

Human Capital, Skill Formation, Early Intervention, and Long-Term Health

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toward Better Health Outcomes
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Introduction

- For early deaths, it is estimated that:
 - ❶ 40% are due to behavioral patterns
 - ❷ 30% are due to genetic predispositions
 - ❸ 15% are due to social circumstances
 - ❹ 10-15% are due to shortfalls in medical care(McGinnis, Williams-Russo, and Knickman, 2002)
- Currently, 95% of the trillion dollars we spend on health is on treatment, not prevention .
- While it is possible that current resource allocations represent a social optimum, this seems unlikely.

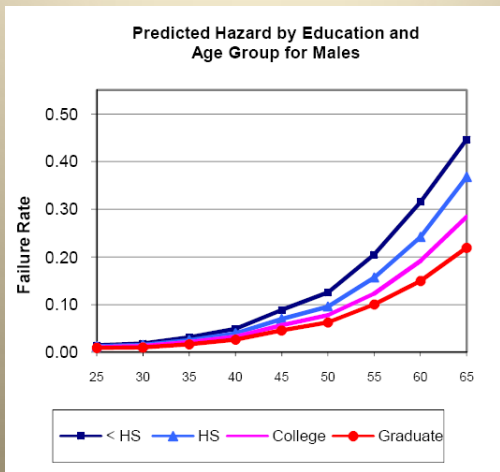
- What are the implications of these observations for policy?
- What causes the onset of disease and the practice of unhealthy behaviors?
- Can we do anything cost effective about reducing or eliminating the causes? At what cost? For what age range is remediation the most effective?
- My talk today takes a developmental approach to these questions.

The Argument

- Behaviors are shaped by abilities and motivations.
- These traits emerge early, and are strongly influenced by the family.
- A neglected avenue of health policy is early intervention programs that help form positive traits.
- This argument goes beyond looking exclusively at education (e.g., Becker, 2008) or nutrition (Barker, 1998; Fogel, 2004) but is consistent with both emphases.
- I have developed a unified approach to human development that unites and extends previous research in a common framework that is the basis for policy interventions in health, education, crime, and employment.

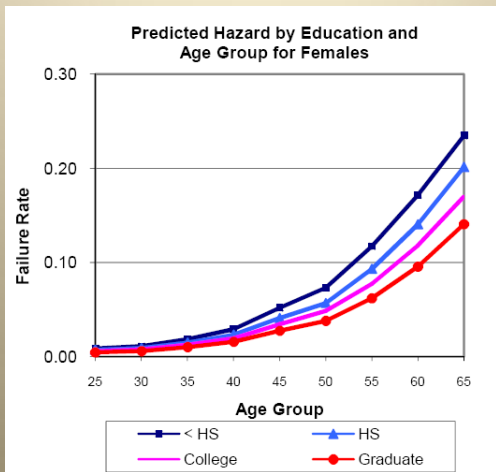
- Cognitive and noncognitive skills—self-regulation, motivation, time preference, far-sightedness, adventurousness and the like—affect the evolution of health capital through choices made by parents and children.
- Grossman (2000), Smith (2007) and Sanchez (2008) show that education is an important determinant of health and health disparities.

Predicted 9-Year Mortality Rates by Education, Holding Income Fixed, Males



Source: Yuri Sanchez. "The Longevity Gains of Education." Working Paper (2008).

Predicted 9-Year Mortality Rates by Education, Holding Income Fixed, Females



Source: Yuri Sanchez. "The Longevity Gains of Education." Working Paper (2008).

- The recent literature in economics shows the importance of personality and cognition in affecting educational choices.
- They also have direct effects on health (Hampson et al., 2007).
- Those with greater self-control and conscientiousness follow medical instructions and take care of themselves in a variety of ways.
- Certain personality types are at greater risk for mental health disorders (Borghans, Duckworth, Heckman, and ter Weel, 2008).

Human Diversity and Human Development

Any analysis of health and human development must reckon with ten observations:

1. Ability matters

A large number of empirical studies document that cognitive ability is a powerful determinant of wages, schooling, participation in crime and success in many aspects of social and economic life (Herrnstein and Murray, 1994; Heckman, 1995; Heckman, Stixrud, and Urzua, 2006; Murnane, Willett, and Levy, 1995) including health (Auld and Sidhu, 2005).

2. Abilities are multiple in nature

Noncognitive abilities

perseverance, motivation, time preference,
risk aversion, self-esteem, self-control,
preference for leisure,

have direct effects on

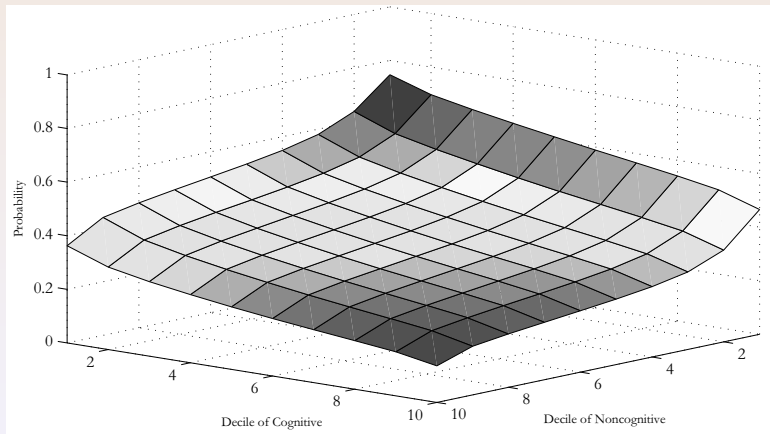
wages (controlling for schooling), schooling, health,
performance on achievement tests, crime, teenage pregnancy,
smoking,

and many other aspects of social and economic life.

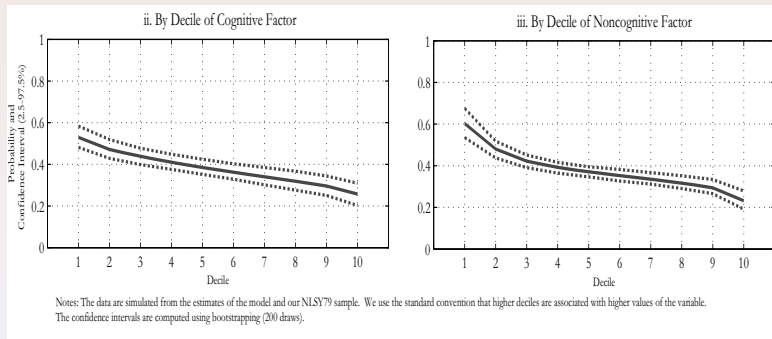
Heckman, Stixrud, and Urzua (2006); Borghans, Duckworth, Heckman, and ter Weel (2007); Bowles, Gintis, Osborne (2001).

