The Economics of Human Development

James Heckman
University of Chicago
University College Dublin

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Introduction

- The labor market is the major source of income for most persons in most countries.
- The recent growth of inequality in the labor market in many countries is a serious problem.
- Differences in abilities and skills (education, post-school training, cognitive and noncognitive skills) are the major sources of inequality in modern society.

Introduction

- Ability is multifaceted and consists of both cognitive abilities (e.g., IQ) and noncognitive abilities (e.g., persistence, motivation, self-discipline and the like).
- Ability gaps open up early, long before formal schooling begins.
- These gaps are produced in large part by differences in family environments.
- The family is the major source of inequality in modern society.

Introduction

- A variety of economists and social scientists have taken very different positions on the importance of the family and the environment.
- Adam Smith claimed that at age 8, people were pretty much the same.
- They became different as they specialized into different occupations.
- We now know that this viewpoint is incorrect.

Introduction

- Important differences in abilities and motivations open up early in the lives of children.
- But the claim that all differences are due to heredity, as claimed by Herrnstein and Murray, is also false.
- Gene-environment interactions are documented to be important.

Introduction

- Through what mechanisms does family influence operate?
- How can society undo the effects of adverse family environments?
- There is a strong positive relationship between family resources and child outcomes.
- There are strong intergenerational correlations of child-parent earnings ($r = .65$) in the US; weaker in Europe.

Introduction

- Understanding these facts and the dynamics of the human skill formation process — the technology of human skill formation — has major consequences for the way we think about education and skill formation policy.
- Policies that reduce inequalities in early environments are the most efficient mechanisms for reducing inequality and raising personal productivity.

Introduction

- For policies directed toward disadvantaged young children, there is no equity/efficiency trade-off.
- This feature is rare for any public policy.
- For policies directed toward later stages of the life cycle, there is an equity-efficiency trade-off.
- Postponed skill investments are less efficient, sometimes dramatically so.

Introduction

- Conventional policy discussions about education and skill formation are off the mark because they ignore the dynamic nature of the skill formation process.
- Schools can remedy years of neglect by families only at great cost, if at all.
- The economic returns to marginal reductions in pupil/teacher ratios and teacher pay increases are small at current levels of expenditure in most societies.

