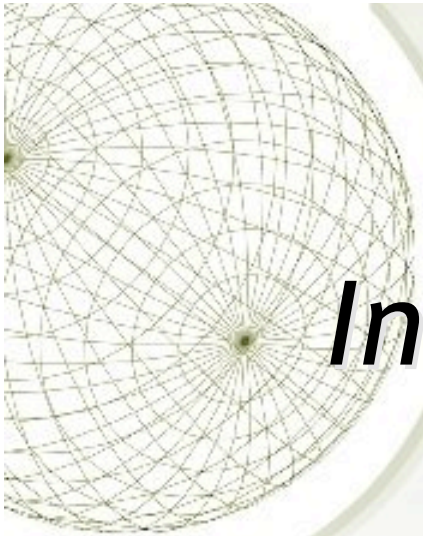

Intelligence and Complex Reasoning

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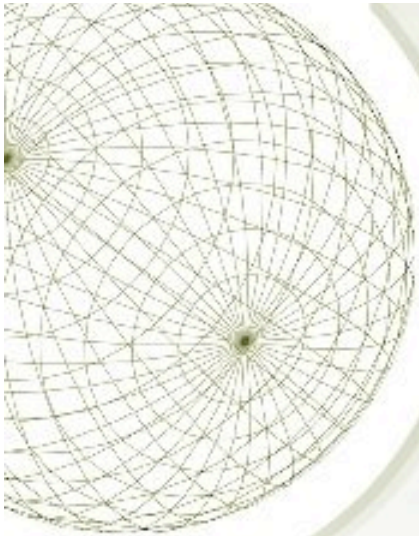
October 11, 2004



More than Ever, Intelligence Matters

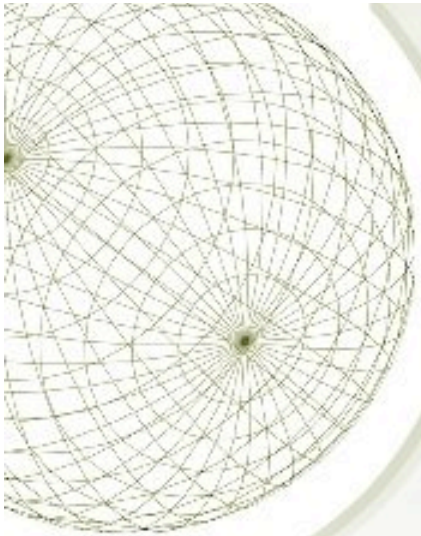
- To promote economic prosperity
  - Of companies and nations
  - Of individuals and families
  - Shift from physical to mental production
- To solve social problems
  - The achievement gap
  - World problems

The Economy

- Symbolic-analysts are on the rise
  - A new taxonomy of the labor force (Reich)
    - Symbolic analysts
    - In-person workers
    - Routine production laborers
  - Complexity, problem solving, symbolic info
  - Routine production laborers are at risk
- IQ predicts job performance
  - Overall, r=.50
  - Prediction is best for complex jobs, r=.61

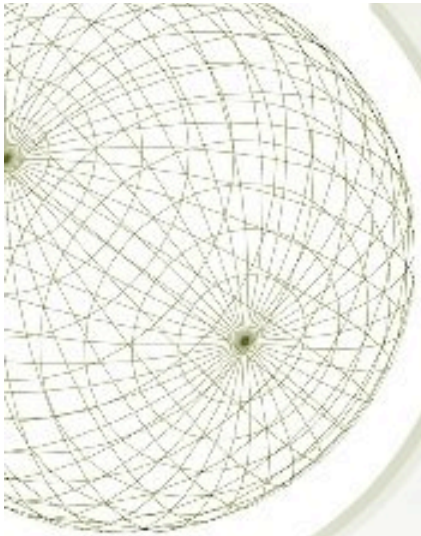
Education and Economic Reward

- Education cultivates intelligence
- Intelligence is a raw material (input) . . . but also a product (output)
- Education, and therefore intelligence, pays
- Wage premium for college education
  - 42% in 1979
  - 89% in 1995



Defining Intelligence

Intelligence is a repertoire of learnable cognitive competencies (knowledge, skills, strategies, habits) that permit effectiveness in a complex, symbol-rich, and problem-oriented world.



