

Lecture -- 2 -- Start

Outline

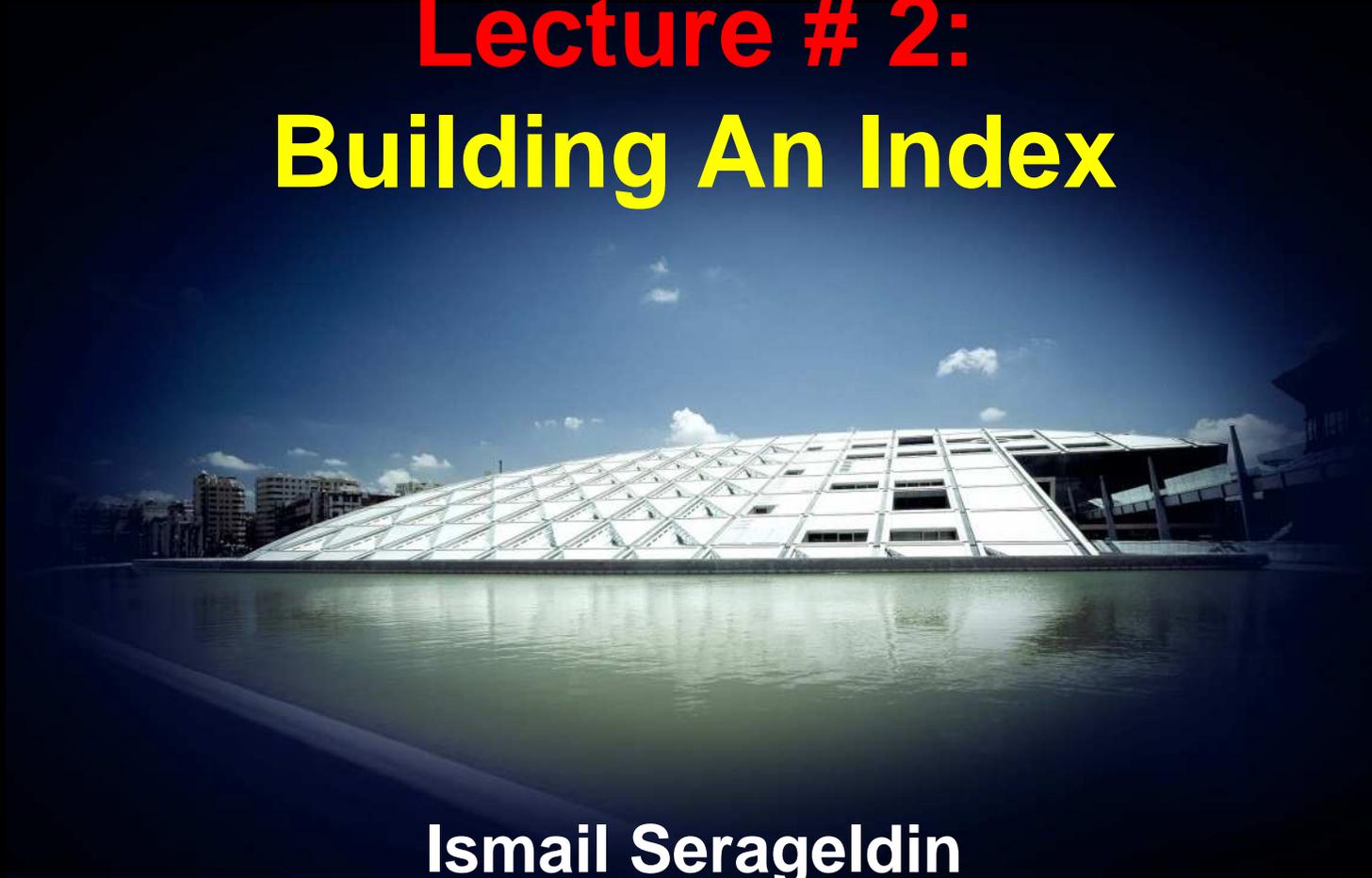
1. **Science, Method & Measurement**
2. **On Building An Index**
3. **Correlation & Causality**
4. **Probability & Statistics**
5. **Samples & Surveys**
6. **Experimental & Quasi-experimental Designs**
7. **Conceptual Models**
8. **Quantitative Models**
9. **Complexity & Chaos**
10. **Recapitulation - Envoi**

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Quantitative Techniques for Social Science Research

Lecture # 2:
Building An Index



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Alexandria

2012

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Building An Index

An Index is

- **A composite measure, usually involving ratio(s), intended to simplify the interpretation of a situation**
- **Examples: Price index, inflation rate, poverty index, success rate in an examination, etc.**

An index should be

- **Robust:** not thrown off by random or partial variations
- **Discriminating:** distinguishes between different cases
- **Efficient:** reasonably easy to build and to measure
- **Effective:** captures what we want to measure

**And
Interpretable for policy-making**

Some Examples

Composite Scores and Index Construction

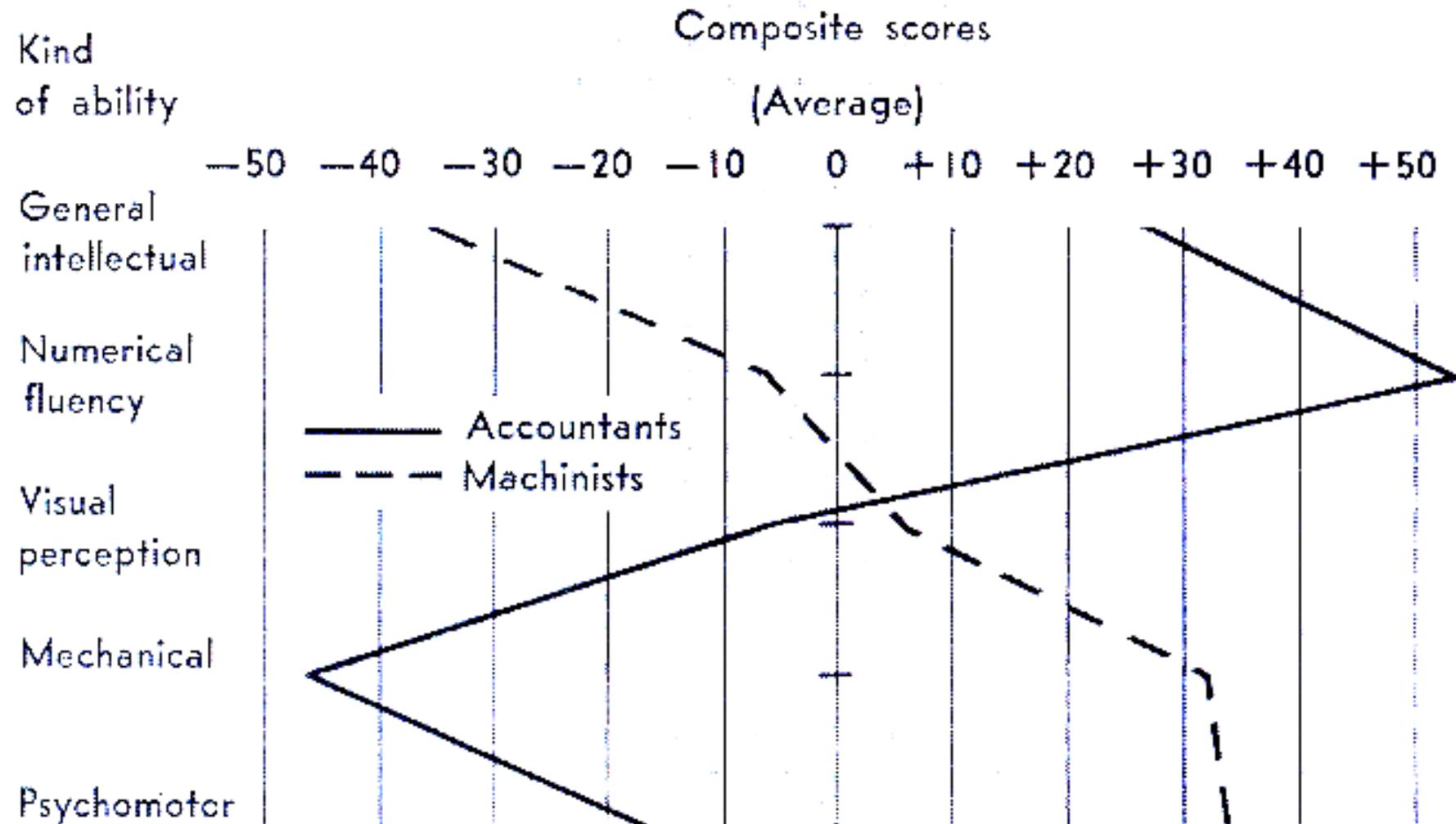
Example:

Measuring staff Abilities (aptitudes)

- **We want to create a scoring system to evaluate our staff.**
- **We have different kinds of staff**
- **We find that we look at several skills:**
 - **General Intellectual ability**
 - **Numerical fluency**
 - **Psychomotor skills**
 - **Visual Perception**
 - **Mechanical**

**So we apply all tests to all staff,
and here are the results:**

Ability Scores: Accountants Vs. Machinists



Machinists and Accountants

- **You can create a composite score of all the skills by adding all the components, but what would that tell you?**

Does it make sense to add the scores and create a single index number?

Why do we go for single numbers in complex issues?

Let's move to a case study

Case Study: Measuring I.Q.

Measuring I.Q.