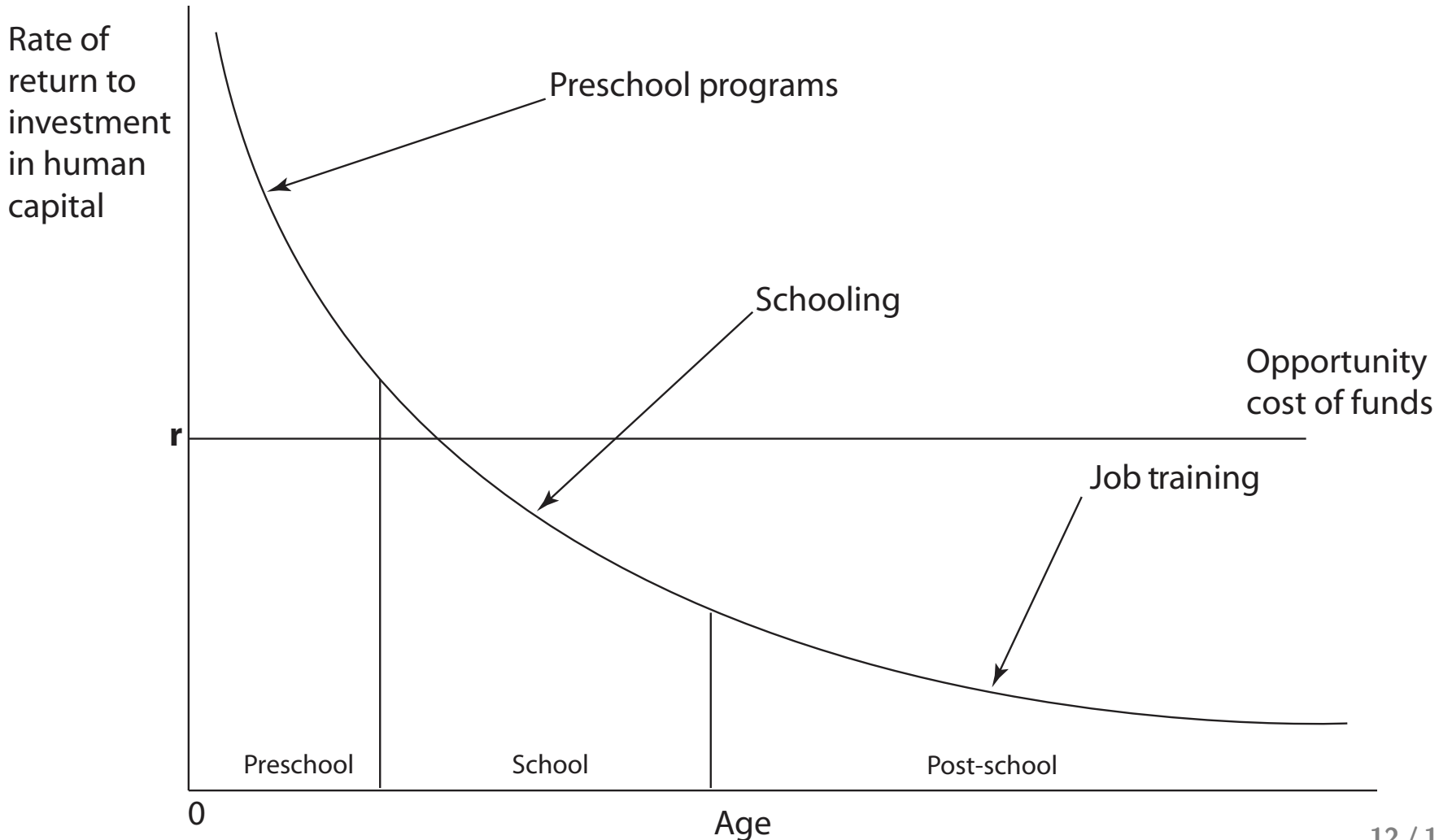
Introduction

- Job training and second chance remediation programs for disadvantaged adolescents and young adults have, at best, modest effects, and are inefficient relative to early interventions.
- The highest returns are to early interventions that set the stage for and create the abilities needed for success in school and in life.

Major Theme of This Lecture:

- Skill begets skill.
- Both a theoretical and an empirical proposition.
- At current levels of spending, most societies underinvest in the early years for children from disadvantaged environments.

Rates of return to human capital investment initially setting investment to be equal across all ages



The Argument in a Nutshell

- Many major economic and social problems can be traced to low levels of skill and ability in the population.
- Abilities are multiple in nature.
- Much public policy discussion focuses on promoting and measuring cognitive ability and especially IQ.
- Cognitive abilities are important for socioeconomic success.

The Argument in a Nutshell

- But socioemotional skills are also important for success in life.
- Motivation, perseverance and tenacity feed into performance in society at large and even affect scores on achievement tests.
- Early family environments are major predictors of both cognitive and socioemotional abilities.
- This is a major source of concern because family environments in the U.S. and many other countries around the world have deteriorated over the past 40 years.

The Argument in a Nutshell

- Experiments support the large body of correlational evidence that adverse family environments promote adult failure.
- Life cycle skill formation is dynamic in nature. Skill begets skill; motivation begets motivation. If the child is not motivated and stimulated to learn and engage, the more likely the adult will fail in social and economic life and the more costly is later remediation.
- If society intervenes early enough, it can affect both cognitive and socioemotional abilities.
- Early interventions that supplement family environments promote schooling, reduce crime, promote workforce productivity and reduce teenage pregnancy.

The Argument in a Nutshell

- Early interventions applied to disadvantaged populations have much higher returns than later interventions applied to disadvantaged populations, such as reduced pupil-teacher ratios, public job training, convict rehabilitation programs, tuition subsidies, or expenditure on police.

- Another way to say this is that later remediation is costly; perhaps infinitely costly for some of the most disadvantaged.

The Argument in a Nutshell

- However, early interventions must be followed up by later investments to be productive. Relatively more investment should be made when the child is young, but later investment is required to harvest it.
- This is dynamic complementarity, a central concept of this lecture.