- They affect health choices (see the evidence on time preference and health in Grossman, 2000).
- Social and emotional factors affect adult health (Ryff and Singer, 2005).
- Common set of abilities help determine multiple behaviors and outcomes.

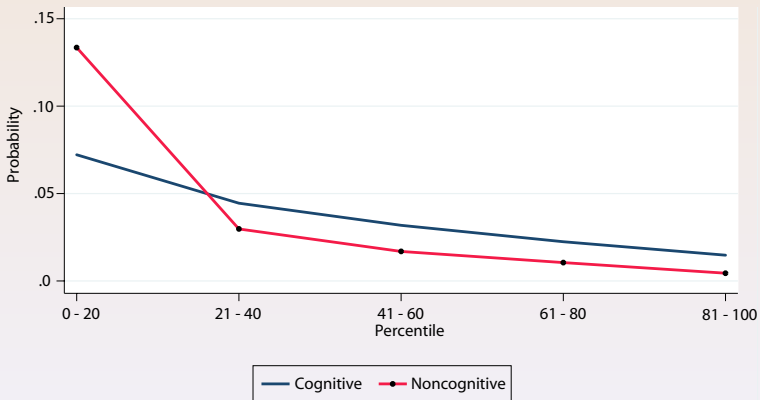
Probability of daily smoking by age 18 (males)



Probability of daily smoking by age 18 (males) (cont.)



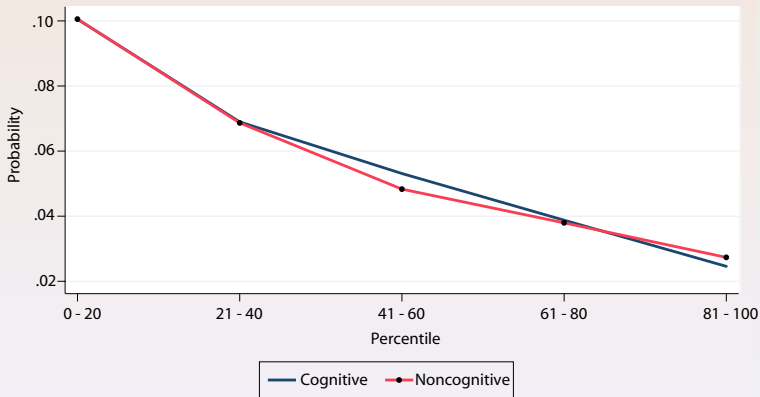
Ever been in jail by age 30, by ability (males)



Note: This figure plots the probability of a given behavior associated with moving up in one ability distribution for someone after integrating out the other distribution. For example, the lines with markers show the effect of increasing noncognitive ability after integrating the cognitive ability.

Source: Heckman, Stixrud, and Urzua (2006).

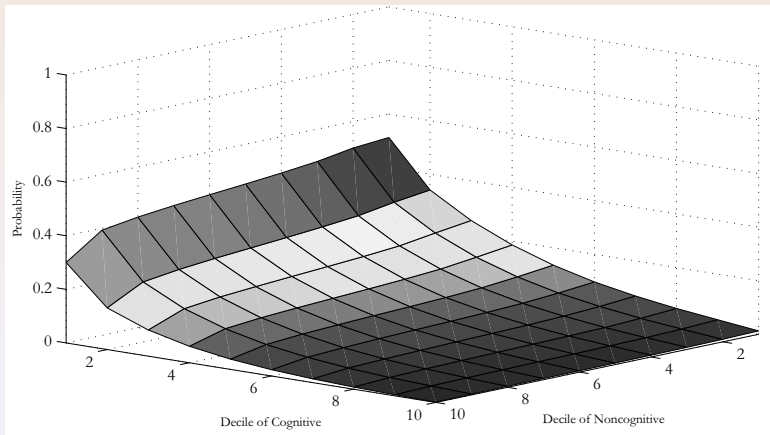
Probability of teenage pregnancy



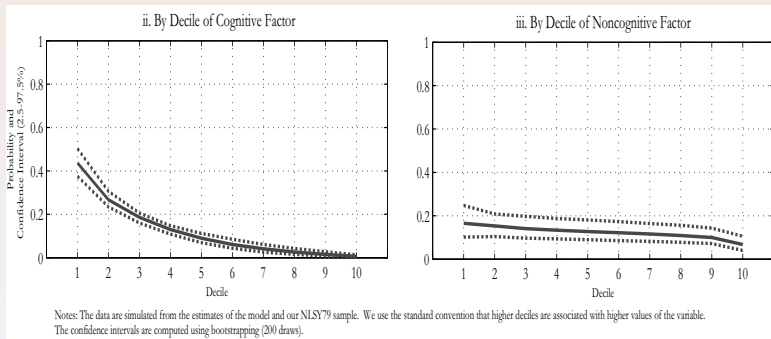
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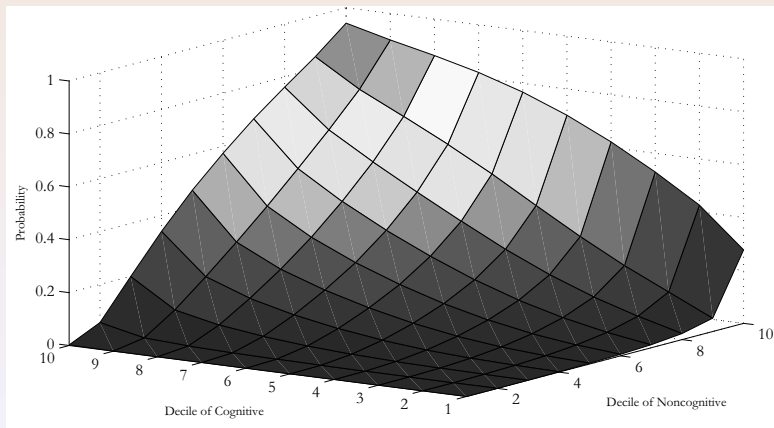
Probability of being a high school dropout by age 30 (males)



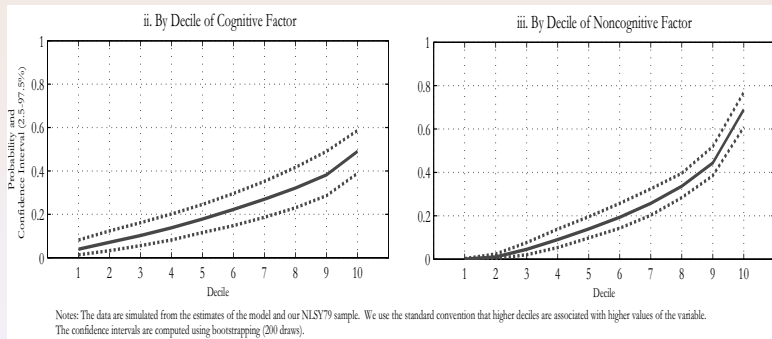
Probability of being a high school dropout by age 30 (males) (cont.)