I.Q. measures

- **I.Q. is an index constructed by dividing the score of an individual (child) of a certain age on a specific test over the average score that a person should have at that age.**
- **If the person matches that average score, the I.Q. = 100**
- **It is sometimes expressed as mental age over biological age**
- **It says nothing more than what you would say of a child being somewhat tall or somewhat short, for his age,**

Abilities, Traits and Constructs

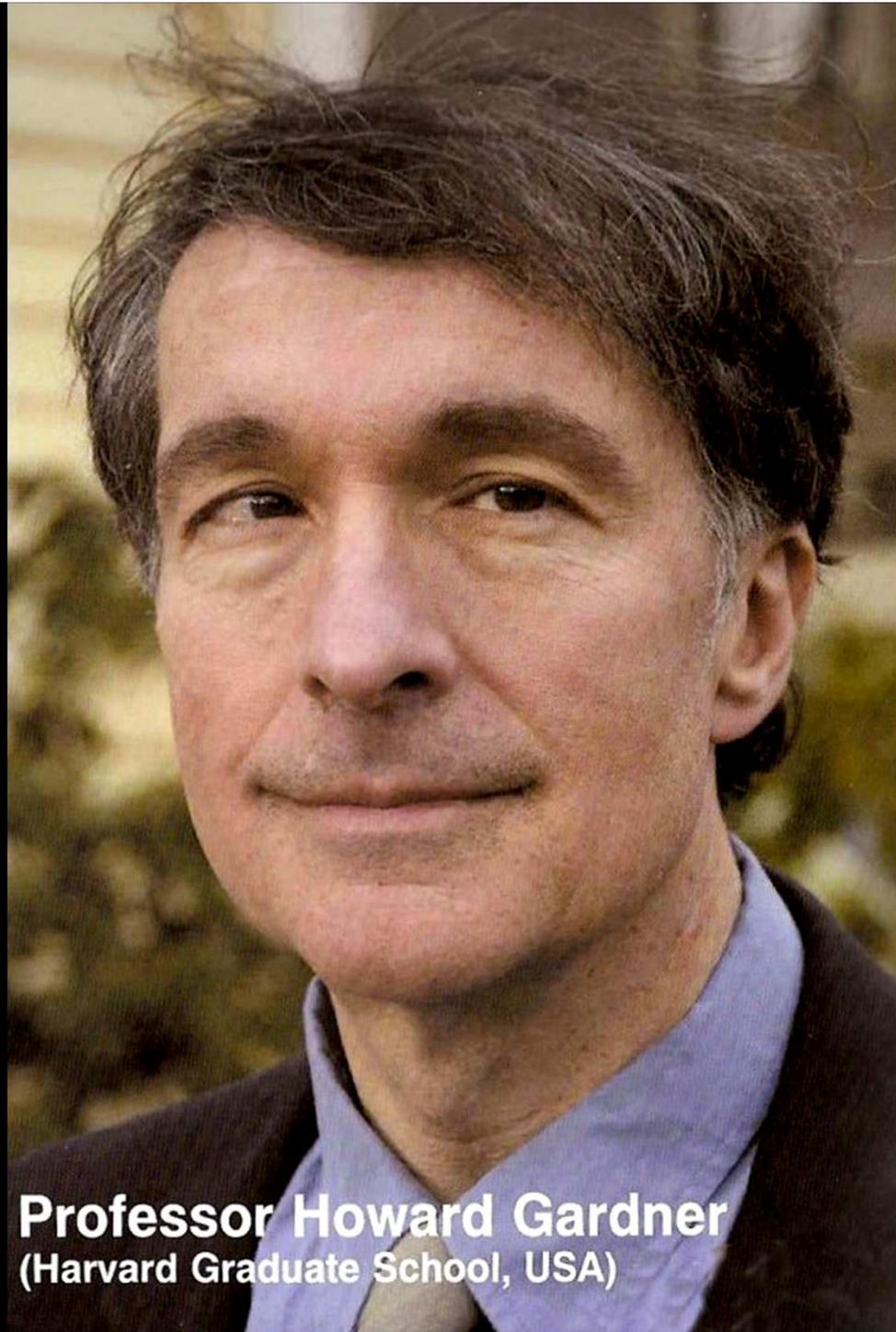
- Abstract thought
- Communication
- Creativity
- Emotional intelligence
- g factor
- Intelligence quotient
- Knowledge
- Learning
- Memory
- Problem solving
- Reaction time
- Reasoning
- Understanding
- Visual processing

Alternative Views

- **Howard Gardner and varieties of human intelligence**

Howard Gardner's Multiple Intelligences

The theory of multiple intelligences was proposed by Howard Gardner in 1983 as a model of intelligence that differentiates intelligence into various specific (primarily sensory) modalities, rather than seeing it as dominated by a single general ability.



Professor Howard Gardner
(Harvard Graduate School, USA)