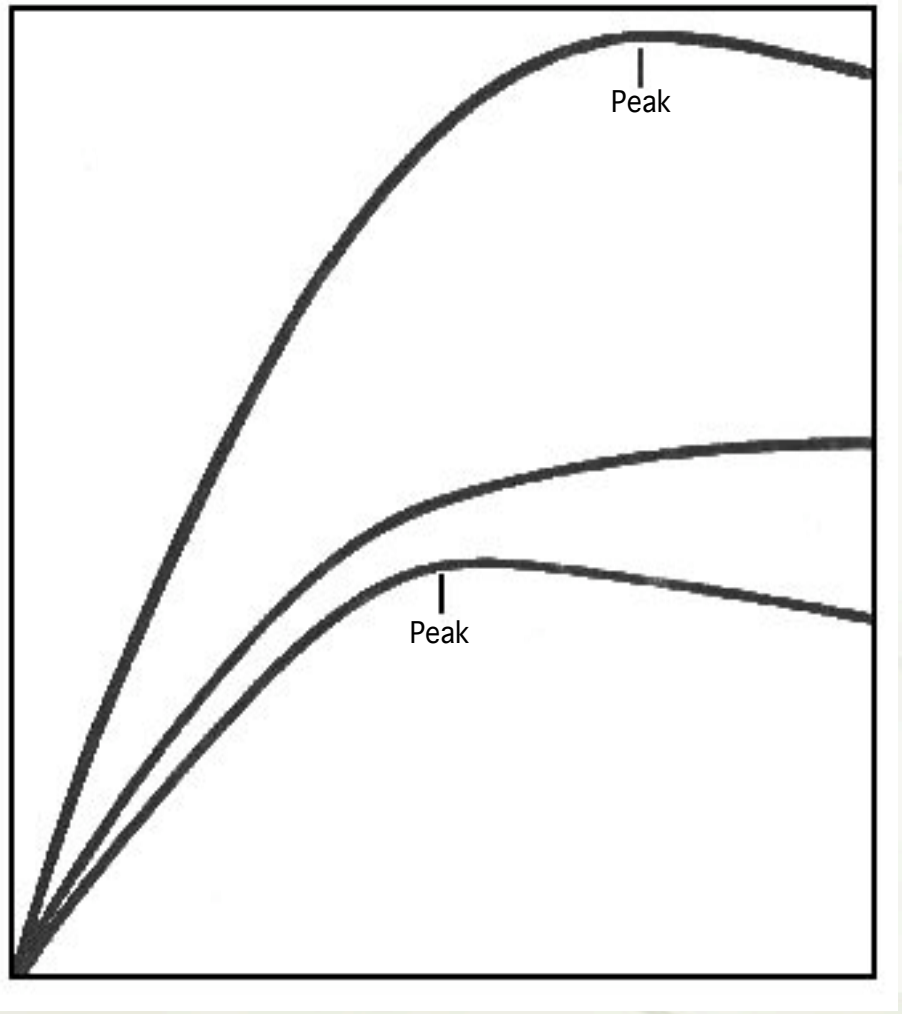
Fluid and Crystallized Intelligence

- Fluid: the ability to succeed in novel, complex, and challenging environments
- Crystallized: the ability to acquire knowledge and knowledge itself
- The Investment Theory

What About Genetics?

- Heritability (h^2) of IQ is about 0.5
- 50% of IQ variance is non-genetic
- h^2 is not a constant
  - The exact value will vary by time, place, and population
  - Not applicable to differences between groups or to individuals

Fluid and Crystallized Intelligence Over the Life Span



FI + CI

Fluid intelligence, crystallized intelligence, and the effect of the two added together.