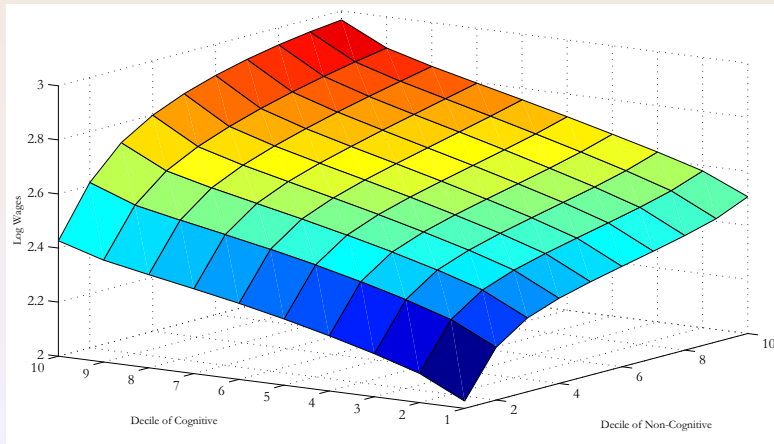
Probability of being a 4-year college graduate by age 30 (males)



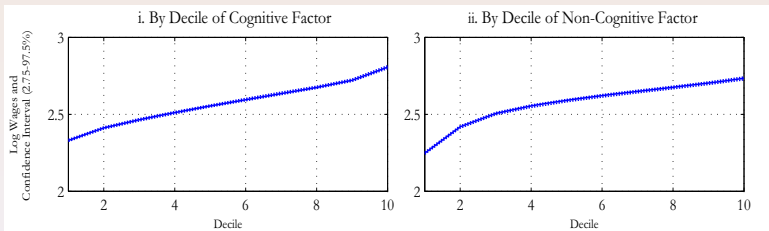
Probability of being a 4-year college graduate by age 30 (males) (cont.)



Mean log wages by age 30 (males)



Mean log wages by age 30 (males) (cont.)

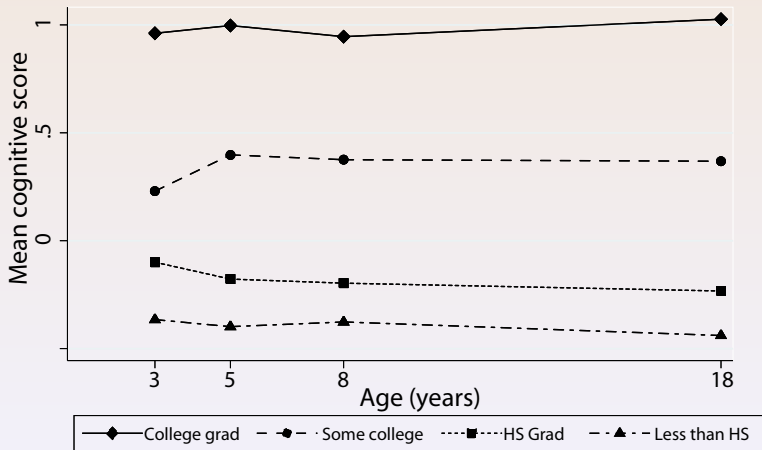


Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (50 draws).

- Third, *ability gaps between individuals and across socioeconomic groups are substantial and open up at early ages, for both cognitive and noncognitive abilities. The same is true of gaps in health status.*

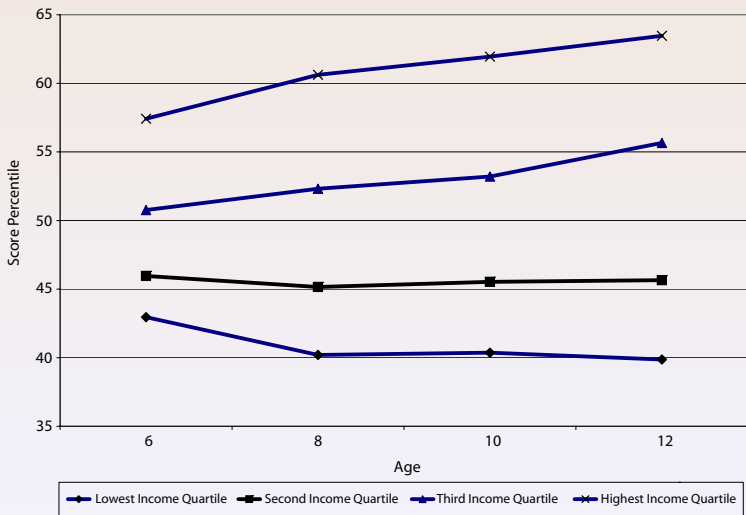
- Research shows that schooling quality, pupil teacher ratios, teacher pay and the like play only a small role in accounting for these gaps or in widening or narrowing them.
- The gaps start early before school begins and they persist.
- Once one controls for early family environments, the gaps substantially narrow.

Trend in mean cognitive score by maternal education

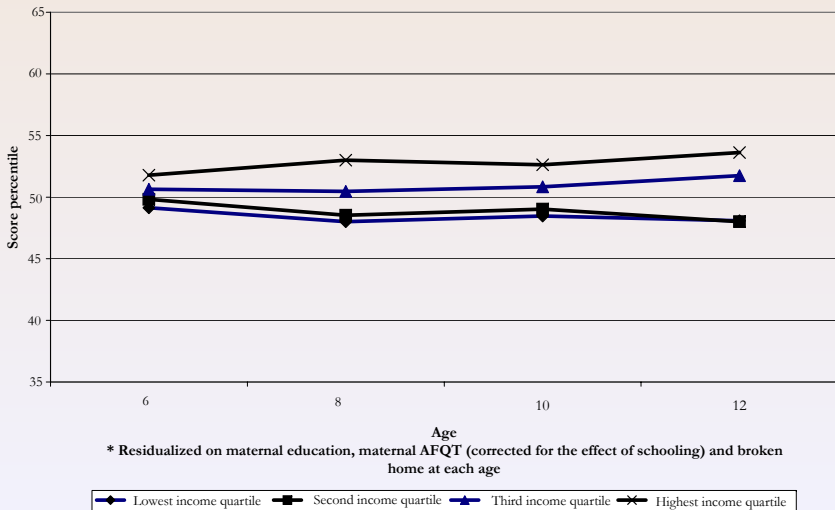


Each score standardized within observed sample. Using all observations and assuming data missing at random. Source: Brooks-Gunn et al. (2006).