Major Problems Facing Many Modern Societies

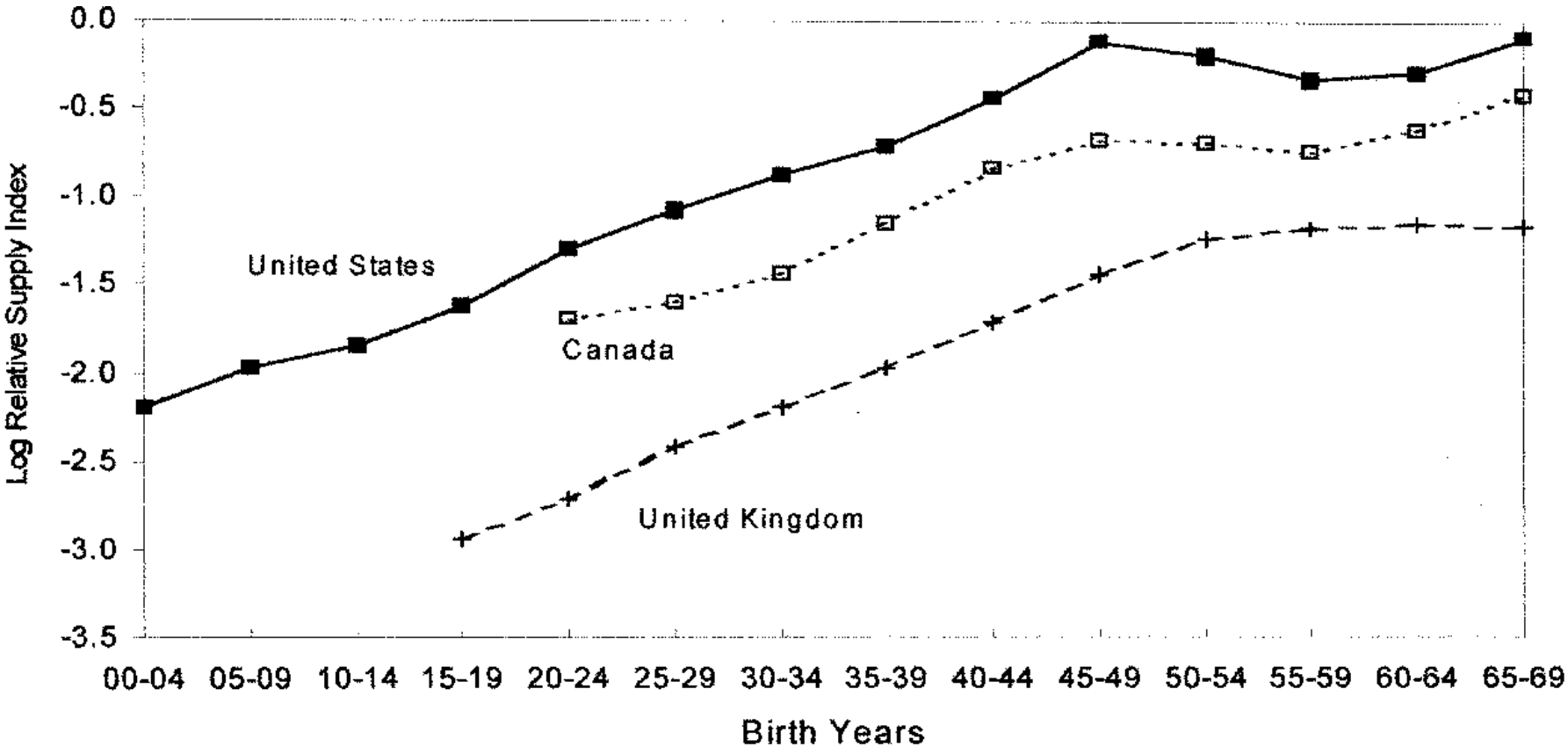
- The U.S. and many other countries face major problems in terms of the growth in the quality of their labor forces, in terms of crime, and in terms of emerging underclass behavior.
- Education and skills more generally are major determinants of productivity growth, crime, and many other important social phenomena.
- Therefore the slowdown in the growth of educational attainment in many countries is a source of concern.

Slowdown in Labor Force Growth

- It has implications for productivity growth (slowdown of 0.3-0.4% per year for the US)
- Translates into slower wage growth.
- Heterogeneity in labor force quality is also expanding.
- This produces inequality in society.

