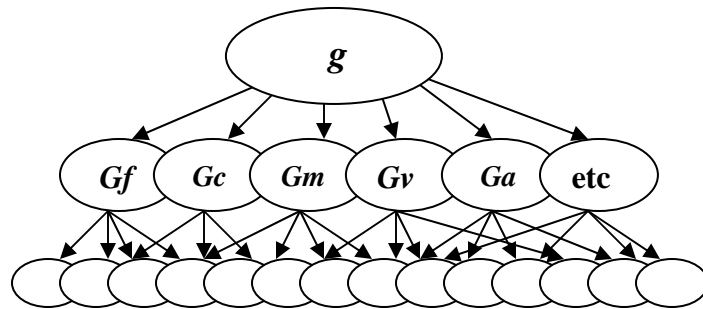
g is core ingredient of
all more specific abilities

Test Scores



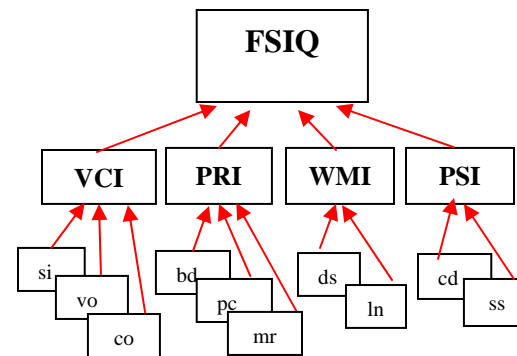
Note: IQ is just sum of scores, **not** of constructs

Constructs



g is core ingredient of all more specific abilities

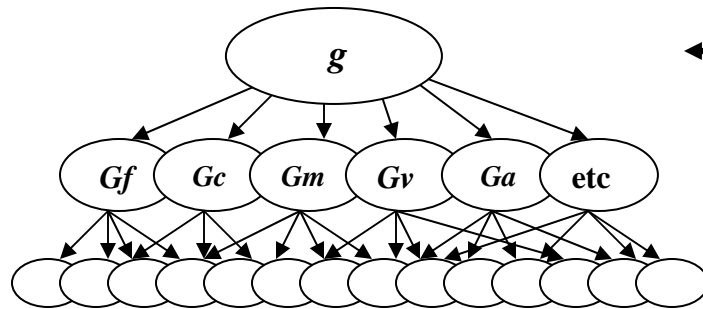
Test Scores



IQ is sum of subtest scores

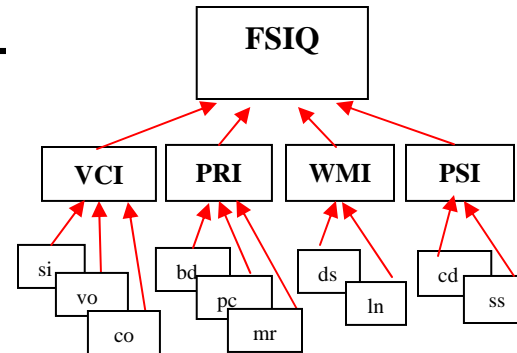
IQ (score) is a good estimate of g (construct)

Constructs



g is core ingredient of all more specific abilities

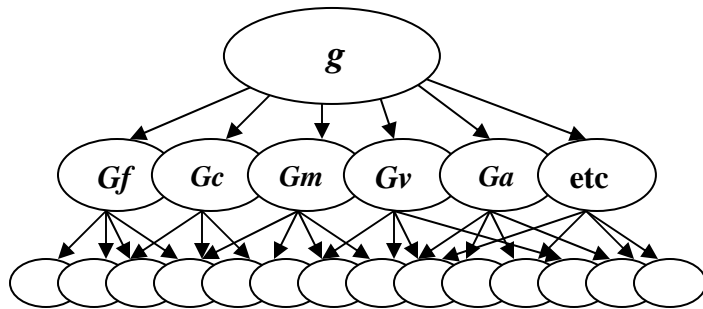
Test Scores



IQ is sum of subtest scores

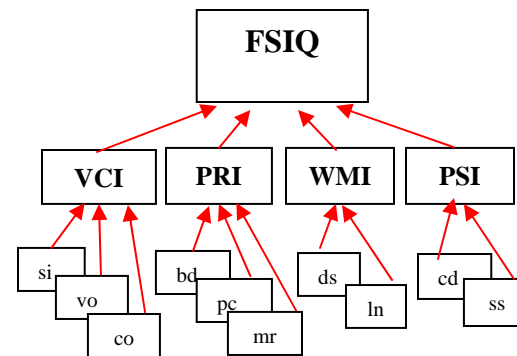
Took 100 years to get here. Lots of conceptual development

Constructs



g is core ingredient of
all more specific abilities

Test Scores

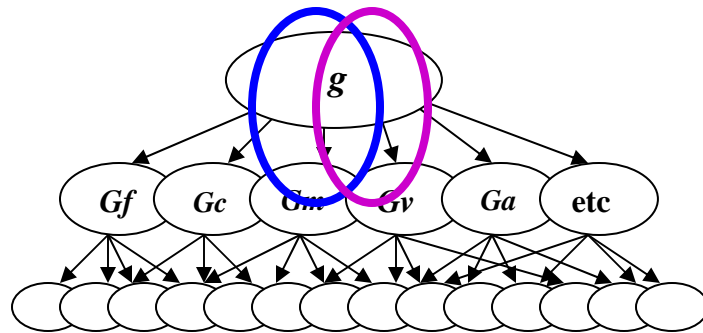


IQ is sum of subtest scores

Jung & Haier (2007) note a serious theoretical problem:
IQ scores in (imaging) studies often not measuring same construct(s)