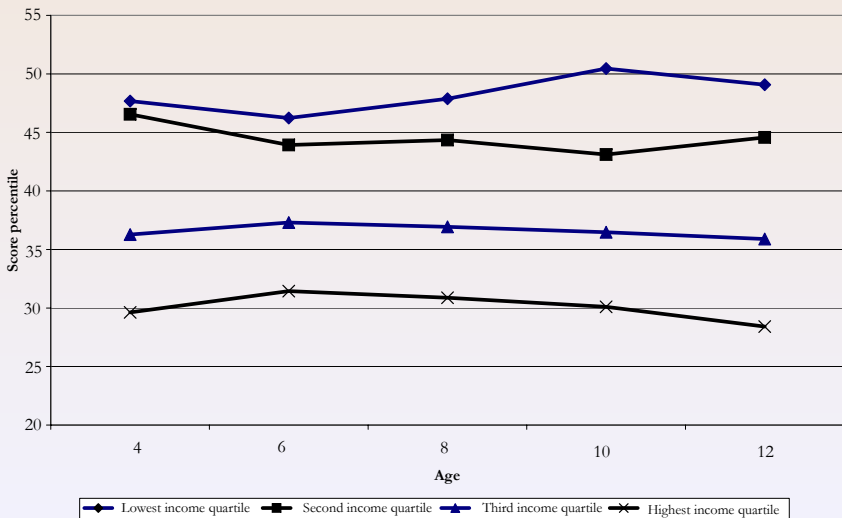
Average percentile rank on PIAT-Math score, by income quartile



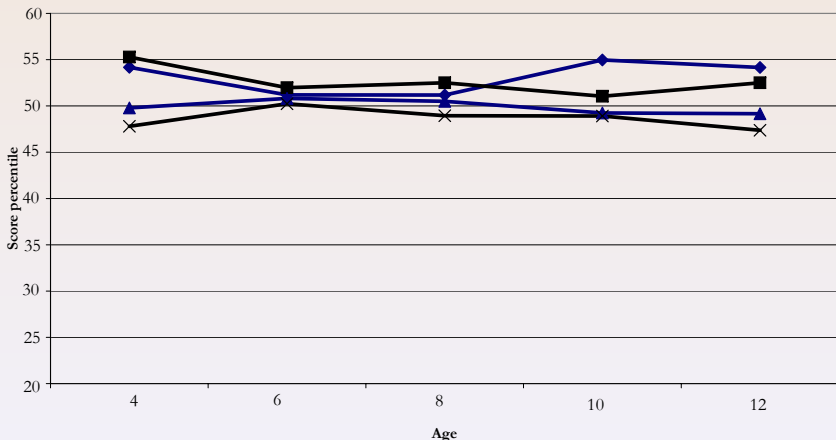
Adjusted average Math score percentiles by income quartile



Average percentile rank on anti-social behavior score, by income quartile



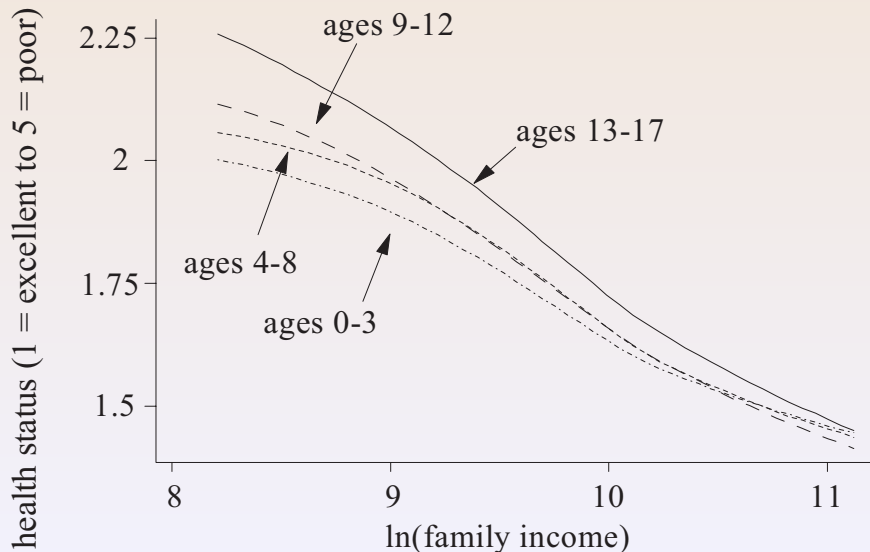
Adjusted average anti-social behavior score percentile, by income quartile



* Residualized on maternal education, maternal AFQT (corrected for the effect of schooling) and broken home at each age

◆ Lowest income quartile ■ Second income quartile ▲ Third income quartile × Highest income quartile

Figure 2: Health and income for children and adults U.S. national health interview survey 1986-1995.



- Gaps in health are not all about access to health care services.

**The Steepening of the Health-Income Gradient with Child Age
A Comparison of the U.S., Canada, and the U.K.
Ordered Probits (1=excellent, 5=poor)**

Age:	0 to 3	4 to 8	9 to 12	13 to 17(15)
<u>U.S.: Case, Lubotsky, Paxson, NHIS</u>				
Ln(Income)	-0.183 [.008]	-0.244 [.008]	-0.268 [.008]	-0.323 [.008]
<u>Canada: Currie and Stabile, NLSCY</u>				
Ln(Income)	-0.151 [.026]	-0.216 [.019]	-0.259 [.024]	-0.272 [.040]
<u>U.K.: Currie, Shields, Price, HSE</u>				
Ln(Income)	-0.146 [.040]	-0.212 [.028]	-0.196 [.031]	-0.174 [.034]

Notes: Standard errors in brackets. Regressions control for year effects, family size, sex, mother age at birth, father present, etc.

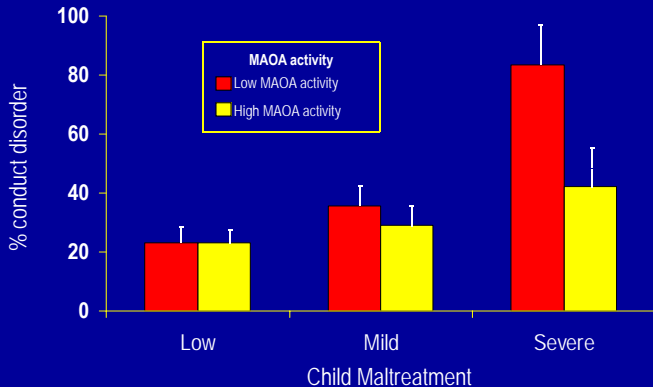
Source: Currie (2006).

- The similarities between Canada and the U.S. suggest that access to health insurance is NOT the driver for the steepening gradient.
- Family environments play a powerful role.

- Fourth, *genes and environments interact to produce outcomes*.
 - Gaps are not purely due to genes.
 - Environments affect gene expression.