FRAMES OF MIND



The Theory
of Multiple
Intelligences

BY

Howard
Gardner

WITH A NEW INTRODUCTION
BY THE AUTHOR

BASIC BOOKS, Inc. / CN 5133 / \$11.95

Second Edition

The Quest for Mind

Piaget, Lévi-Strauss,
and the Structuralist
Movement

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Howard Gardner

HOWARD GARDNER



AUTHOR OF
FRAMES
OF
MIND

INTELLIGENCE
REFRAMED

MULTIPLE INTELLIGENCES

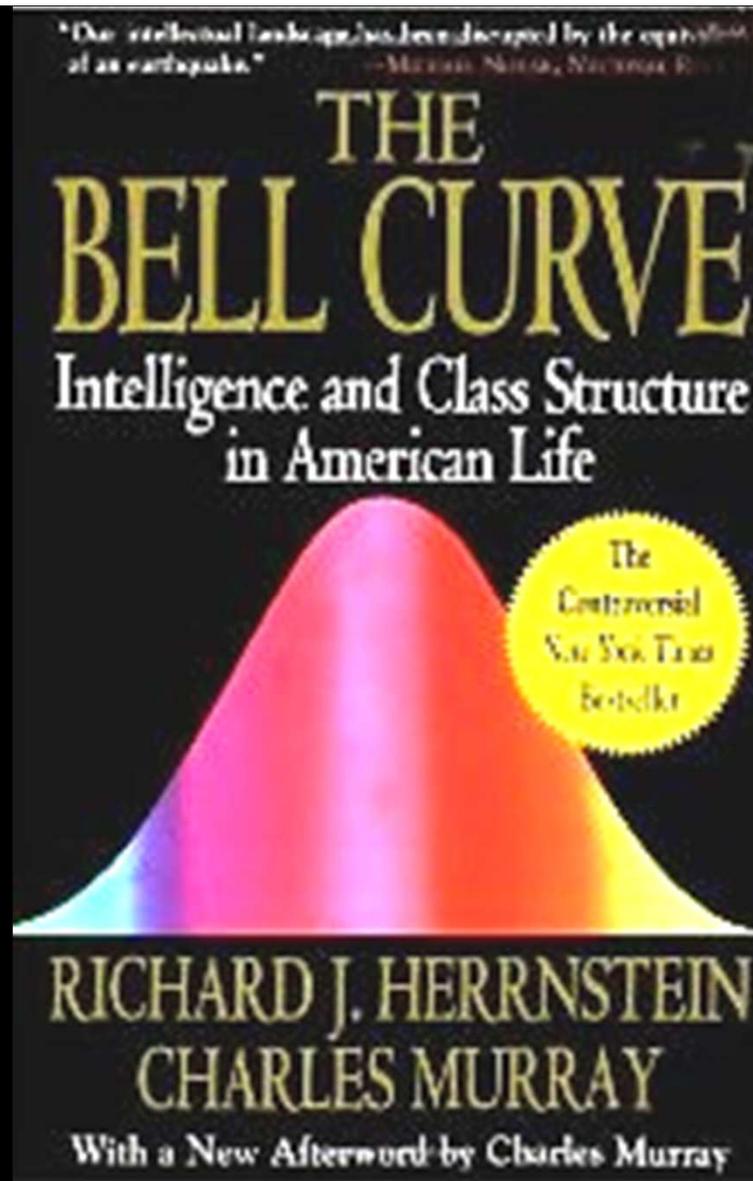
for the 21st Century

The multiple intelligences

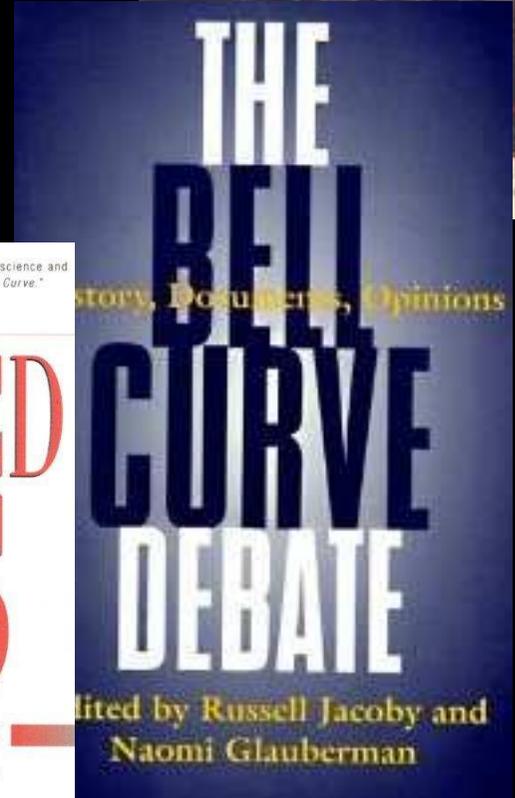
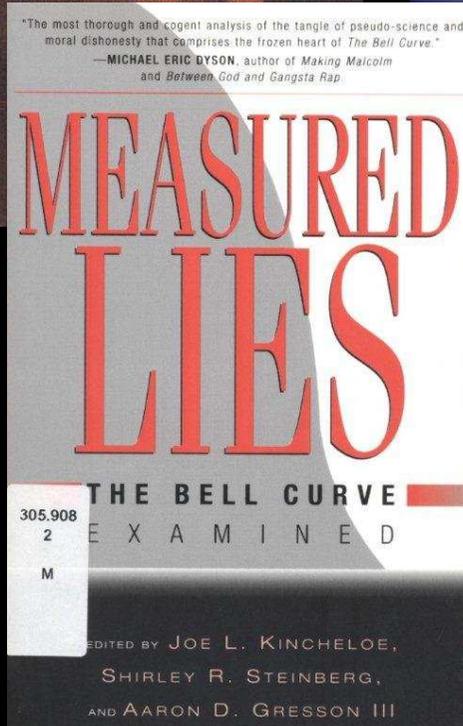
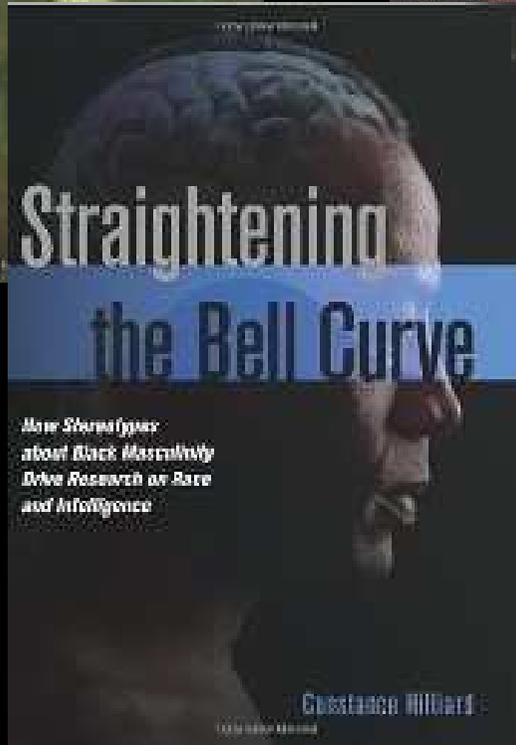
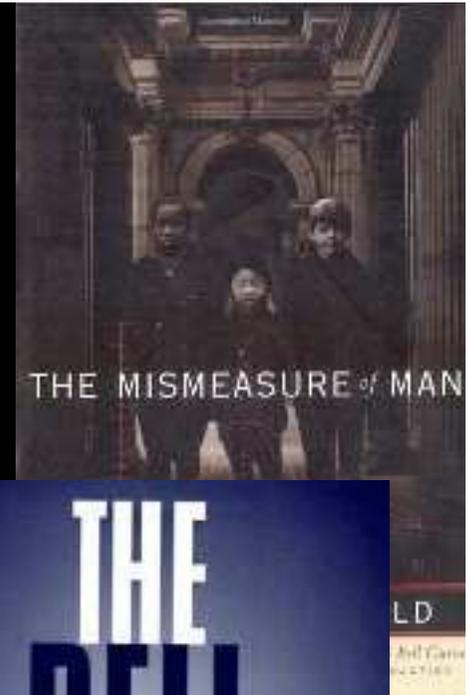
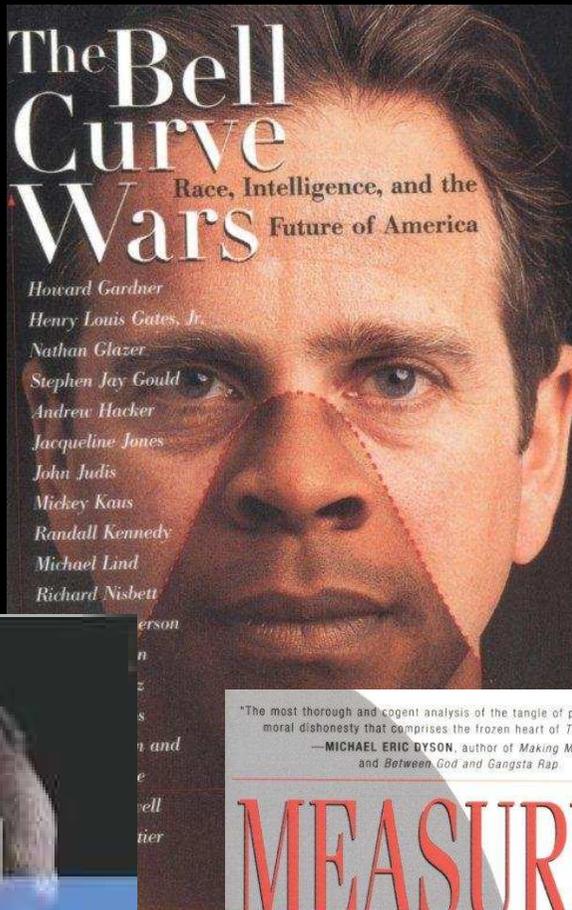
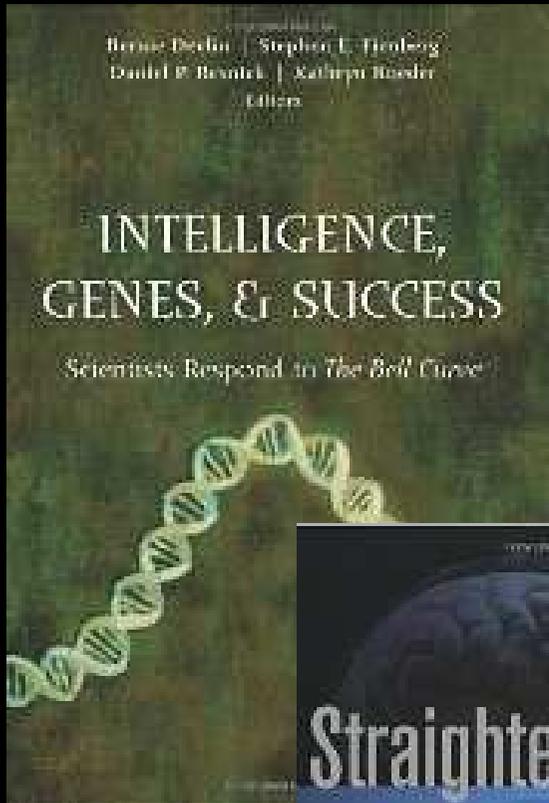
1. Logical-mathematical
2. Spatial
3. Linguistic
4. Bodily-kinesthetic
5. Musical
6. Interpersonal
7. Intrapersonal
8. Naturalistic
9. Existential

Misreading the index

- **History is full of examples of people misreading the index**
- **Some even wanted to use it for racist purposes and argued for Eugenics**
- **In the USA, where race is a big issue, there was a recent case of the Book called “The Bell Curve”**

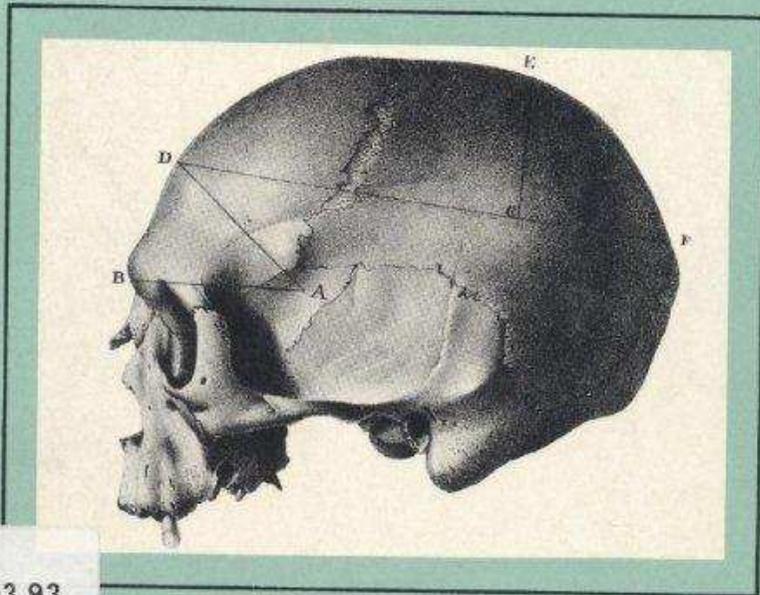


IQ, Nature and Nurture



The debates are far from over...

The Mismeasure of Man

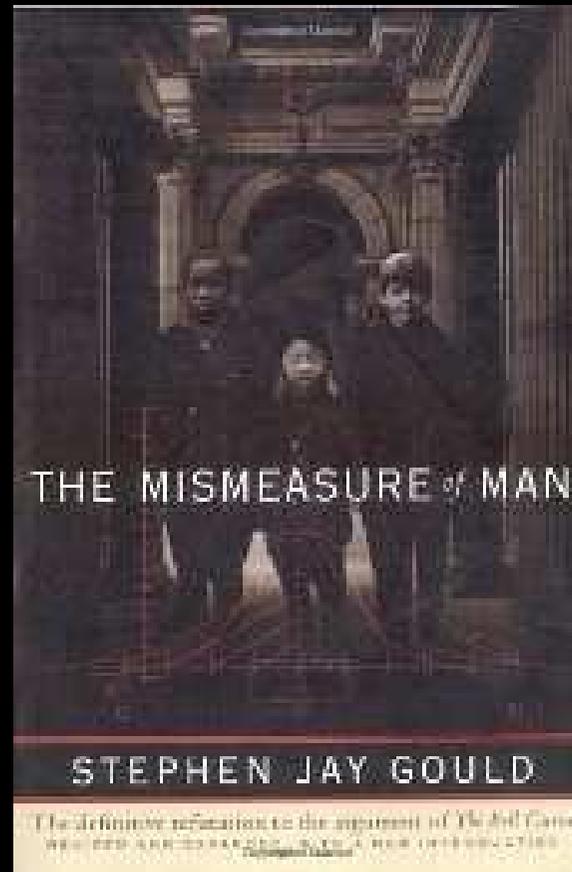


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Stephen Jay Gould

of *Ever Since Darwin* and *The Panda's Thumb*



Many alternative theories of Intelligence

- **Cattell–Horn–Carroll theory**
- **Fluid and crystallized intelligence**
- **Theory of multiple intelligences**
- **Three stratum theory**
- **Triarchic theory of intelligence**
- **PASS theory of intelligence**

Cattell–Horn–Carroll theory

- CHC theory of cognitive abilities is about the content and structure of human cognitive abilities.
- Combines two theories:
 - **Gf-Gc theory** (Raymond Cattell, 1941; Horn 1965), and
 - **Three-Stratum theory**, John Bissell Carroll's (1993)

CHC is based on Factor Analysis (surveying 60-70 years of research)

- CHC theory is the most comprehensive and **empirically supported** psychometric theory of the structure of cognitive and academic abilities.
- The CHC model was expanded by McGrew (1997), later revised with the help of Flanagan (1998), and extended again by McGrew (2011).

CHC: 3 Levels of Ability

- There are many distinct individual differences in cognitive ability, and CHC theory holds that the relationships among them can be derived by classifying them into **three different strata**:
 - stratum I, "**narrow**" abilities;
 - stratum II, "**broad**" abilities; and
 - stratum III, consisting of a **single "general"** ability (or g).

CHC Broad Abilities

- There are **9 broad stratum abilities** (and a tenth which is not incorporated in current tests)
- There are **over 70 narrow abilities** below these.
- The broad abilities are used in tests today.