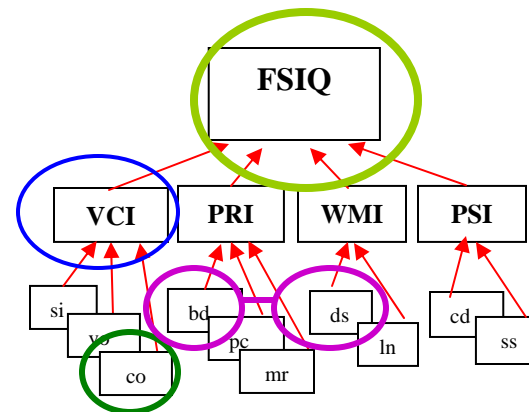
“IQ” scores differ in tilt & precision

Constructs



g is core ingredient of
all more specific abilities

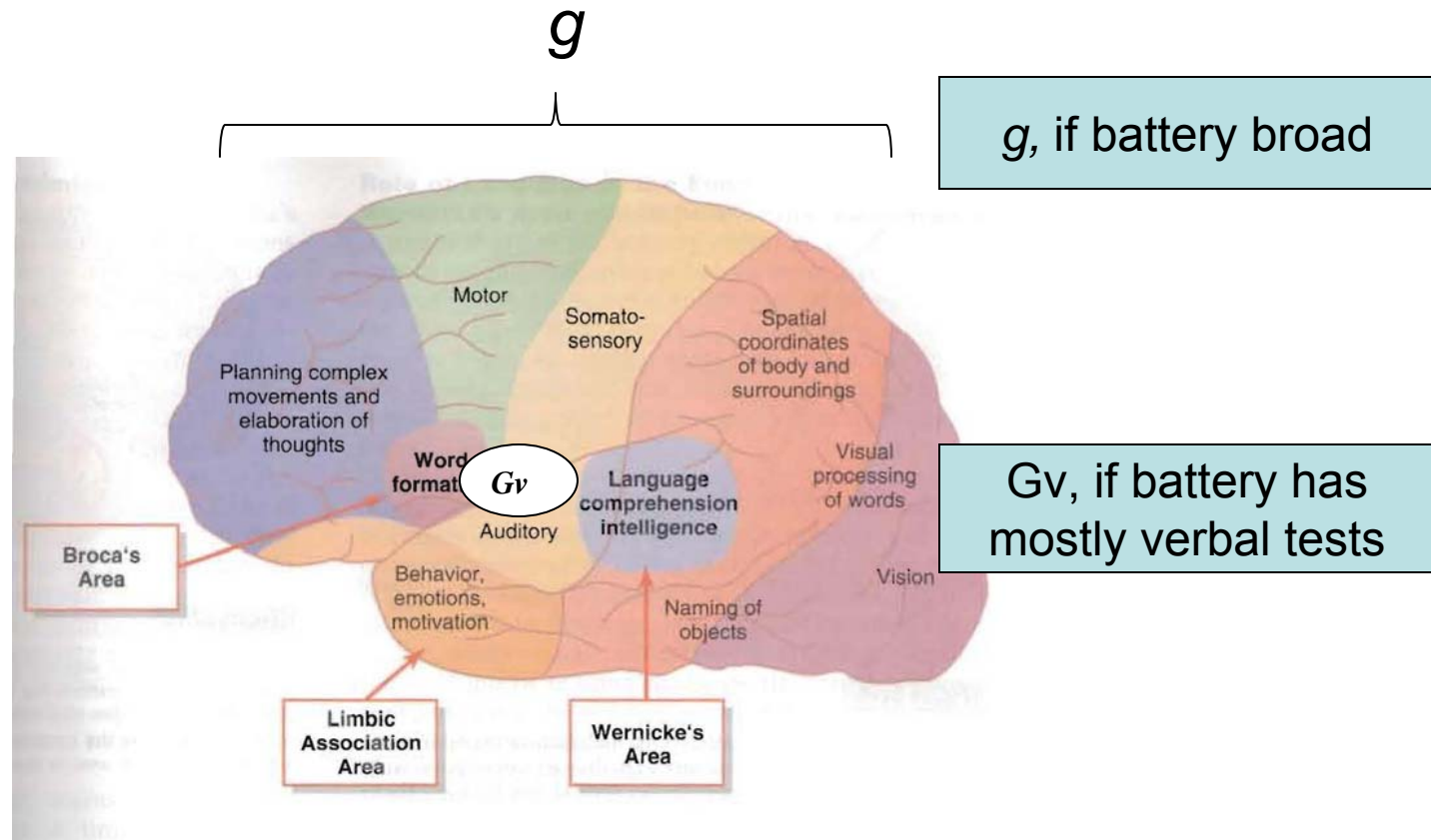
Test Scores



Different studies
use different
“intelligence”
tests.