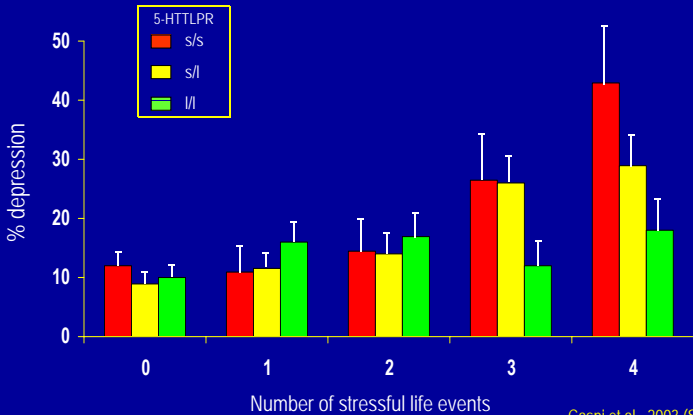
Evidence of Gene-Environment Interactions in Causes of Diseases and Behaviors

Male conduct disorder: Child maltreatment interacts with MAOA genotype



Caspi et al., 2002 (Science)

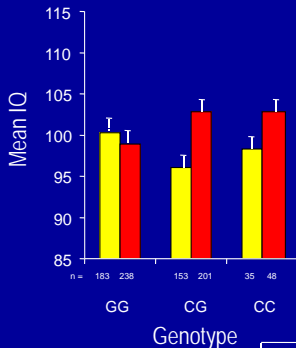
Adult depression: Adult life stress interacts with 5HTT genotype



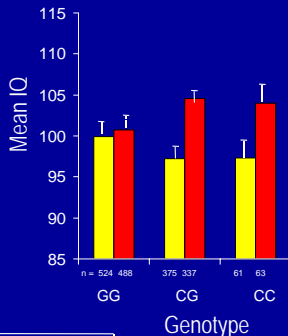
Caspi et al., 2003 (Science)

The IQ: Breastfeeding interacts with FADS2 genotype

(A) New Zealand Birth Cohort

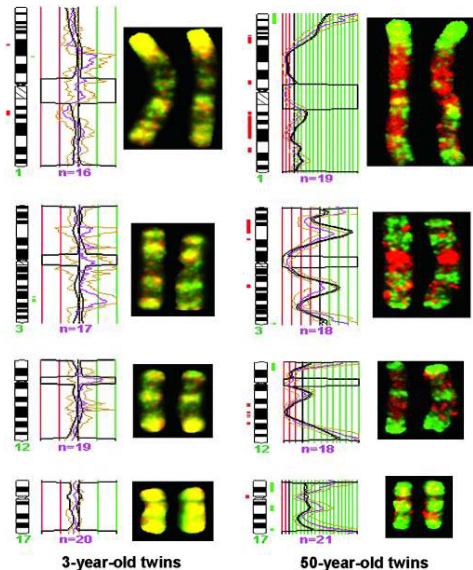


(B) British E-risk Birth Cohort



Caspi et al., 2007 (PNAS)

Methylation patterns in young and old twins



Manel Esteller

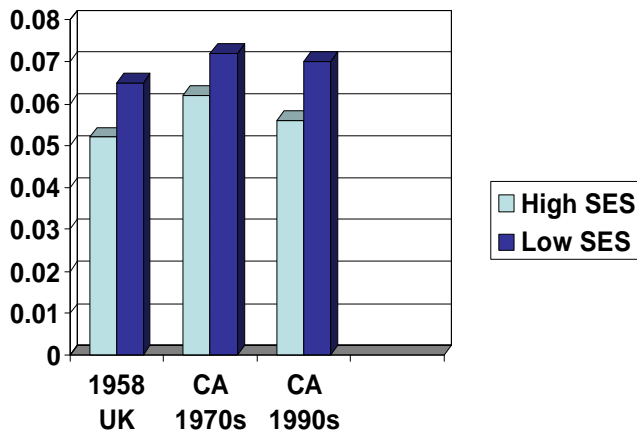
- Fifth, *family and environmental conditions in the early years are predictive of adult outcomes including health.*

Parent Education and Income and Child Health

- Differences in child health are apparent at birth.
- Consider rate of occurrence of low birth weight (birth weight less than 2500 grams).

SES Difference in Low Birth Weight

Note: In CA SES=zip income at birth, in UK SES defined using Father occupation.



Source: Currie, 2006.

- Using data from the 1999 PSID, James Smith (2005) shows that a retrospective question about health during childhood is strongly predictive of future outcomes.
- (What was your general health status when you were 16 years old? 1=excellent, 5=poor)

**Predicting Adult Education and Earnings Using Child Health.
PSID 1999, 25-47 Year Old Children of Original Respondents**

	OLS Education	Sib-FE Education	OLS Ln(Earnings)	Sib-FE Ln(Earnings)
Health in Childhood	0.356	0.111	0.138	0.251
Excellent/Very Good	[4.40]	[1.12]	[3.07]	[3.69]
Parent's Income 1-16	0.01	...	0.002	...
	[10.7]		[4.29]	

Source: Smith (2005). Models also control for mother and father education, race/ethnicity, age, age squared. Age 1999 squared. T-statistics in brackets. Income in \$10,000.

The Adverse Childhood Experiences (ACE) Study (Felitti and Anda)

- The largest study of its kind ever done to examine the effects of adverse childhood experiences on health and human development over the lifespan (17,337 participants).
- The study shows with data that the insights of Freud about the effects of adverse early childhood environments are correct.
- Exactly what features of early trauma or adverse environment affect child outcomes is not yet known.

Disease

ACEs Increase Likelihood of Heart Disease*

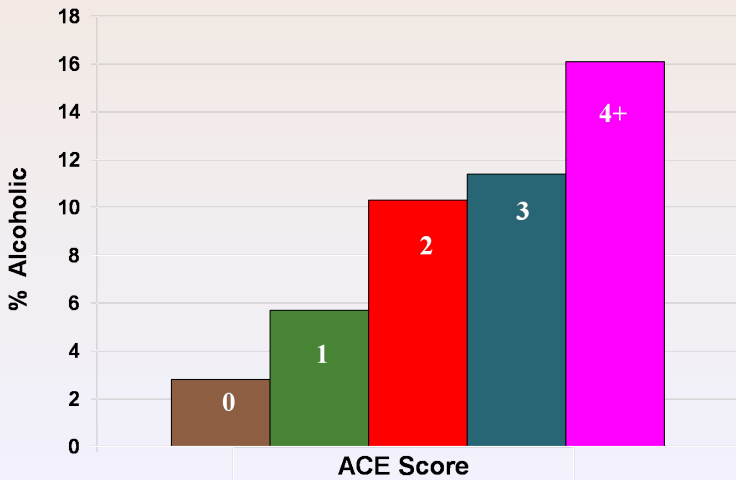
- Emotional abuse 1.7x
- Physical abuse 1.5x
- Sexual abuse 1.4x
- Domestic violence 1.4x
- Mental illness 1.4x
- Substance abuse 1.3x
- Household criminal 1.7x
- Emotional neglect 1.3x
- Physical neglect 1.4x



*After correction for age, race, education, and conventional risk factors like smoking and diabetes.
Circulation, Sept 2004.