CHC's 9 Broad Categories

(The tenth, Gt, is not measured in current tests)

- Crystallized Intelligence (Gc):
- Fluid Intelligence (Gf):
- Quantitative Reasoning (Gq):
- Reading & Writing Ability (Grw):
- Short-Term Memory (Gsm):
- Long-Term Storage and Retrieval (Glr):
- Visual Processing (Gv):
- Auditory Processing (Ga):
- Processing Speed (Gs):
- Decision/Reaction Time/Speed (Gt):

CHC Broad Abilities

- **Crystallized Intelligence (Gc):** includes the breadth and depth of a person's acquired knowledge, the ability to communicate one's knowledge, and the ability to reason using previously learned experiences or procedures.
- **Fluid Intelligence (Gf):** includes the broad ability to reason, form concepts, and solve problems using unfamiliar information or novel procedures.

CHC Broad Abilities

- **Quantitative Reasoning (Gq):** is the ability to comprehend quantitative concepts and relationships and to manipulate numerical symbols.
- **Reading & Writing Ability (Grw):** includes basic reading and writing skills.
- **Short-Term Memory (Gsm):** is the ability to apprehend and hold information in immediate awareness and then use it within a few seconds.

CHC Broad Abilities

- **Long-Term Storage and Retrieval (Glr):** is the ability to store information and fluently retrieve it later in the process of thinking.
- **Visual Processing (Gv):** is the ability to perceive, analyze, synthesize, and think with visual patterns, including the ability to store and recall visual representations.

CHC Broad Abilities

- **Auditory Processing (Ga)**: is the ability to analyze, synthesize, and discriminate auditory stimuli, including the ability to process and discriminate speech sounds that may be presented under distorted conditions.
- **Processing Speed (Gs)**: is the ability to perform automatic cognitive tasks, particularly when measured under pressure to maintain focused attention.

CHC Broad Abilities

- **Decision/Reaction Time/Speed (Gt):** reflect the immediacy with which an individual can react to stimuli or a task (typically measured in seconds or fractions of seconds; not to be confused with Gs, which typically is measured in intervals of 2–3 minutes).
- This tenth ability, Gt, is considered part of the theory, but **is not currently assessed by any major intellectual ability test.** For this reason, it does not appear in cross-battery reference materials.

CHC Theory and Beyond...

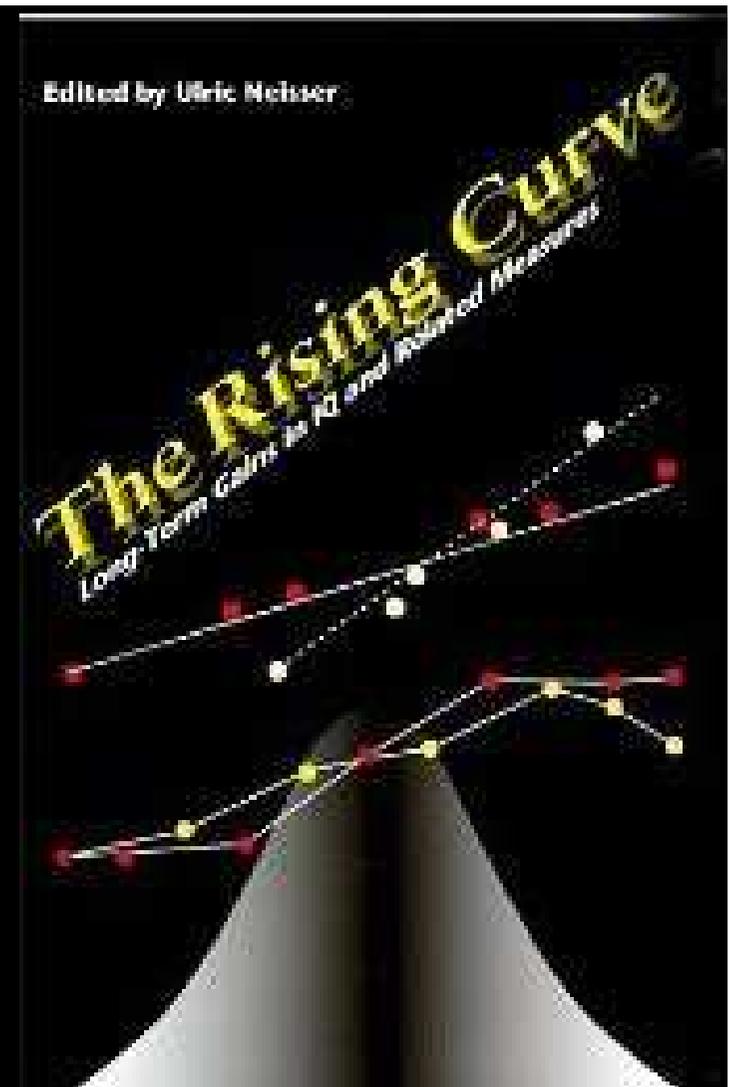
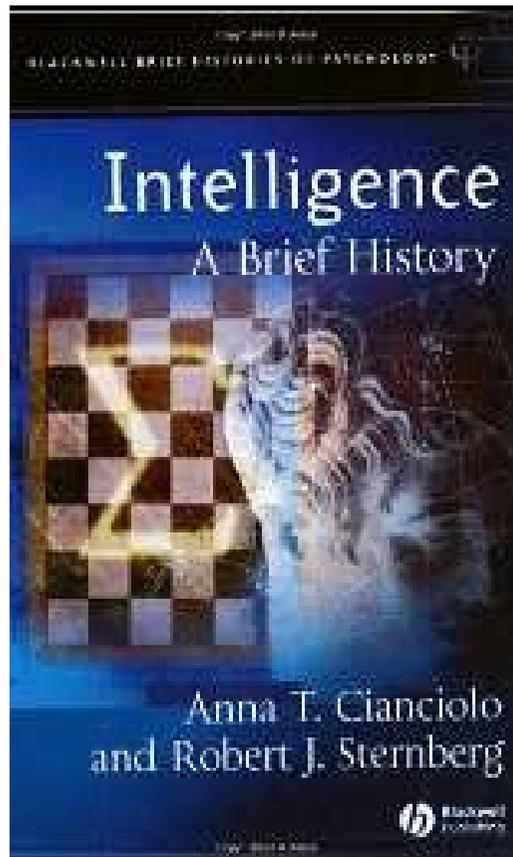
- 5 of the 7 major tests of intelligence have changed to incorporate CHC theory as their foundation .
- All modern intellectual test instruments fail to effectively measure all 10 broad stratum abilities
- Yet McGrew keeps adding more abilities: Gkn, Domain-specific knowledge, Gp, Psychomotor ability, and Gps, Psychomotor speed, and tactile (Gh), kinesthetic (Gk), and olfactory (Go).

Cross Battery Assessment

- Since all modern intellectual test instruments fail to effectively measure all 10 broad stratum abilities
- Hence an alternative method of cognitive assessment and interpretation called **Cross Battery Assessment** was developed. (see XBA; Flanagan, Ortiz, Alfonso, & Dynda, 2008)

**So building a single index is very
difficult, if not impossible...**





Rising I.Q. Scores over the 20th Century (The Flynn Effect)

Let's move to another case study

Case Study: Measuring Poverty

Defining Poverty

Poverty

- **Income or consumption measures**

Poverty

- Income or consumption measures
- **Marginalization and powerlessness**

Poverty

- Income or consumption measures
- Marginalization and powerlessness
- **Social context (link to inequality)**

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- Individual self-esteem and culture of poverty

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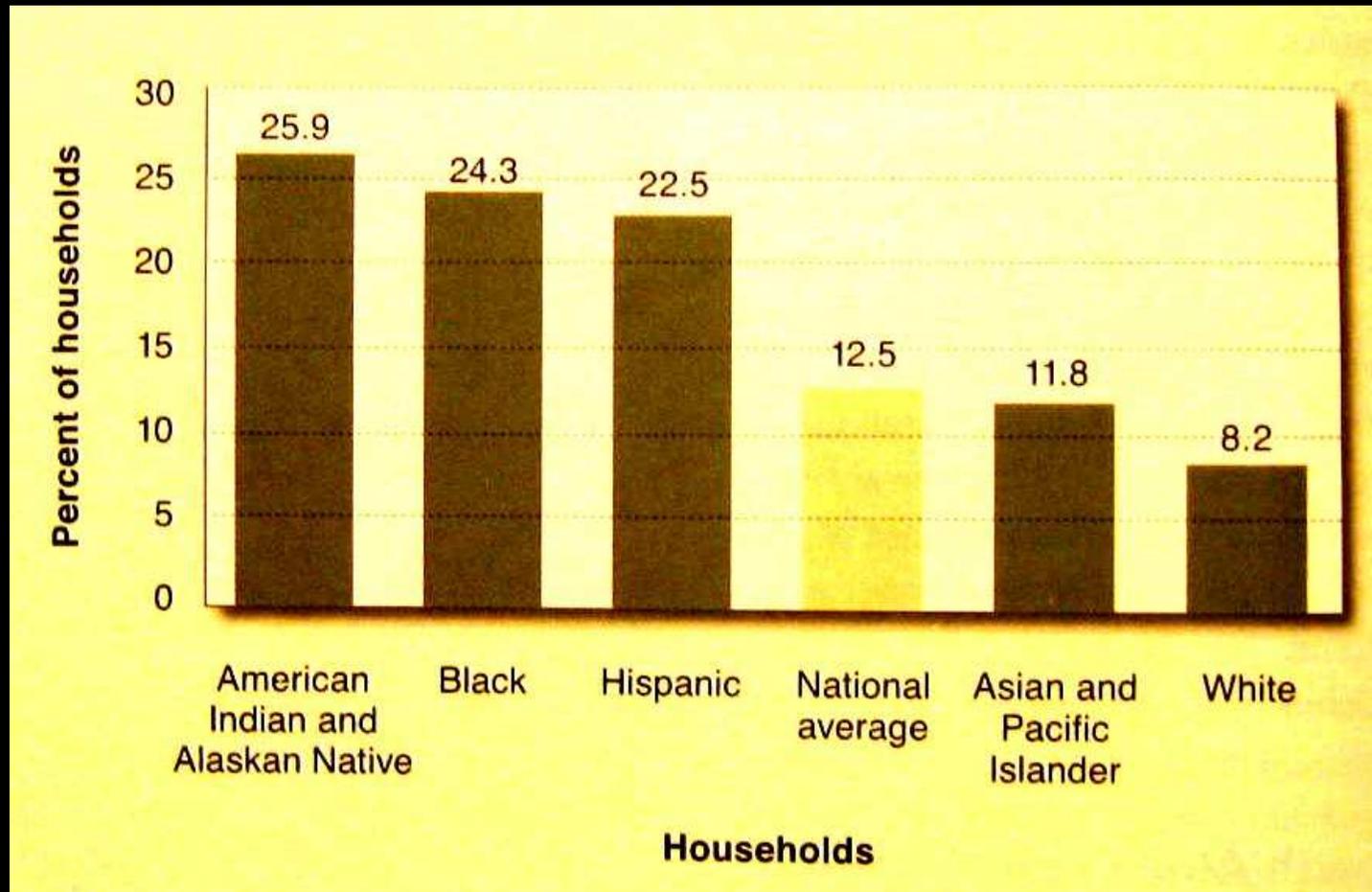