- Rates of return to education have been increasing at a time when the supply response has slowed down.
- To an economist, the sluggish response of the supply of skills is an enigma — when the rate of return has increased, the supply response should lead to many more educated workers, not the stunted growth rates we observe.

Relative supply of college-educated workers by cohort



- Whatever increase in educational attainment that has occurred has been concentrated among the most affluent American families.
- This trend threatens to perpetuate and enhance inequality across income groups and race groups.
- Threatens workforce productivity because more of our future workers are coming from disadvantaged families.

Slowdown in Labor Force Growth

- Given that education is so important in modern society, it is important to know what determines education.

The Importance of Parental Resources

- It is well known that parental background and financial resources are important in determining schooling and lifetime achievement.
- Economists study this under the rubric of "credit constraints".
- Economists often interpret these constraints in terms of the money families have at their disposal when they make decisions about children going to college.

The Importance of Parental Resources

- However, recent research shows that the operative credit constraints are the inability of children to buy better parents, and the inability of parents to borrow against children's future income to support investment in their children.
- These are not the constraints that attract attention in public policy discussions.
- In most Western societies, family credit constraints in the school going years explain very little of the gaps in college enrollment among socioeconomic groups.

The Importance of Parental Resources

- Yet family income is strongly correlated with education and skill attainment.
- At issue is how to interpret this correlation and how to devise policies to undo it.
- Conditioning on child ability and family background eliminates racial gaps and gaps attributed to family income at the age the child is deciding to enroll in school.

- In the US, only 8% of American families are credit constrained in the short run sense.
- Gaps in the abilities that determine participation in schooling open up early.