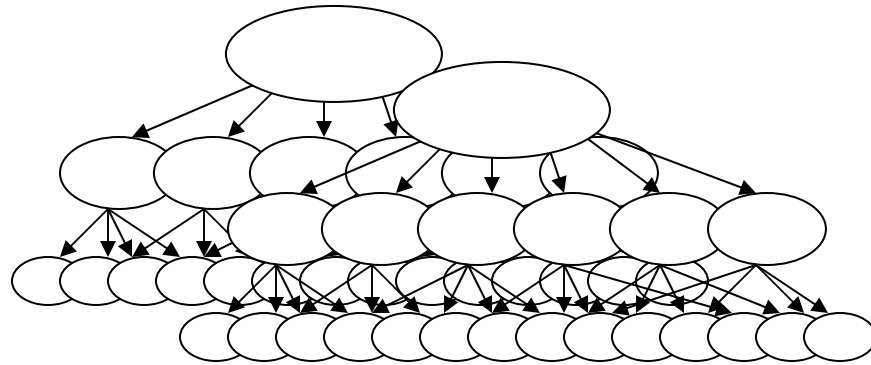
IQ is sum of subtest scores

So, not same processes tapped



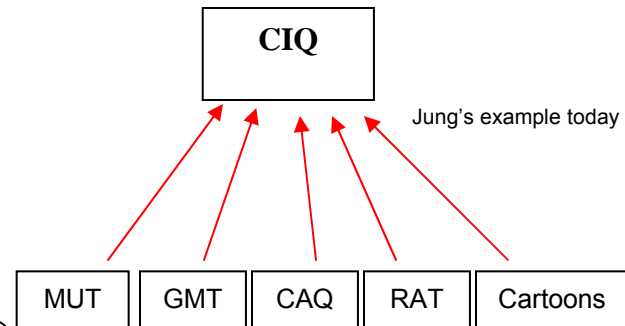
We Need Parallel Conceptual Effort for Creativity

Constructs??



- What is the structure?
- Is there a single *c*?

Test Scores



- Domain coverage?
- Common factors?

Intersection of 2 domains?

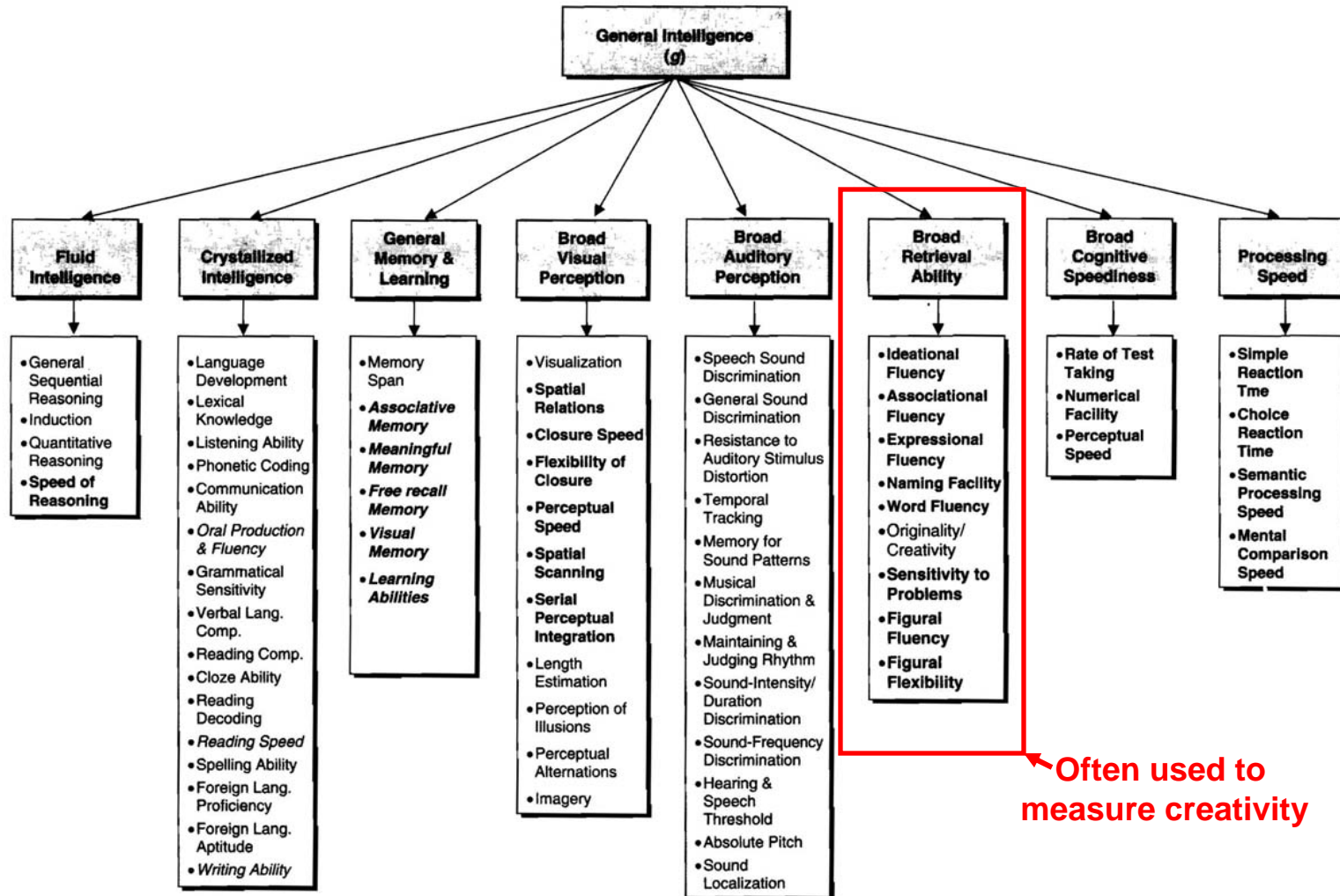
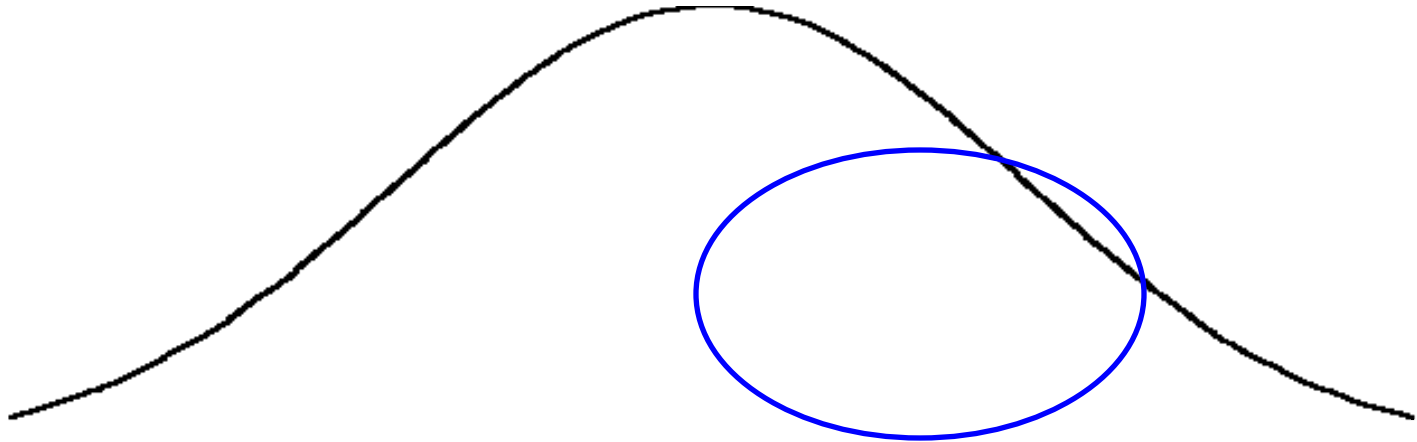