Measuring Poverty

Measuring Poverty

- **Headcount Index**
- **Depth of Poverty (Poverty Gap)**
- **Foster-Greer-Thorbecke Index (P_{α})**

USA % Households below the poverty line (2003)



Headcount Index

The Headcount Index is the proportion of people below the poverty line:

$$H = \frac{q}{n}$$

where q is pop. Whose $Y < Z$

Depth of Poverty (Poverty Gap)

Measures how far the average poor person is below the poverty line and multiplies that by the headcount Index

$$P_G = \frac{1}{n} \sum_{i=1}^q \left[\frac{z - y_i}{z} \right]$$

$$\therefore P_G = I.H \quad \text{where} \quad I = \frac{z - y^i}{z}$$

and I = mean depth of poverty as a proportion of the poverty Line

P_G = Cost of eliminating poverty by Y - transfer to the poor.

A	α	alpha	N	ν	nu
B	β	beta	Ξ	ξ	xi
Γ	γ	gamma	O	o	omicron
Δ	δ	delta	Π	π	pi
E	ϵ	epsilon	P	ρ	rho
Z	ζ	zeta	Σ	σ	sigma
H	η	eta	T	τ	tau
Θ	θ	theta	Υ	υ	upsilon
I	ι	iota	Φ	ϕ	phi
K	κ	kappa	X	χ	chi
Λ	λ	lambda	Ψ	ψ	psi
M	μ	mu	Ω	ω	omega

Greek Alphabet

P_α : The FGT Poverty Index

$$P_\alpha = \frac{1}{n} \sum_{i=1}^q \left[\frac{z - y_i}{z} \right]^\alpha$$

P_α

- If $\alpha = 0$ $\therefore P_0 =$ Headcount Index
- If $\alpha = 1$ $\therefore P_1 =$ Poverty Gap Measure
- If $\alpha = 2$ $\therefore P_2 =$ Mean of squared proportionate poverty gaps

A better statement about P_α

- If $\alpha = 0$ $\therefore P_0 =$ **Amount** of poverty
- If $\alpha = 1$ $\therefore P_1 =$ **Depth** of Poverty
- If $\alpha = 2$ $\therefore P_2 =$ **Severity** of Poverty
(usually associated with hunger)

Understanding P_α

$$\therefore P_\alpha = \frac{1}{n} \sum_{i=1}^q \left[\frac{z - y_i}{z} \right]^\alpha$$

P_α is the weighted mean over the poor population

$$\text{The measure} = \left(1 - \frac{y_i}{z} \right)^\alpha \text{ for poor } (y_i < z)$$

$$= 0 \quad \text{for non-poor } (y_i > z)$$

P_2 -- what does it measure?

If $\alpha = 2$, then P_2 = mean of squared proportionate poverty gaps ... AND:

$$P_2 = \underbrace{\frac{PG^2}{H}}_{\text{Contribution of pov. gap to } P_2} + \underbrace{\frac{(H - PG)^2}{H} \cdot CV_P^2}_{\text{Contribution of inequality amongst the poor to } P_2}$$

The FGT P_α Indexes

- Provide much richer measurement

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- But P_2 is difficult to interpret for decision makers

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- But P_2 is difficult to interpret for decision makers
- Decomposable

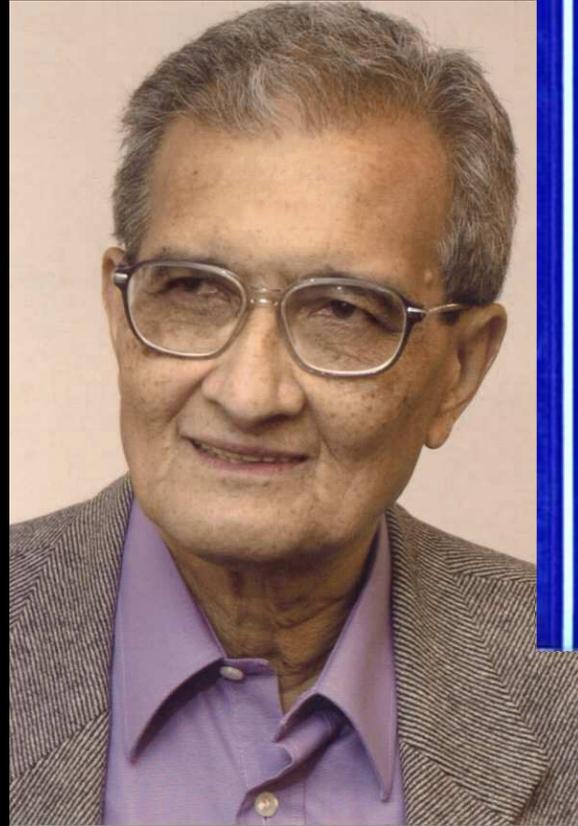
The FGT P_α Indexes

- Provide much richer measurement
- But P_2 is difficult to interpret for decision makers
- Decomposable – an attractive feature, **BUT...**

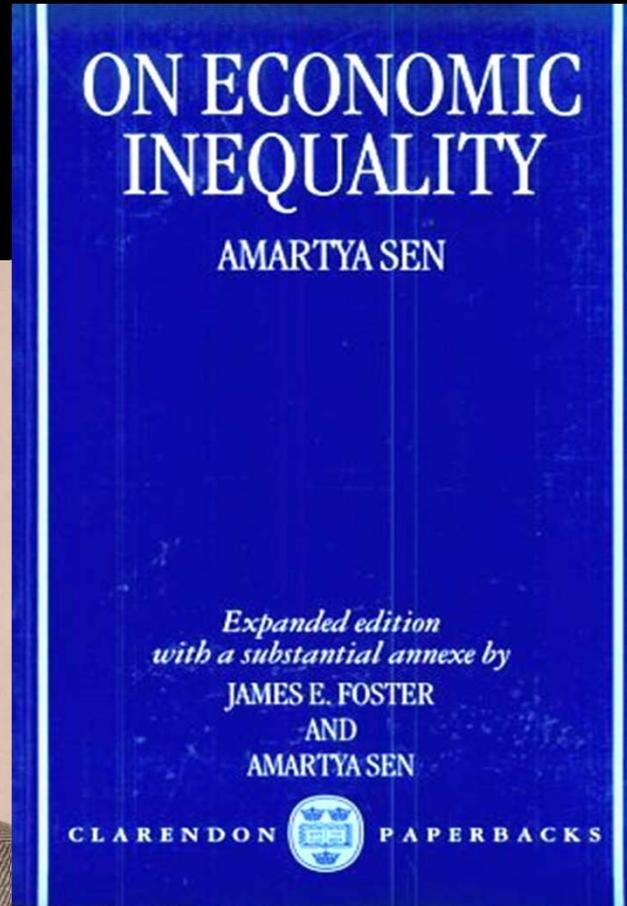
The underlying mathematical structure for the index allows partitioning the set (decomposability) by any dimension, no matter how absurd

**This means that ultimately it is
an individual measure and
voids the relational or social
context aspect of poverty.**

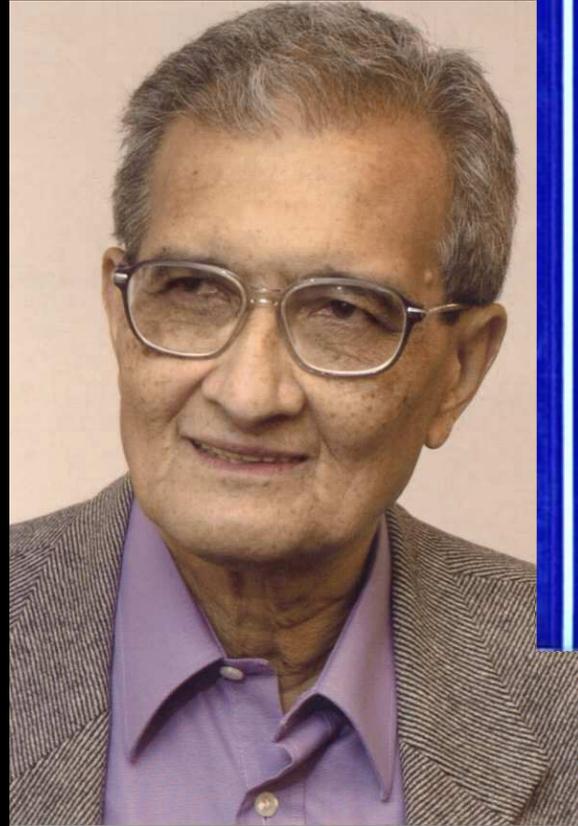
**Ideally, the use of FGT indexes
should be supplemented by
inequality indicators.**