CI

FI

Heritability Does Not Preclude IQ Change

- Within individuals
  - Childhood: Escalating mental age
  - Lifelong:Up and down IQ fluctuation (up to 20 pts.)
- Between generations
  - Height h^2 is close to 1.0
  - Height has increased by 3 cm or more per generation (Europeans, Americans, Asians)

The Flynn Effect

- The “brute phenomenon”
- IQ rose in 20th century in every country (20) for which data are available
- As much as 1 s.d. per generation
- Probably originating at the dawn of industrialization
- Intergenerational plasticity of IQ

What Caused The Flynn Effect?

- Not caused by:
  - Genetic changes (not enough time)
  - Test sophistication (effect too large)
- Possibly caused by:
  - Improved nutrition
  - Mass media
  - Universal education
  - Longer average education

Prenatal Experience

- Can inhibit development
  - Maternal stress
  - Toxins: alcohol, cigarette smoke, pesticides, radiation, barbiturates, mercury, polychlorinated biphenyls (PCBs)
  - Infection (e.g., cytomegalovirus)
- Can facilitate development
  - Vitamin/protein supplementation
  - Breastfeeding/essential fats (e.g., DHA)

Family Experience

- Home environment
  - Cognitive and emotional richness
    - Play materials, interaction, variety of experiences
- Socioeconomic status (SES)
  - Income, parental education, flexible structure
  - Cross-SES adoption studies
    - Biological and adopting about equal effects