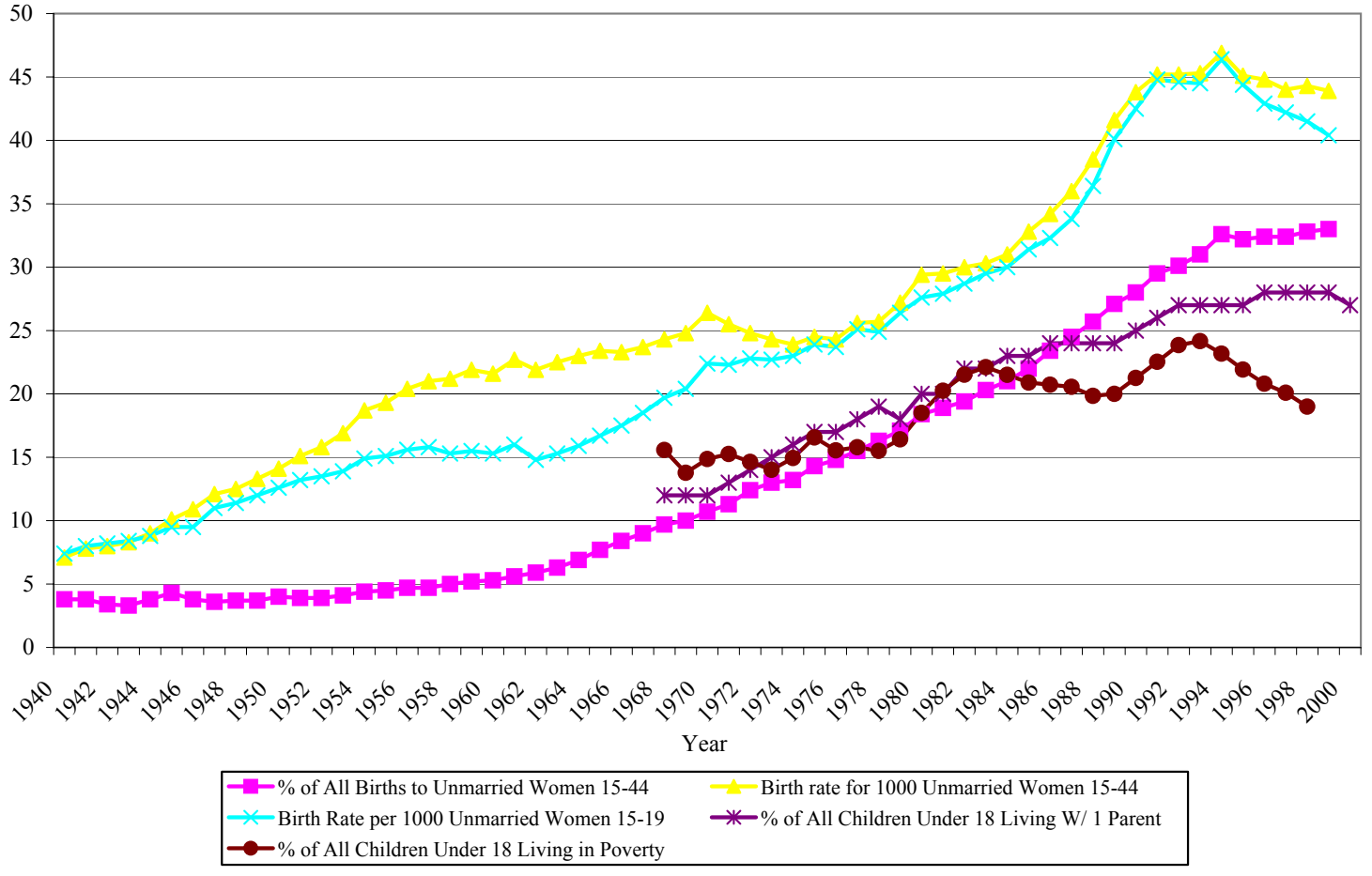
The Importance of Parental Resources

- Because long term family environments and abilities are major predictors of skill attainment, we should be alarmed because family environments are deteriorating in many countries.

Trends in Home Environments

- Relatively more children in many countries are growing up in adverse environments, independently of how one measures adversity.
- Fewer children are living with two married parents.

Trends in unhealthy child environments



Data for births and birth rates are from Ventura and Bachrach (2000). Data for children living with one parent are available at the census bureau at http://www.census.gov/population/socdemo/hh-fam/tabCH-1.txt. Data for children living in poverty is available at www.childtrendsdatabank.org/

Trends in Home Environments

- In most countries, most of that increase has to do with non-marital childbearing rather than divorce.
- Single-parenthood and divorce are much more common for secondary school dropout mothers.
- Non-marital teen childbearing is relatively high.
- Single parent family structures with poorly educated mothers are associated with poor outcomes for kids.

Cognitive and Emotional Stimulation

- Uneducated teenage mothers provide less cognitive and emotional stimulation to their children than other mothers.
- Their children are less successful in life in a number of dimensions.

Abilities Are Multiple

- Before turning to the dynamics of the skill formation process, it is important to understand that there are multiple abilities.

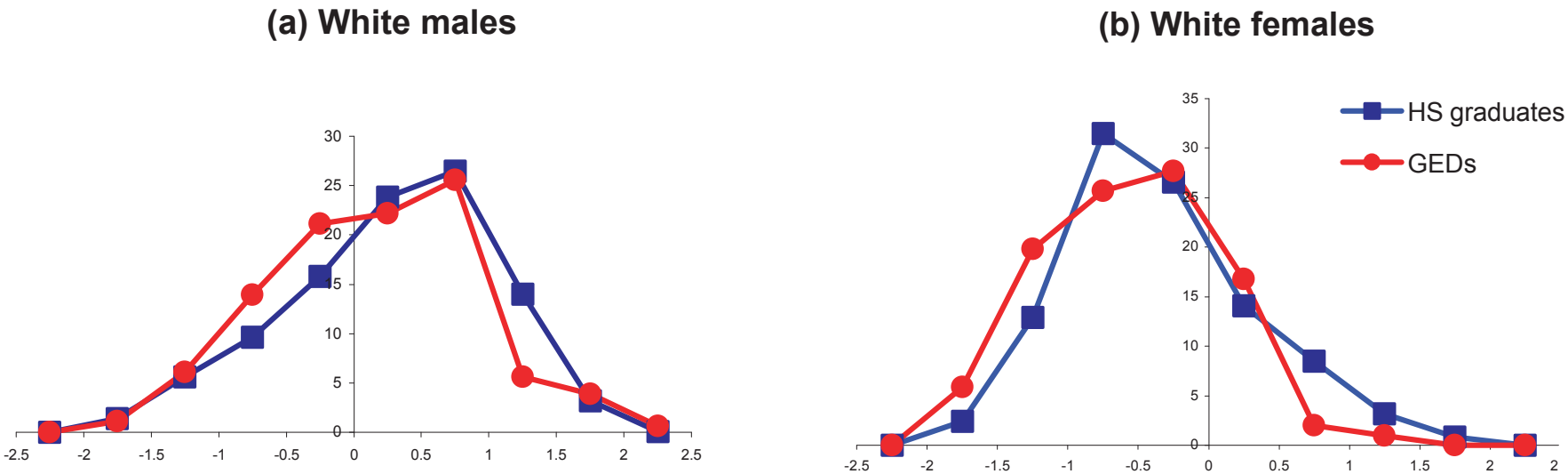
- Much public policy discussion is devoted to cognitive test scores, IQ or "smarts".
- An emerging body of evidence shows that, as is intuitively obvious and commonsensical, much more than smarts are required for success in life.
  - Motivation,
  - Attention,
  - Self Esteem,
  - Time Preference.