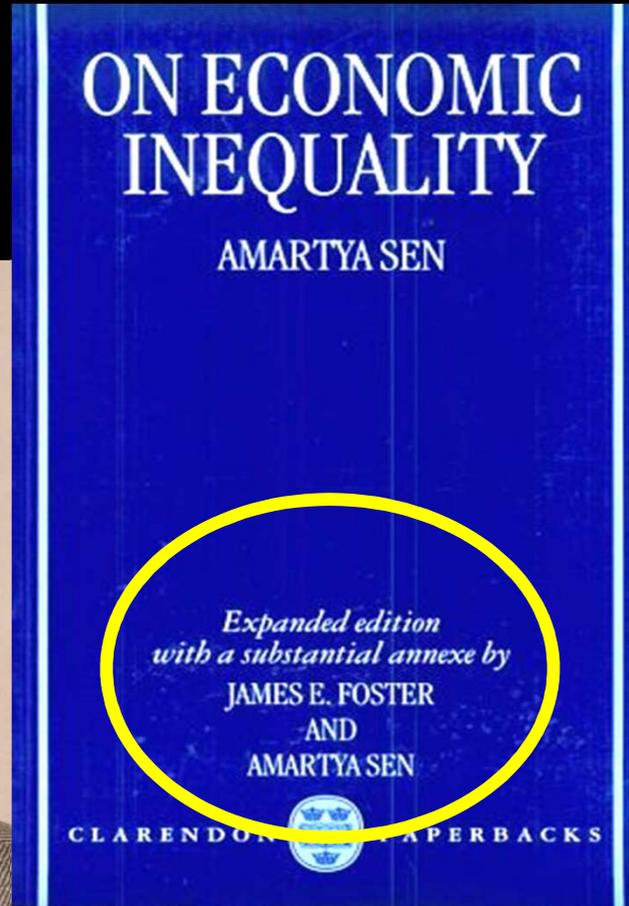
Amartya Sen



James Foster

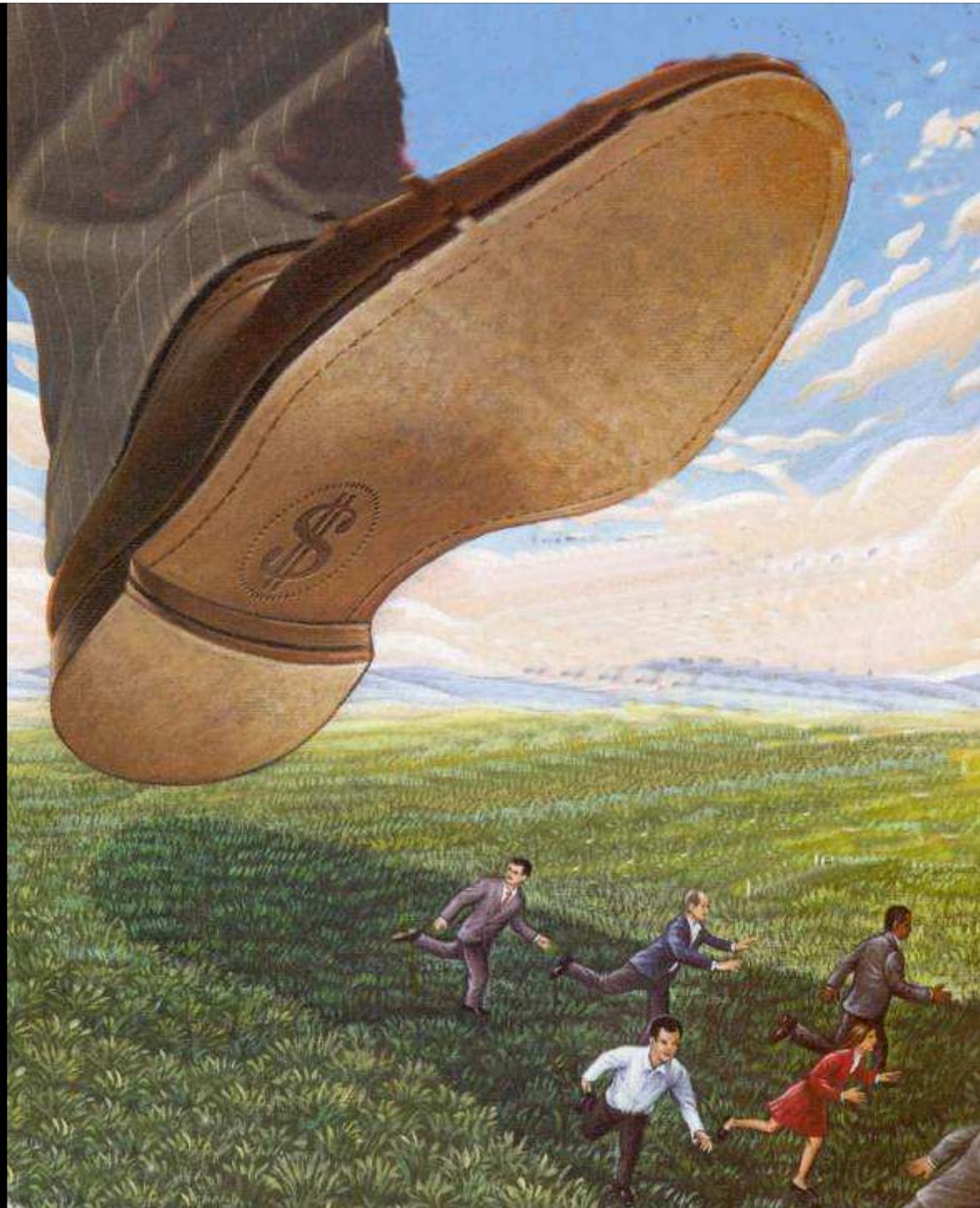


Amartya Sen



James Foster

Links To Inequality



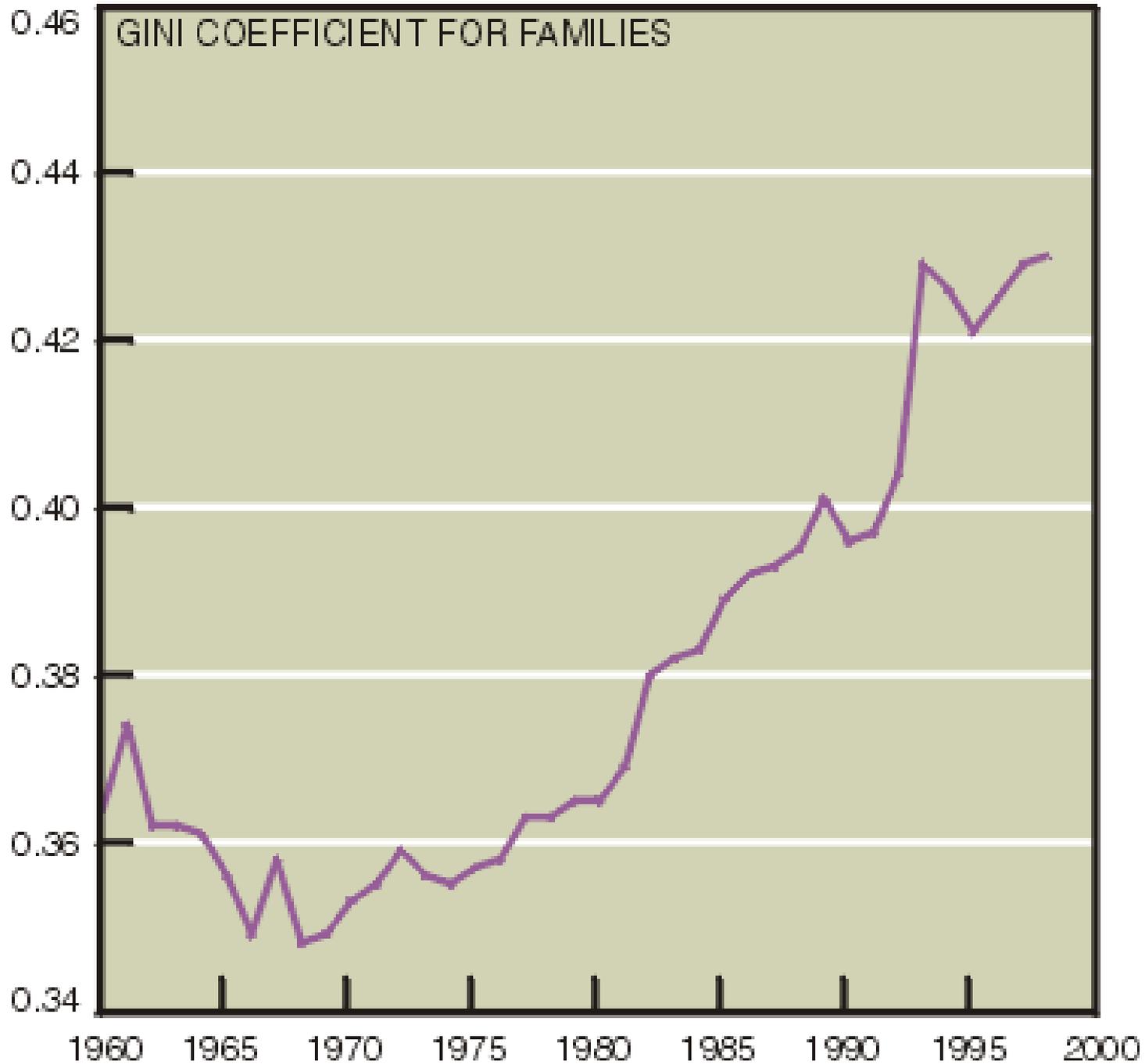
Measuring Inequality: Gini Coefficients

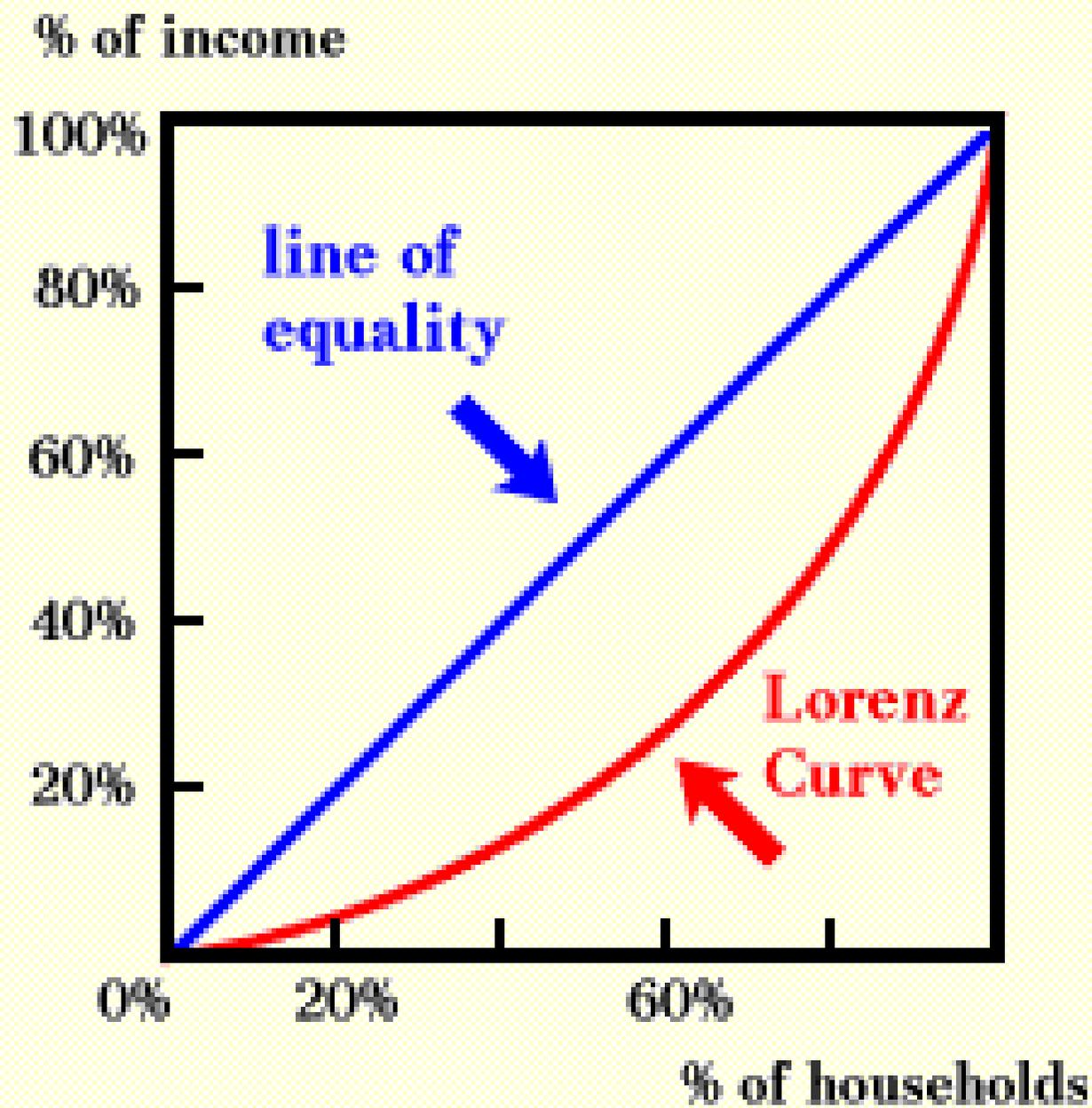
$$G = \frac{1}{2} \sum_{i=1}^k |x_i - y_i|$$