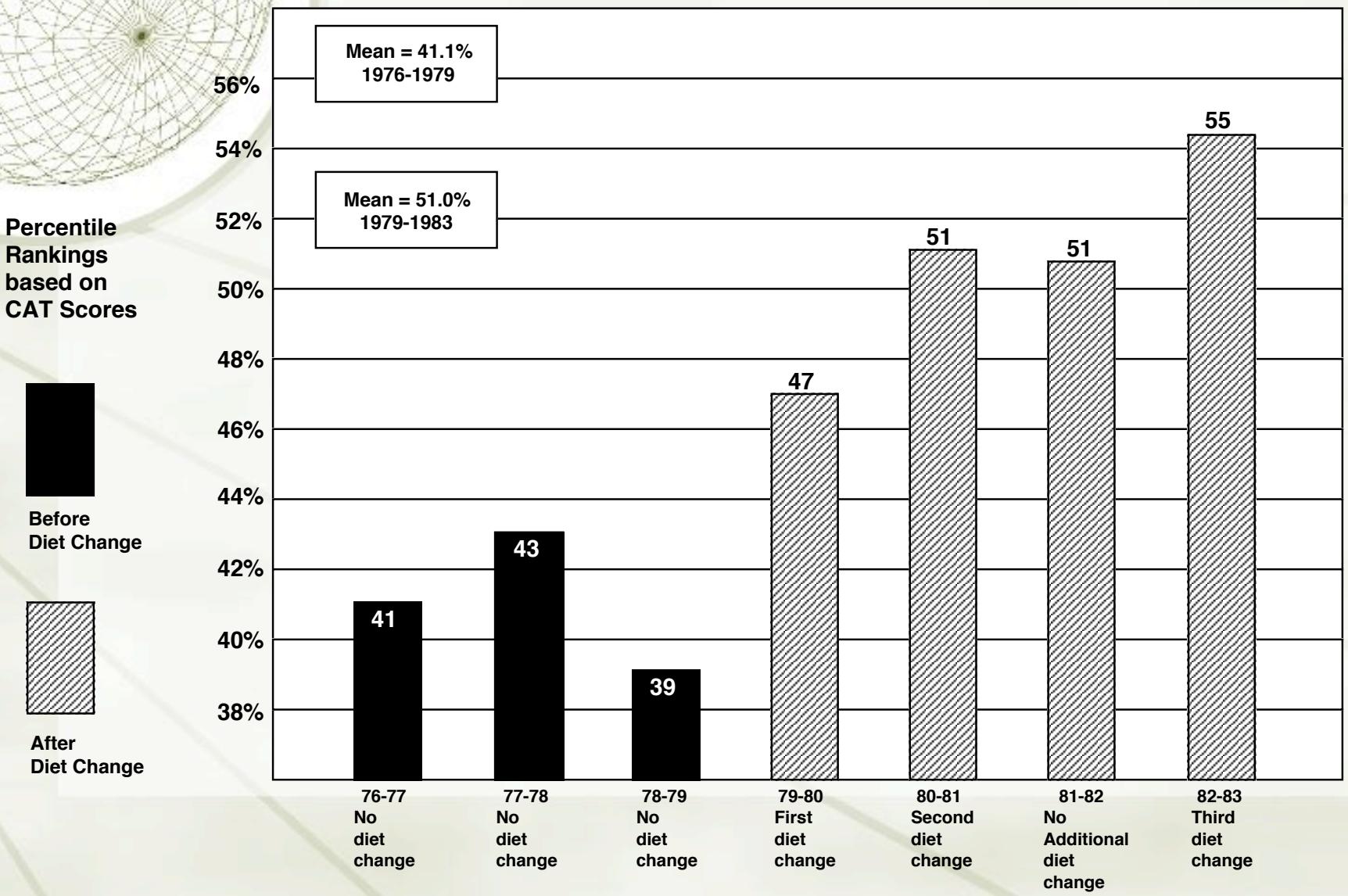
School-Age Experience

- IQ and amount of schooling
  - Between generations: WWI and WWII soldiers
  - Within generations: United States, Sweden
- IQ and disruption of schooling
  - War-time in Eindhoven, Holland
  - Public school closure in Virginia
- IQ and quality of schooling
  - Grade acceleration and delay
- Quality of home life: Summer vacation

Experience in Adulthood

- University experience
  - Cognitive effects of about 1 standard dev.
- Job experience
  - Complex jobs increase cognitive flexibility
- Old age experience
  - Neurotrophins respond to exercise
  - Neurogenesis is possible

Nutrition and Achievement

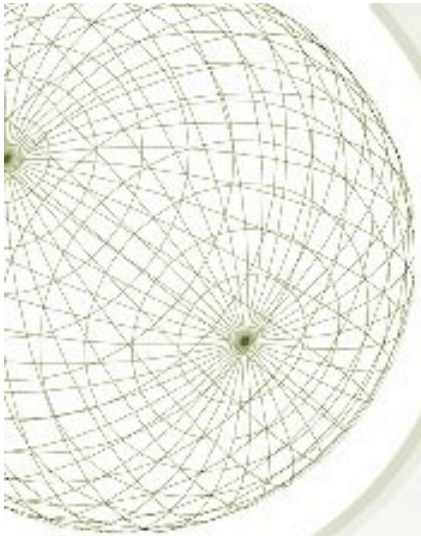


Infancy and Early Childhood

- Infancy intervention — 10 IQ pts
- Early childhood interventions
  - Iowa Soldiers Orphans' Home — 16 IQ pts
  - Early Training Project — 9 IQ pts
  - The Academic Preschool — average 15 IQ pts
  - Carolina Abecedarian Project — 8 IQ pts
  - Project Head Start — 9 IQ pts
    - "fade out"
  - The Milwaukee Project — 25 IQ pts

School-Age Interventions

- Project Intelligence (Venezuela)
  - 460 seventh graders, 56 lessons
  - Gains of up to 6 IQ points
- Brown and Campione's Research
  - Advances in metacognition
- Feuerstein's Instrumental Enrichment
  - Mediated learning (9 IQ points)
- Kvashchev's Experiments
  - Creative problem solving (6 to 8 IQ points)



Defining Intelligence (Again)

Intelligence is a repertoire of learnable cognitive competencies (knowledge, skills, strategies, habits) that permit effectiveness in a complex, symbol-rich, and problem-oriented world.