- Their importance tends to be underrated in current policy discussions because they are not easily measured.
- Evidence from the GED program (Heckman and Rubinstein, 2001).

- The GED program is a second chance program given to secondary school dropouts.
- They pass a test and this certifies that they are the equivalents of ordinary secondary school graduates.
- In the US, 20% of all high school graduates are now GEDs.

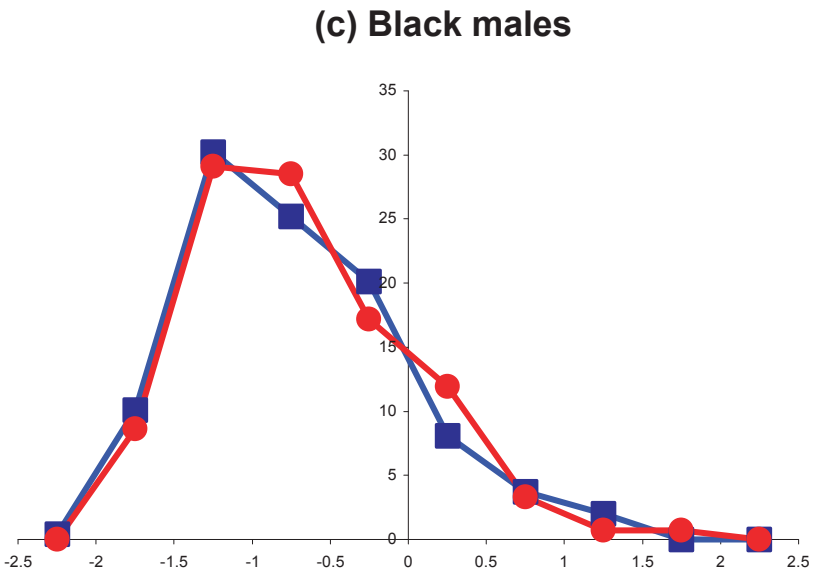
- GEDs are required to pass a test of cognitive abilities.
- Level relatively low–at the grade 8 to grade 10 level.
- However, the test is successful in its own terms.

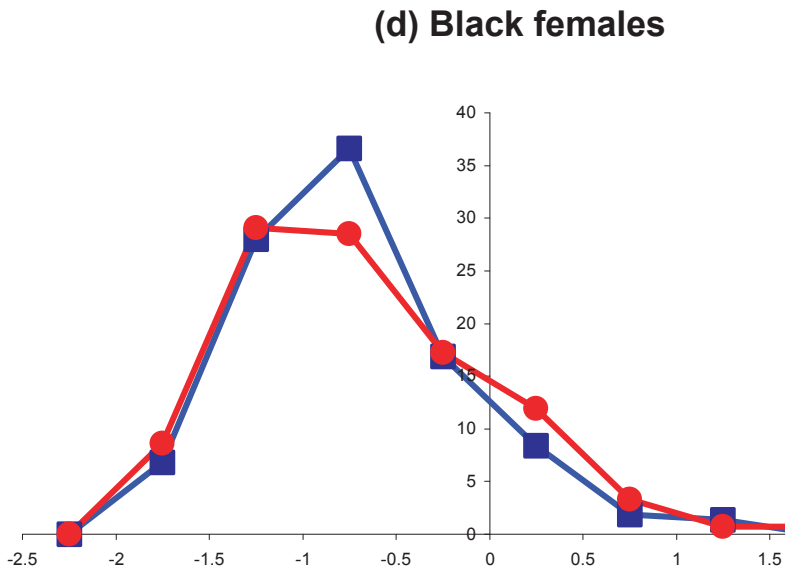
Density of age adjusted AFQT scores, GED recipients and high school graduates with twelve years of schooling