G = 1.0 perfect Inequality

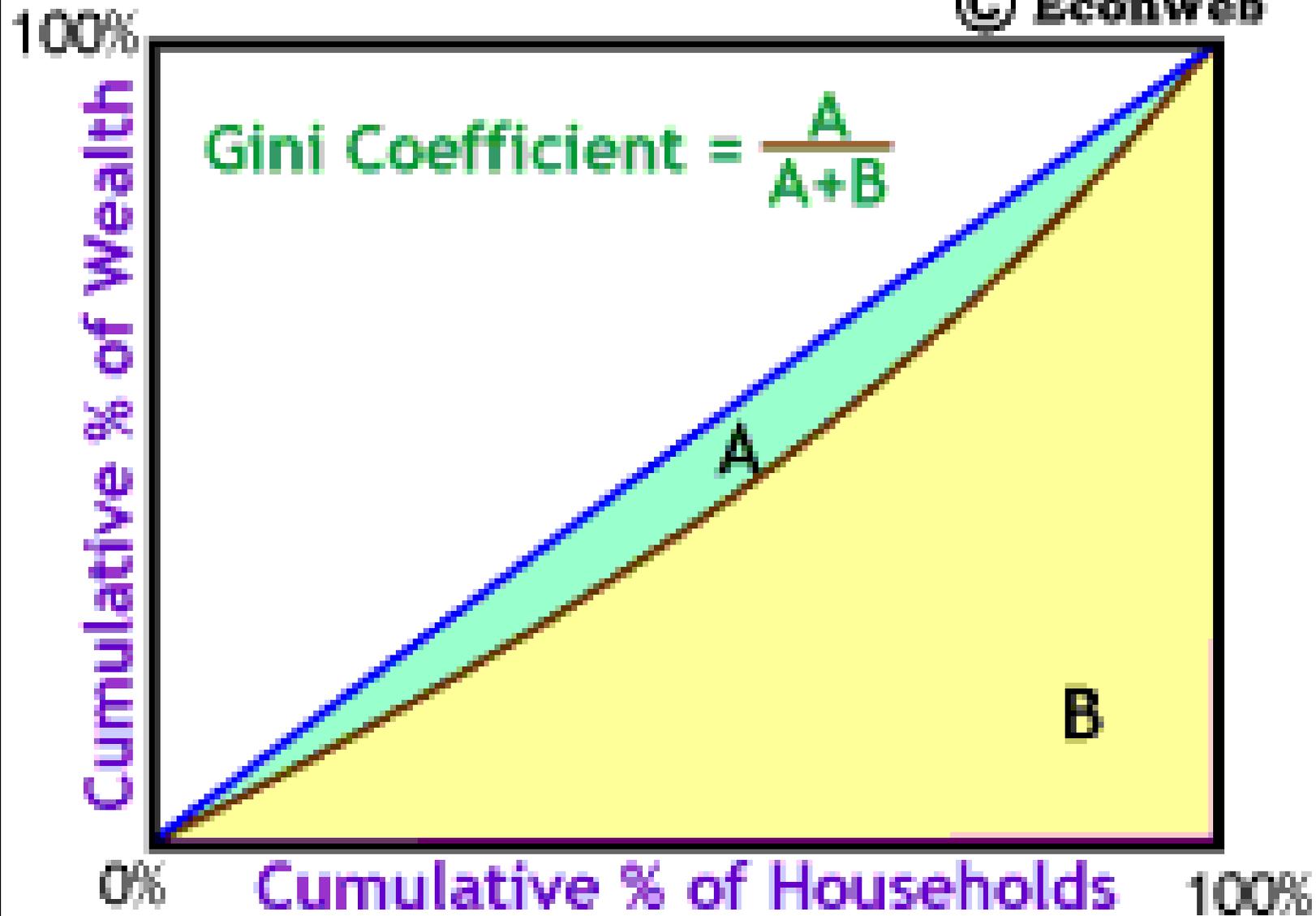
G = 0.0 Perfect Equality

Index: 0 = perfect equality; 1 = perfect inequality





A Lorenz Curve illustrates inequality

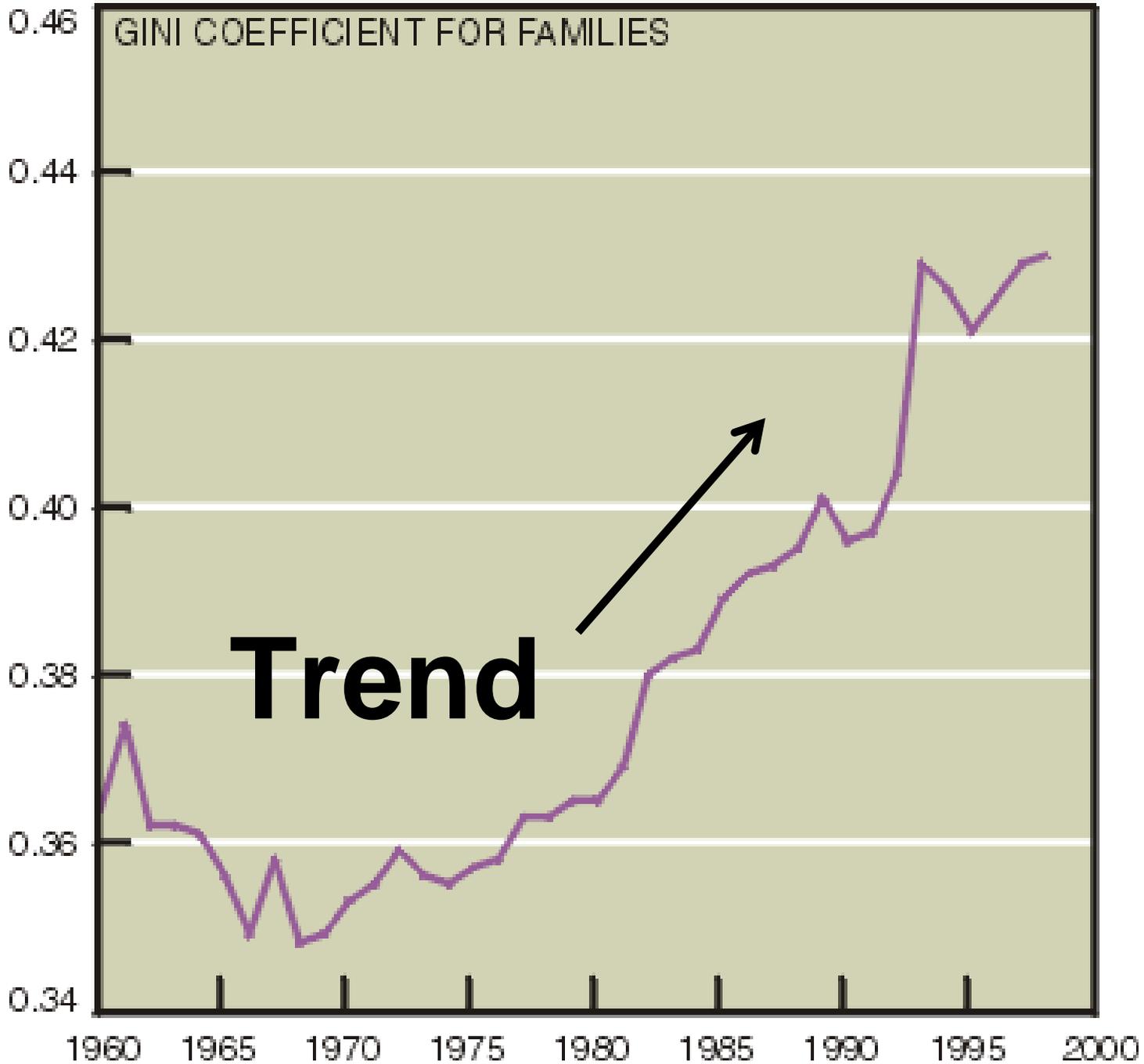


Increasing Gini Coefficient
Due to Increasing Inequality

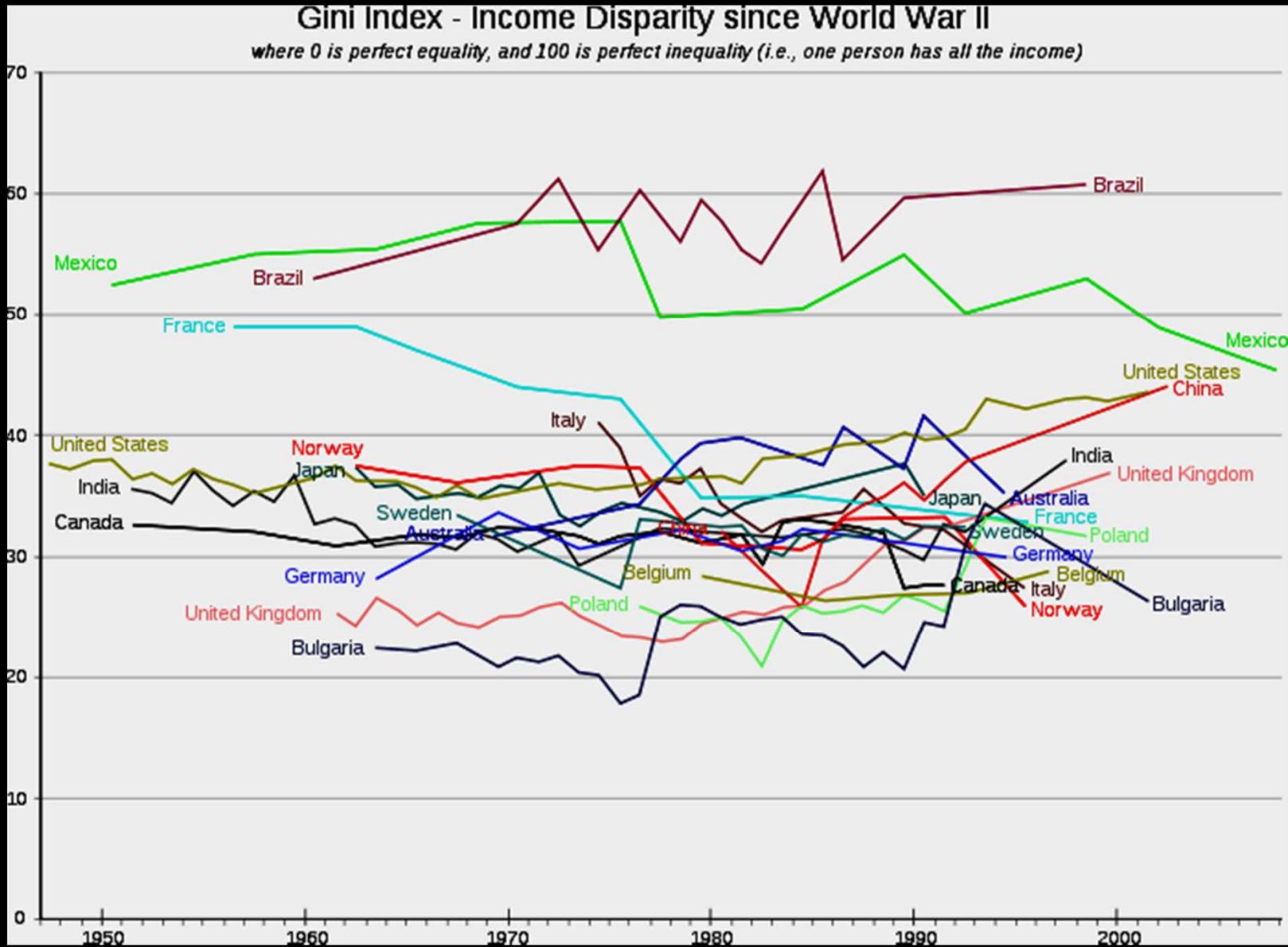
Thoughtful use of multiple indicators for analysis will lead to richer and more nuanced policy and program design

**But index numbers allow
shorthand indications of status,
trends and inter-country
comparisons
(all with due caution!)**

Index: 0 = perfect equality; 1 = perfect inequality



Gini Index – Income Disparity Since WWII



**Conclusions:
On creating Index
Numbers**

We like single numbers because:

- **Shorthand way of giving an indication of the size of a problem**
- **Easier to compare changes over time**