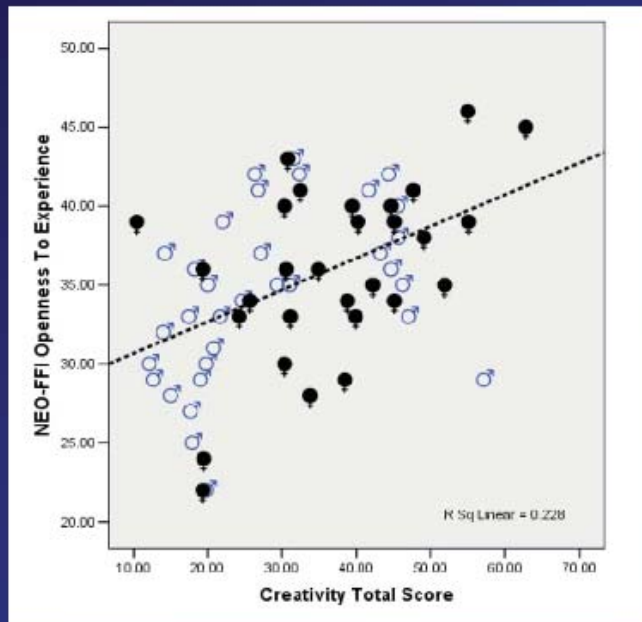
Figure 7-9. The Carroll structure of mental abilities. The three-stratum structure of cognitive abilities (lightface type = level, bold type = speed, italic type = speed and level, and bold italic type = rate factors). Adapted from Carroll (1993, 2005).

Artifact #1

Restriction in Range in Scores
(whole range not sampled)



“Creativity” Results



Creativity and IQ

- $r = .4$ ish up to 120
- $r = .0$ ish > 120

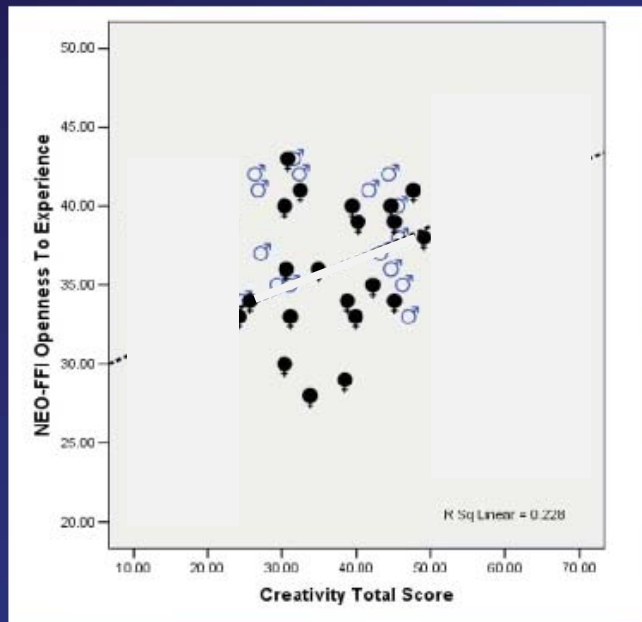
Creativity and Personality

- $r = .5$ ish with Openness

We have a measure that looks like “creativity”

Restricted

“Creativity” Results



Creativity and IQ

- $r = .4$ ish up to 120
- $r = .0$ ish > 120

Creativity and Personality

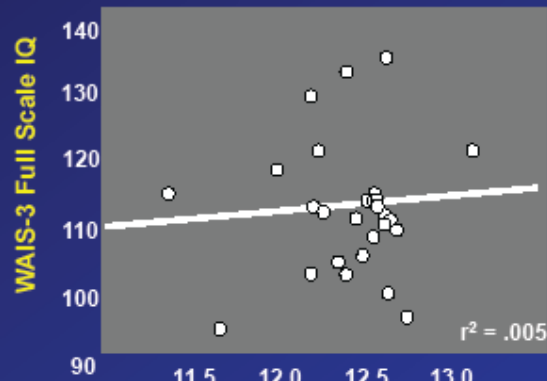
- $r = .5$ ish with Openness

We have a measure that looks like “creativity”