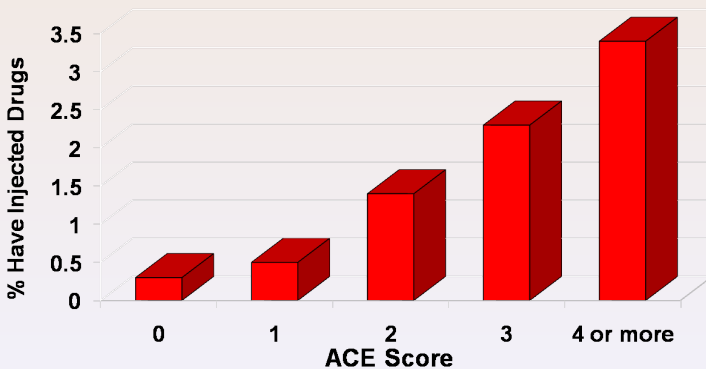
Health Risk

Childhood Experiences vs. Adult Alcoholism

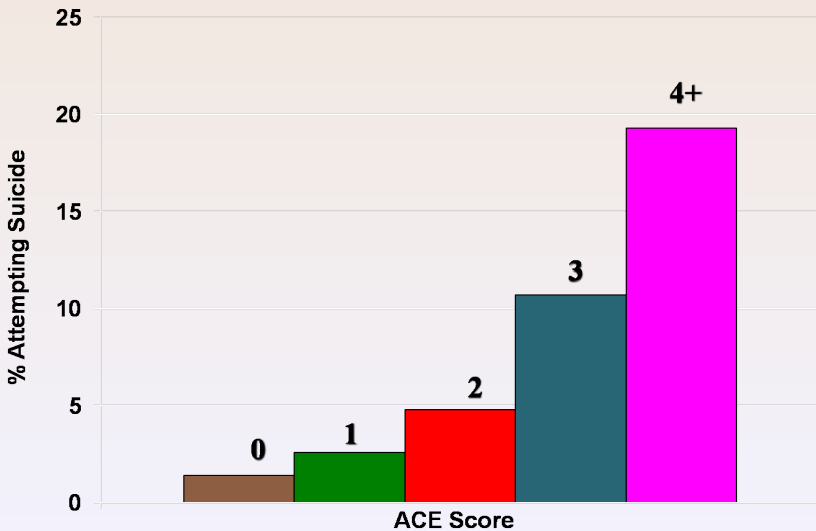


Health Risk

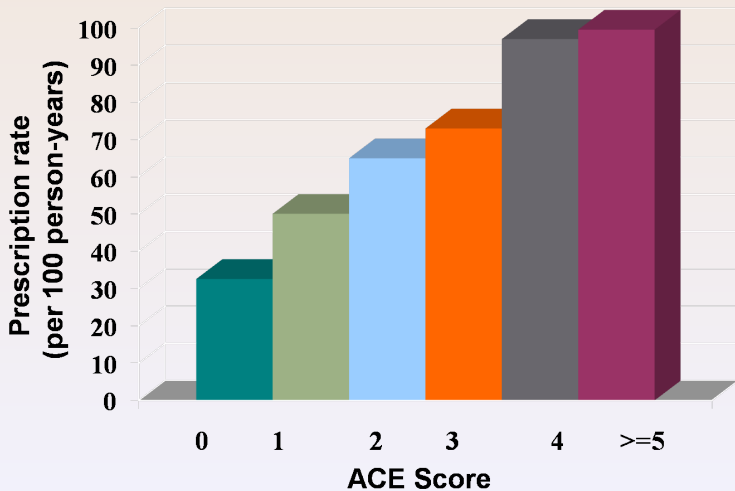
ACE Score vs Intravenous Drug Use



Childhood Experiences Underlie Later Suicide

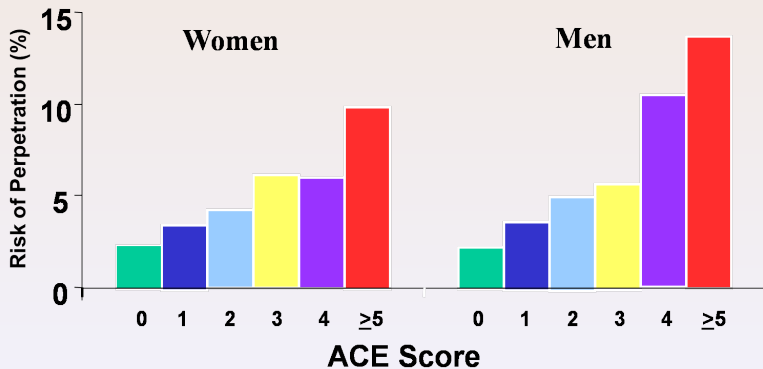


ACE Score and Rates of Antidepressant Prescriptions



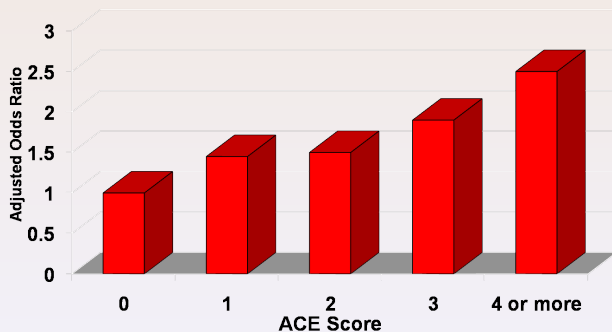
Well-being

ACE Score and the Risk of Perpetrating Domestic Violence



Disease

Adverse Childhood Experiences vs. History of STD



Adverse Childhood Experiences and the Likelihood of:

ACE Score	Multiple Sexual Partners*	3 or More Marriages*	Unwanted Pregnancy* (abortion)
0	1.0	1.0	1.0
1	1.6	1.5	1.5
2	1.9	1.6	1.7
3	3.4	2.3	2.3
4	4.4	2.9	2.1
≥5	5.8	3.8	2.9

***Adjusted Odds Ratio**

CHILDHOOD MALTREATMENT

AGE 3-11 in Dunedin cohort



Maternal rejection (14%)

Harsh discipline (10%)

Caregiver changes (6%)

Physical abuse (4%)

Sexual abuse (12%)