- **Easier to compare with other cases (countries, locations, groups) where they have the same number**

**But what we gain in convenience
we lose in diagnostic power,
accuracy of interpretation, and
as guidance for effective
policies.**

SO:

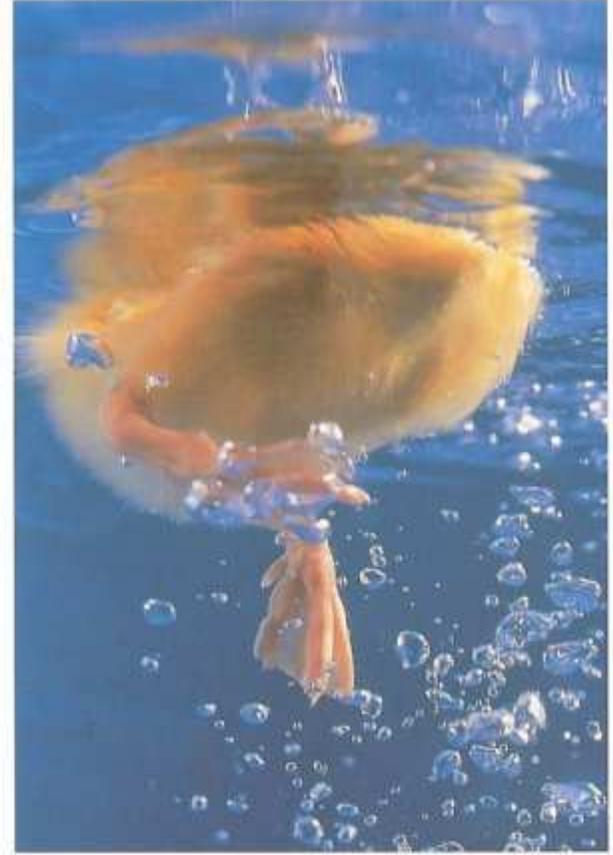
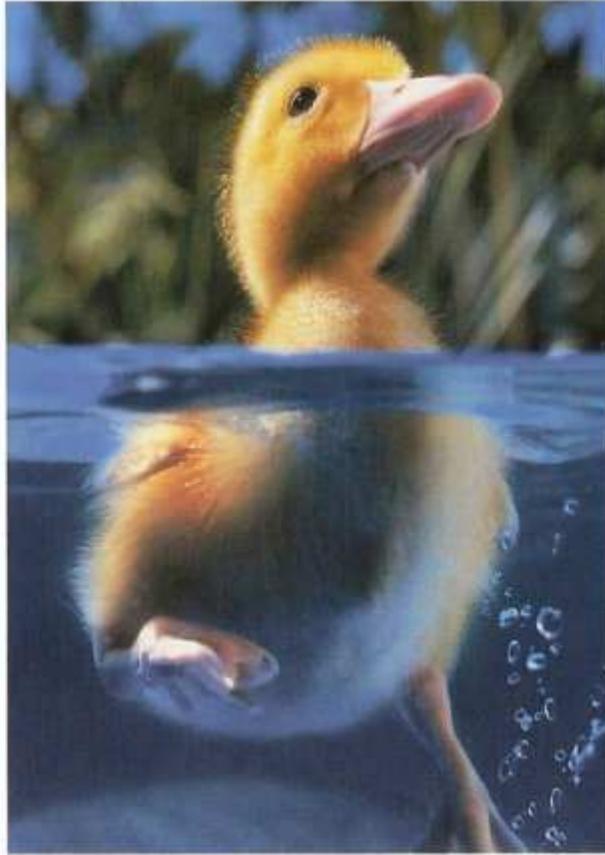
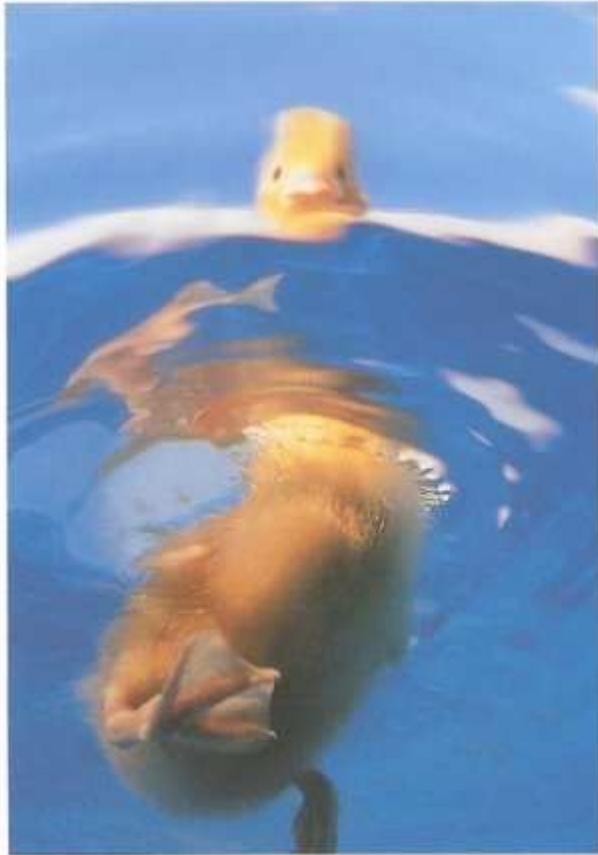
Always Try to Understand:

- **How the index number is constructed**
- **What the number does NOT capture**
- **How relevant to the question at hand is that index**
- **How relevant are the things that it misses**

Then, and only then,

- **You can use such numbers with care**

Now...



Are we sinking? Or Swimming?



I don't want any dead ducks!



Learn to fly...



I want us all to be flying together



Not just fly... Soar like an eagle!

Thank You