Sample 1 Results

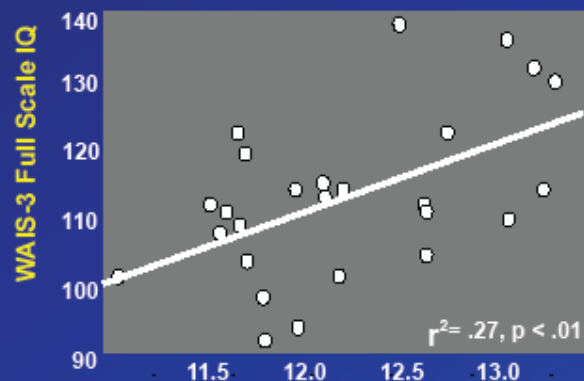
Demographic, Neuropsychological, Spectroscopic values				
N = 26	Mean	s.d.	Minimum	Maximum
Age	22.0	4.6	17	35
FSIQ	111.0	11.4	91	135
VIQ	110.8	13.0	88	137
PIQ	109.5	9.2	94	127
NAA	12.38	.53	11.39	13.29

Left Frontal White Matter



NAA (mM) in White Matter

Occipito-Parietal White Matter

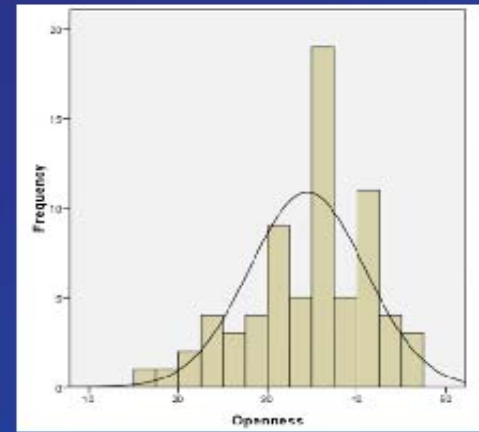
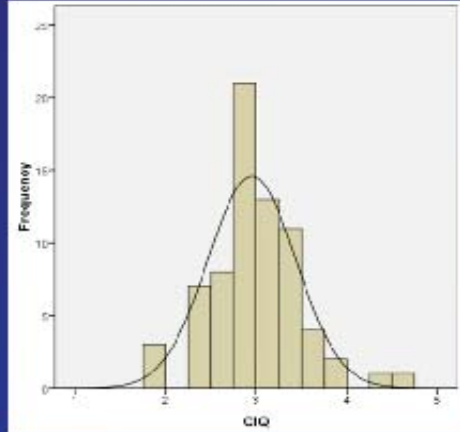
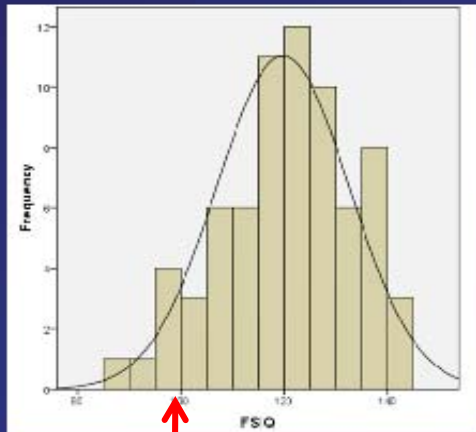


NAA (mM) in White Matter

Jung et al., (1999). *Proc Royal Society of London - B*. 266:1375-9.
Jung et al., (2005). *NeuroImage*, 26(3): 965-72.