None

1 type

≥2

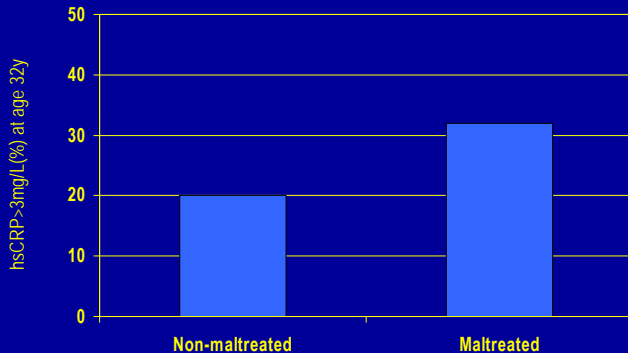


No

Probable

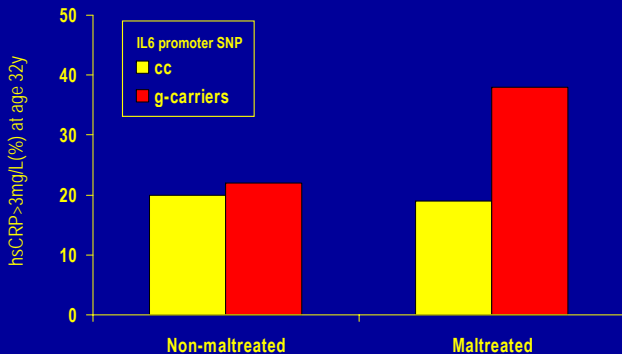
Definite

CHILDHOOD MALTREATMENT AND ADULT INFLAMMATION



Danese et al. 2007 (PNAS)

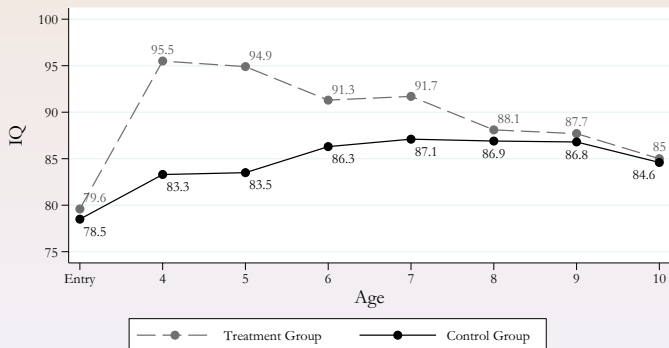
IL6 GENOTYPE x MALTREATMENT > ADULT INFLAMMATION: Gene x Environment interaction



Danese et al. (in preparation)

- Sixth, *the importance of the early years in predicting outcomes is not solely a manifestation of genes determining life outcomes or of correlated environments over time.*
- Experimental evidence shows that improved environments matter — produce positive causal effects on both cognitive and noncognitive ability for early interventions.
- Primarily through noncognitive skills for later (\geq age 3) interventions.

Figure: Perry Preschool Program: IQ, by Age and Treatment Group.



Source: Perry Preschool Program. IQ measured on the Stanford Binet Intelligence Scale (Terman and Merrill, 1960). Test was administered at program entry and each of the ages indicated.

Figure: Educational Effects, by Treatment Group. *High Achievement Defined as Performance At or Above the Lowest 10th Percentile on the California Achievement Test (1970). Source: Barnett (2004).

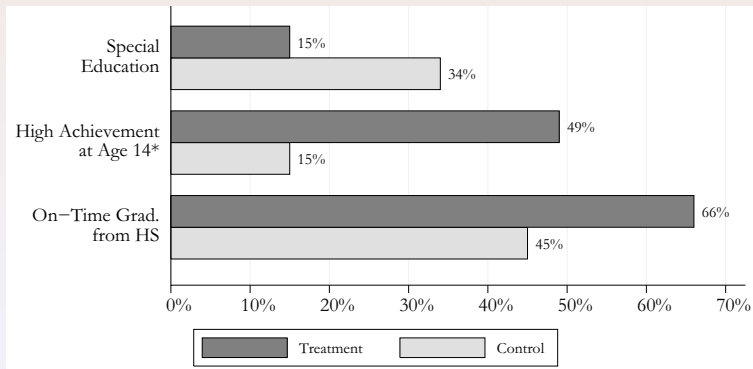


Figure: Economic Effects at Age 27, by Treatment Group. *Updated through Age 40 using recent Perry Preschool Program data, derived from self-report and all available state records. Source: Barnett (2004).

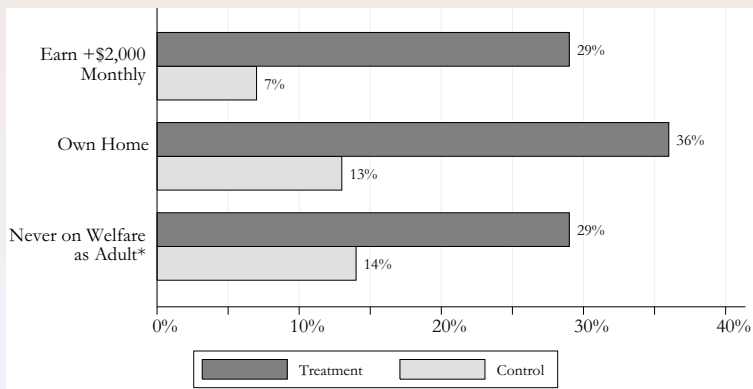
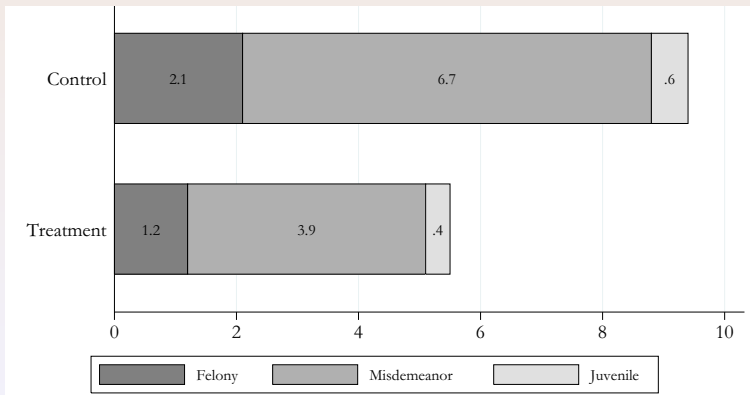
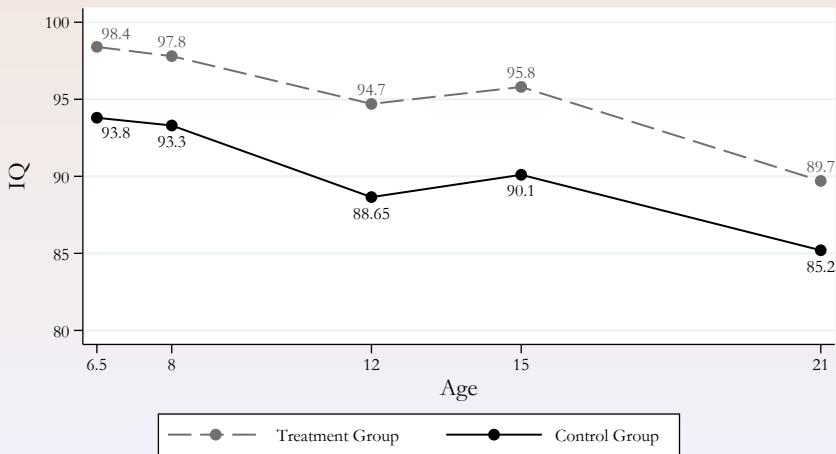


Figure: Arrests Per Person before Age 40, by Treatment Group. Juvenile arrests are defined as arrests prior to age 19. Source: Barnett (2004).