Source: Heckman, Hsee and Rubinstein (2001)

Density of age adjusted AFQT scores, GED recipients and high school graduates with twelve years of schooling





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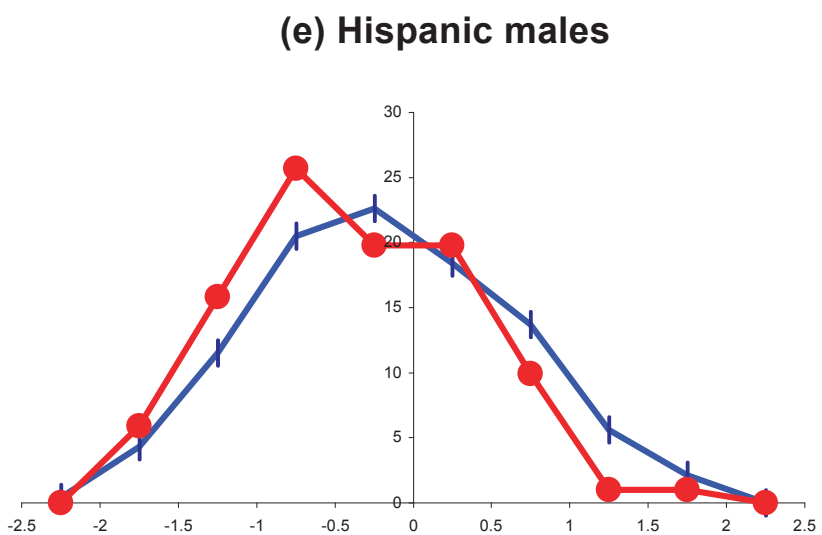
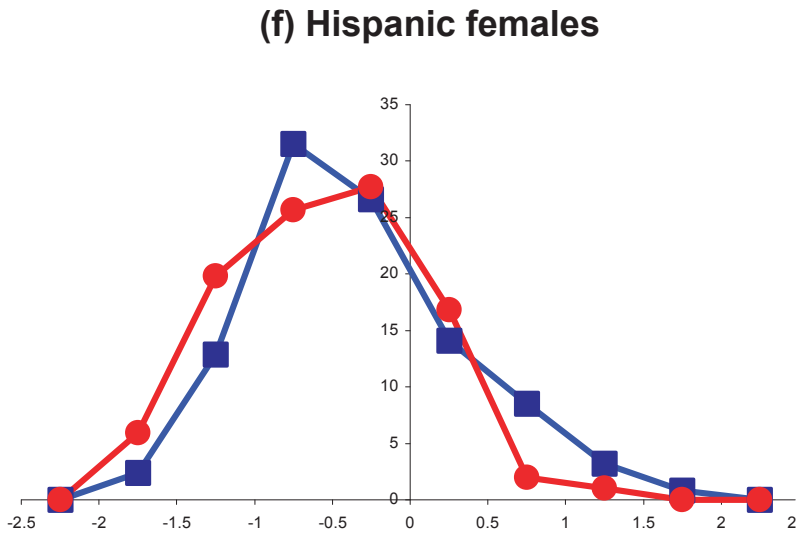




Source: Heckman, Hsee and Rubinstein (2001)

- Yet GEDs earn at the rate of high school dropouts.

How does the labor market treat GED recipients?