Sample

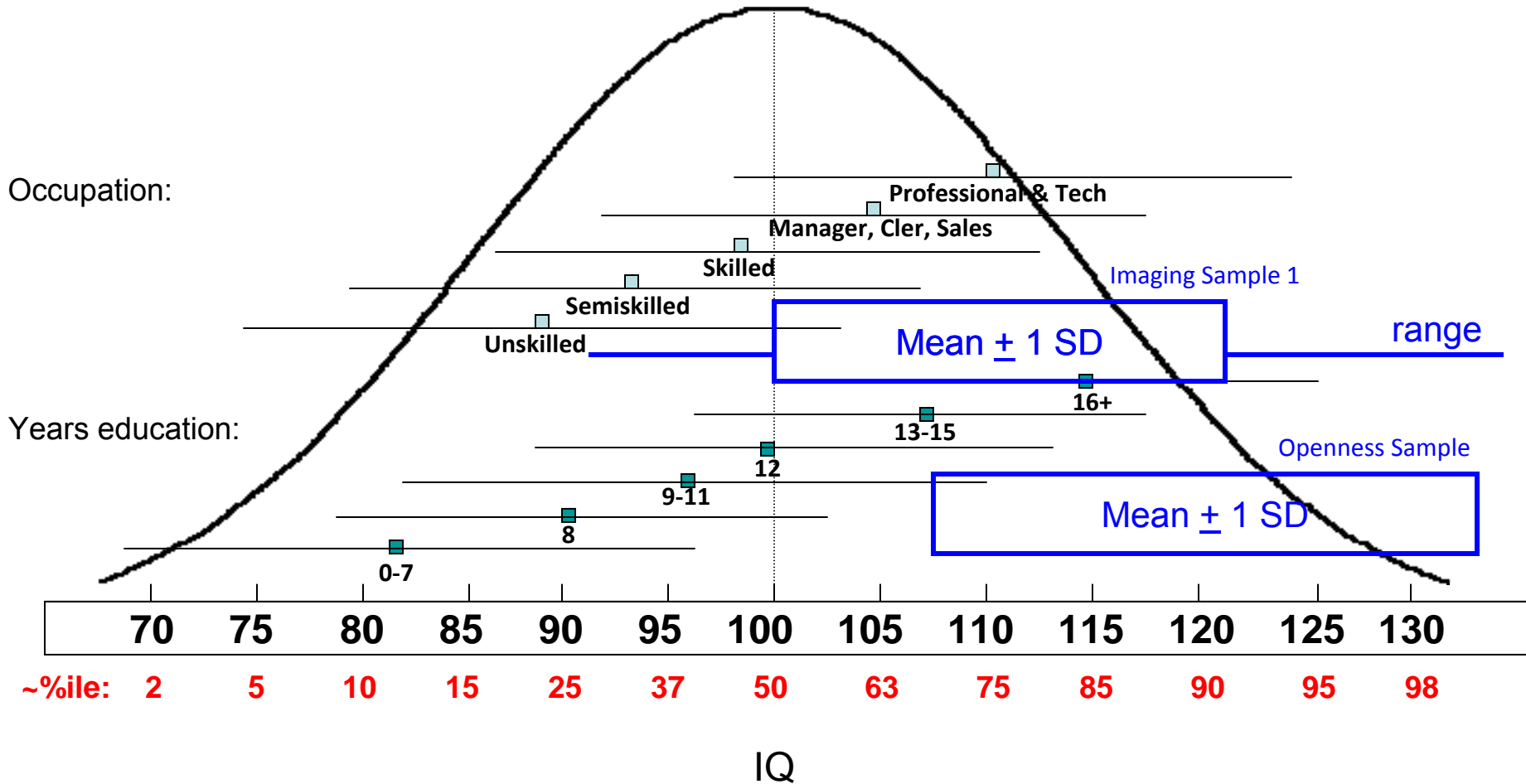
	Sex	N = 71	Mean	SD	t	p
Age	Male	38	21.76	2.78	.73	.46
	Female	33	22.27	2.06		
FSIQ	Male	38	121.34	13.73	1.07	.29
	Female	33	118.06	11.69		
CIQ	Male	38	2.93	.48	.38	.70
	Female	33	2.98	.50		
Open	Male	38	33.84	6.29	.86	.39
	Female	33	35.18	6.81		