- In the more intensive, earlier starting, Abecedarian program, IQ gains were found.

Abecedarian program: IQ, by age and treatment group



Source: Barnett (2004).

- The Nurse Family Partnership Act which intervenes with pregnant teenage mothers and teaches them mothering and infant care has strong effects on adult success.
- A consortium of scholars researching early childhood based at the Harris school at the University of Chicago is synthesizing and refining this evidence and conducting new experiments.
- The lesson is clear: the earlier the better and the more disadvantaged the child the more powerful effects of the intervention.

- Different types of abilities appear to be manipulable at different ages. IQ scores become stable by age 10 or so, suggesting a sensitive period for their formation below age 10 (Schuerger and Witt, 1989).
- On average, the later remediation is given to a disadvantaged child, the less effective it is.
- At historically funded levels, public job training programs and adult literacy and educational programs, like the GED, that attempt to remediate years of educational and emotional neglect among disadvantaged individuals, have a low economic return and produce meager effects for most persons.

- Much evidence suggests that returns to adolescent education for the most disadvantaged and less able are lower than the returns for the more advantaged (Carneiro and Heckman, 2003; Carneiro, Heckman, and Vytlačil, 2006; Meghir and Palme, 2001).
- The available evidence suggests that for many skills and human capabilities, later intervention for disadvantage may be possible, but that it is much more costly than early remediation to achieve a given level of adult performance (Cunha and Heckman, 2006).

- Seventh, *despite the low returns to interventions targeted toward disadvantaged adolescents, the empirical literature shows high economic returns for remedial investments in young disadvantaged children.*
 - This finding is a consequence of dynamic complementarity and self-productivity captured by the technology of skill formation.
 - Olds (2002) documents that perinatal interventions that reduce fetal exposure to alcohol and nicotine have substantial long-term effects on cognition, socioemotional skills and on health and have high economic returns.

- Eighth, *if early investment in disadvantaged children is not followed up by later investment, its effect at later ages is lessened.*

- Ninth, *the effects of credit constraints on a child's adult outcomes depend on the age at which they bind for the child's family.*
 - Controlling for cognitive ability, under policies currently in place in American society, family income during a child's college-going years plays only a minor role in determining socioeconomic differences in college participation, although much public policy is predicated on precisely the opposite point of view.
 - Credit constraints operating in the *early* years have lasting effects on adult ability, schooling, and hence health outcomes.

- Tenth, *the technology of capability formation rationalizes the evidence, and predicts diverse behaviors from a common framework that can be used for policy analysis.*

- Cunha and Heckman (2008) and Cunha, Heckman, and Schennach (2007) estimate technologies of skill formation to understand how the skills of children evolve in response to
 - (1) the stock of skills children have already accumulated;
 - (2) the investments made by their parents; and
 - (3) the stock of skills accumulated by the parents themselves.

- C_t = cognitive skill at age t
- N_t = noncognitive skill at age t
- H_t = health at age t
- C_m = maternal cognition
- N_m = maternal noncognitive skills
- H_m = health of mother

- Technology for the production of cognitive skills:

$$C_{t+1} = F_{C,t}(N_t, C_t, H_t, I_t, C_M, N_M, H_m).$$

- Equation is a technology for the production of non-cognitive skills:

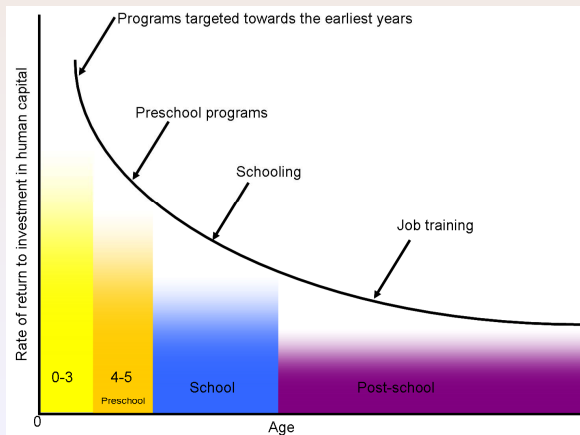
$$N_{t+1} = F_{N,t}(N_t, C_t, H_t, I_t, C_M, N_M, H_m).$$

- Equation of health skills:

$$H_{t+1} = F_{H,t}(N_t, C_t, H_t, I_t, C_M, N_M, H_m).$$

- These technologies recognize intergenerational transmission and dynamic multipliers.
- Captures the effect of critical and sensitive periods on development.
- Captures cross-effects of noncognitive skills on fostering cognitive skills and vice versa.
- Allow us to estimate the capacity to substitute late for early?
- How much remediation is possible?

Figure: Return to a Unit Dollar Invested at Different Ages from the Perspective of the Beginning of Life, Assuming One Dollar Initially Invested at Each Age



Comparison of different investment strategies. Disadvantaged Children: First decile in the distribution of cognitive and non-cognitive skills at age 6. Mothers are in first decile in the distribution of cognitive and non-cognitive skills at ages 14-21.

Outcome	Baseline	Changing early conditions: changing investment from the 1 st to 7 th decile of distribution of early investment	Adolescent intervention: moving investments at last transition from 1 st to 9 th decile	Changing initial conditions and performing a balanced intervention using the resources of the adolescent intervention
High School Graduation	0.4109	0.6579	0.6391	0.9135
Enrollment in College	0.0448	0.1264	0.1165	0.3755
Conviction	0.2276	0.1710	0.1773	0.1083
Probation	0.2152	0.1487	0.1562	0.0815
Welfare	0.1767	0.0905	0.0968	0.0259
			35 – 50% more costly	

Source: Cunha and Heckman (2006).

- The evidence strongly supports the economic efficiency of early initial investment that is sustained.
- Optimal distribution of investment:
 - Invest early? Yes.
 - But must be followed up to be effective.
- This is a consequence of dynamic complementarity.
- Later remediation is possible but to attain what is accomplished by early investment is much more costly.
- If we start at too low a level, later skill investment is economically inefficient.

Summary

- 1 Need for an integrated approach to understanding health and human development.
 - i Integrated across the life cycle
 - ii Integrated across diverse outcomes
- 2 The technology of skill formation recognizes that common developmental processes are at work across the life cycle on many aspects of health and human development.
- 3 The early years are important for producing abilities.

- ④ This is not just a manifestation of genes or persistent environments over the life cycle.
- ⑤ Genes matter but are activated by the environment.
- ⑥ Experiments show high returns for investments in disadvantaged children.
- ⑦ Remediation is costly.