The Duplex Model

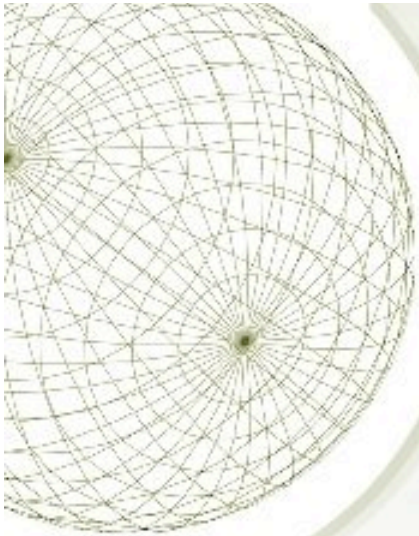
- Short-Term Memory
  - Small capacity
    - 7±2 “chunks”
  - Short duration
  - “Working” memory
  - Locus of consciousness
- Long-Term Memory
  - Large capacity
    - Unlimited
  - Very long duration
  - Multi-code
  - The warehouse of the mind

Cognitive Processes and Structures

- STM to LTM: Learning
- LTM to STM: Remembering
- Schema Theory
  - The mind is not a video camera
  - The construction of knowledge
  - Schema development
    - Accretion, tuning, restructuring
  - Pursuing quality of thought

Defining Metacognition

- Possible definitions
  - Most simply: Thinking about thinking
  - More exactly: The monitoring and control of thought
- Areas of application
  - Metamemory and metacomprehension
  - Problem solving
  - Critical thinking



Metamemory and Metacomprehension

- Both concern awareness of one's own knowledge state
- Metamemory: How accurately a learner can appraise his or her own knowledge state
- Metacomprehension: How accurately a learner can appraise his or her understanding of any message, written or spoken

Problem Solving

- A major category of human cognition
- What is problem solving?
  - The pursuit of a goal when the path to that goal is uncertain
- Closely linked to scientific thinking
- Problem solving involves metacognition at each step.
  - What am I trying to accomplish?
  - What are the most promising pathways?
  - Is my strategy working?

Critical Thinking

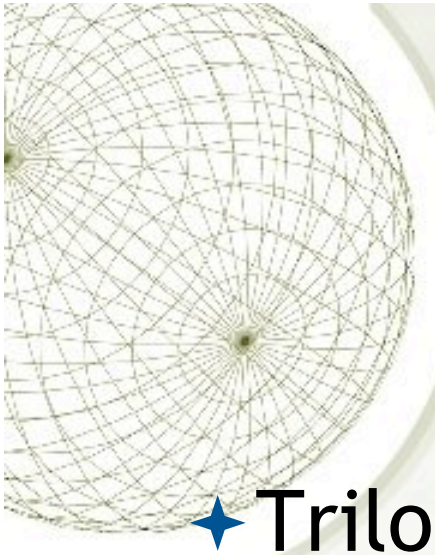
- Yet another major category of cognition
- What is critical thinking?
  - The evaluation of ideas for their quality, especially in judging whether they make sense
- Critical thinking involves metacognition at each step.
  - Is the idea clear?
  - Does one idea follow from another?
  - Are the ideas backed by evidence?

Vygotskian Connections

- The social origins of higher-order cognition
  - Higher-order thought processes begin as social discourse
  - Social discourse is internalized for the individual as inner speech
- Vygotsky's theory is perhaps the best rationale for group processes in learning

How to Enhance Metacognition

- Credible presence in the curriculum
  - Explicit goal of learning
  - Opportunity to engage in metacognition
  - Assessment of metacognition
- Cognitive modeling by teacher/professor
- Social interaction among learners
  - Potentially very effective
  - Difficult to sustain quality



Emotional and Self-Regulatory Aspects

- Trilogy of Mind
  - Cognitive (thinking/reasoning)
  - Affective (emotion/feeling)
  - Conative (choosing/doing)
    - Motivation
    - Volition (post-decision)
- Self-efficacy
  - Specific beliefs about what one can do

Prospects

- Better thinking
  - In specific subject domains and in life
- Greater human effectiveness
  - Productivity (including economic)
  - Creativity
  - Wisdom
- New models for intelligence and for education