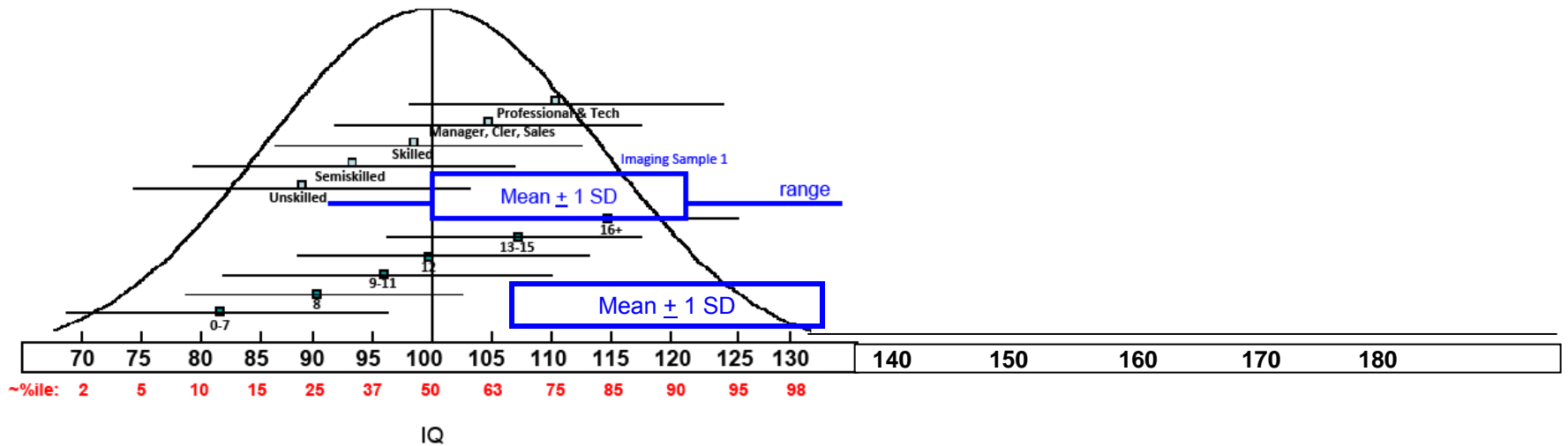
100

Mean IQs by occupation level & years education

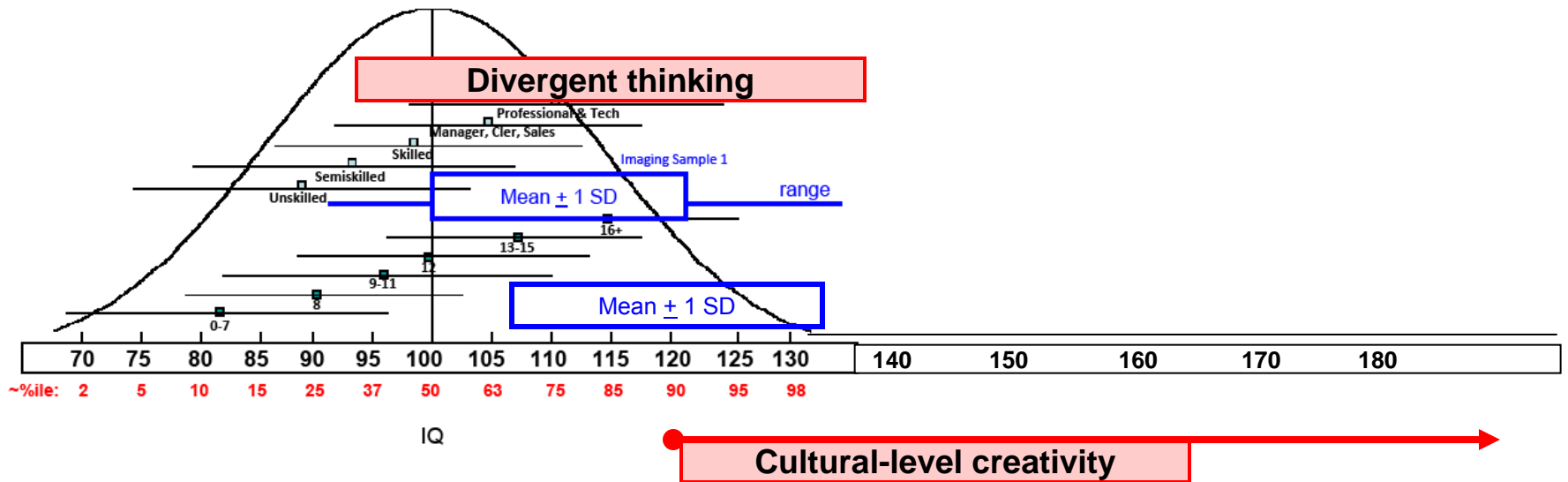
WAIS-R IQ (mean \pm 1 SD), US adults ages 16-74



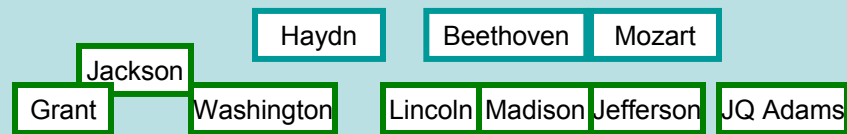
The missing top third



What kind of creativity?

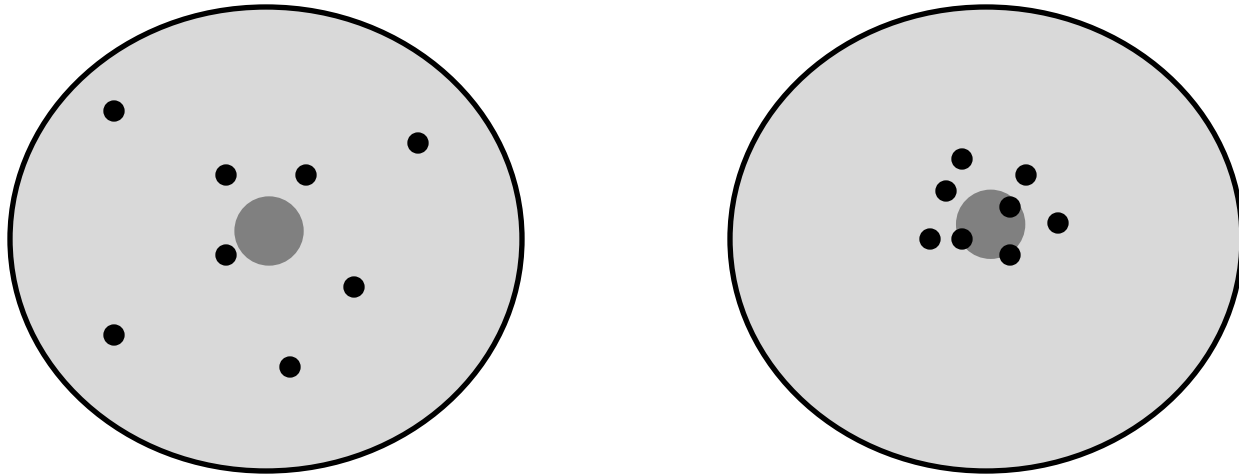


Cox estimates:



Artifact #2

Reliability of Measurement



Reliability of Creativity Measures?

How do we measure creativity?

Multiple Uses Test

Name all the uses for a brick:

- a paperweight
- a doorstop
- a mock coffin at a Barbie funeral
- to throw through a window
- to use as a weapon
- to hit my sister on the head with

Creative Achievement Questionnaire:

- Place a check mark beside the areas in which you feel you have more talent, ability, or training than the average person.

- | | |
|------------------|------------|
| 1. Visual Arts | 7. Humor |
| 2. Architecture | 8. Science |
| 3. Invention | 9. Dance |
| 4. Writing | 10. Music |
| 5. Culinary Arts | |
| 6. Drama | |

“Do you still maintain, A-Rod, that you have never taken steroids?”

Remote Associations Test

Targets:

- cottage
- swiss
- cake

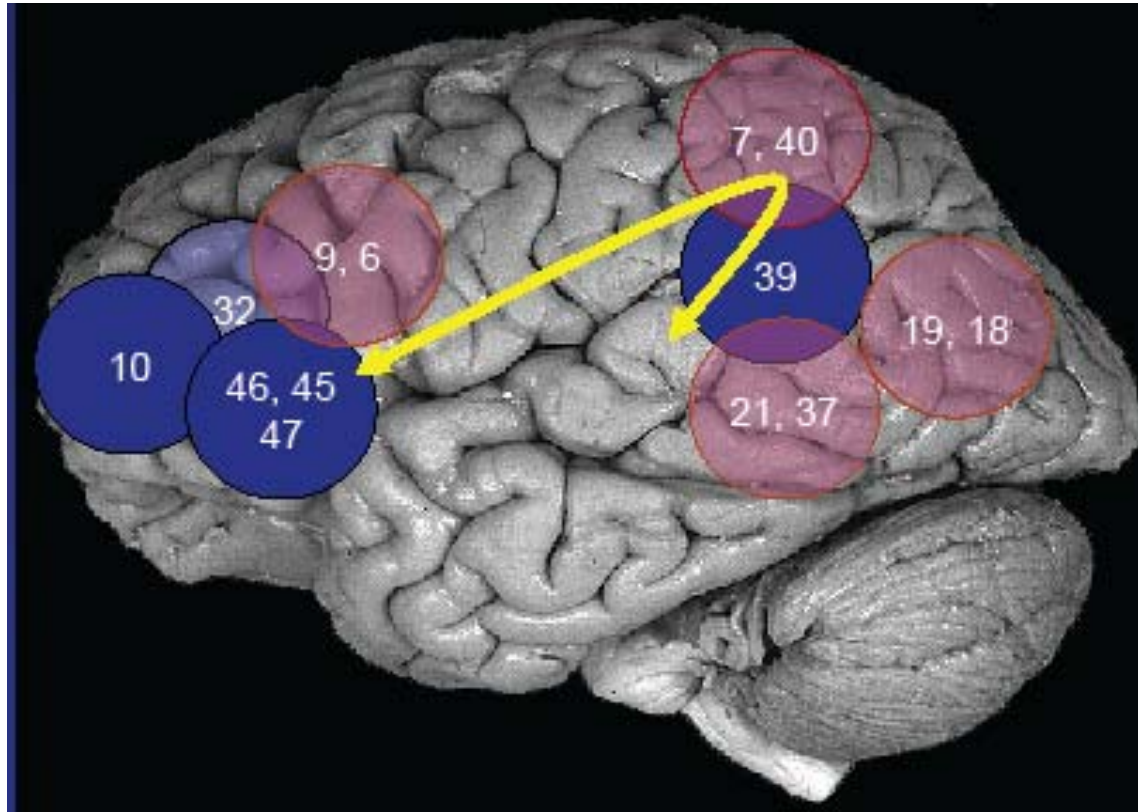
Response:

- **cheese**



- Subjective ratings (self vs. other)

Reliability of Brain Measurements?

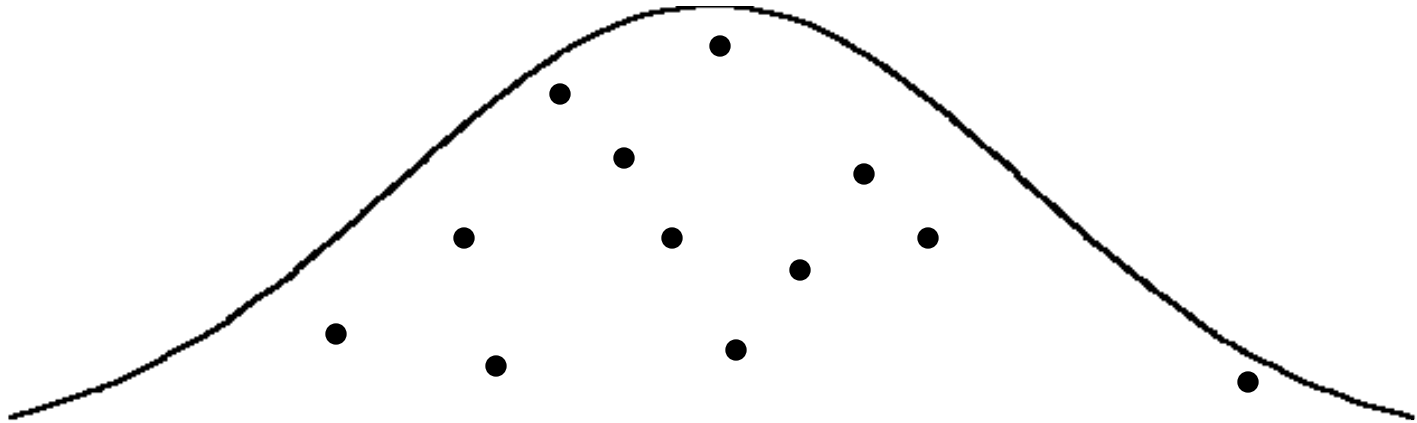


- Lower reliability will lower correlations.
- Differential reliability will change patterns of correlations.

Artifact #3

Sampling Error

(chance errors in reflecting full population)



Small samples = Big confusion

- Small sample Ns
 - = large confidence intervals (CI)
- Different sample sizes
 - = different confidence intervals
- Leads to:
 - Unstable parameter estimates
 - Unstable patterns of significance

All 3 Artifacts = Chaos

- Small sample Ns

plus

- Unreliability

plus

- Restriction in range

equals:

- “Complex” pattern of results
- “Specificity” theories

False inferences!!

Point? Knowing amount & type of artifacts helps un-muddy the picture, as it did in personnel selection psychology. Clockwork-like patterns emerged.

Questions?

Thank you.

www.udel.edu/educ/gottfredson