A First Glance at the Data
High School Dropouts, GED Recipients and High School Graduates

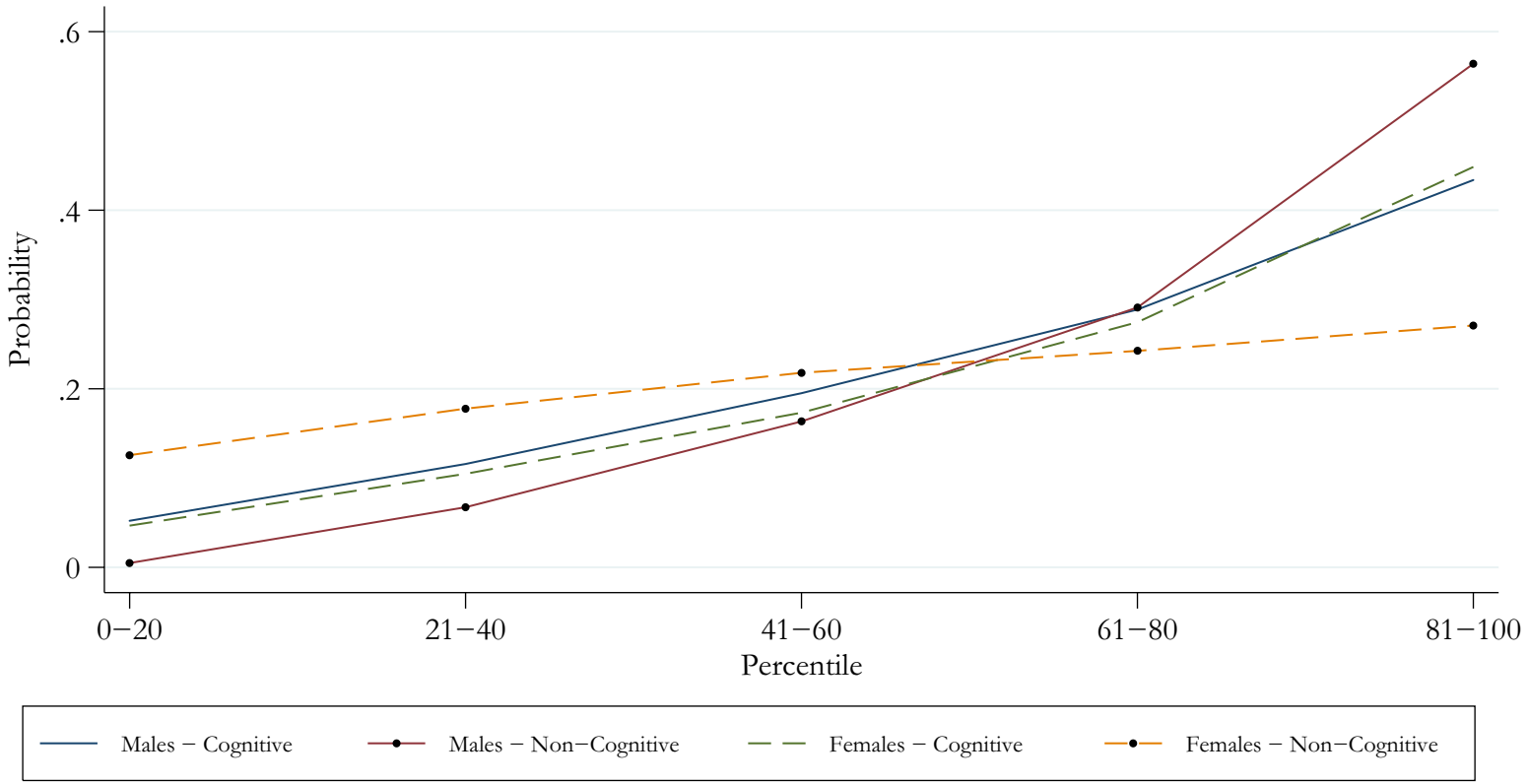
	OLS		
Variable	**(i)**	**(ii)**	**(iii)**
High school dropout	**-0.273**	**-0.193**	**-0.022**
	(0.024)	(0.026)	(0.033)
GED degree	**-0.181**	**-0.187**	**-0.107**
	(0.039)	(0.038)	(0.038)
Armed Forces Qualifying Test*		0.106	0.074
		(0.013)	(0.014)
Years of schooling			0.070
			(0.011)
Training			0.029
			(0.005)

- GEDs are as "smart" as ordinary high school graduates.
- They lack noncognitive skills.
- The GEDs are the wise guys who can't finish anything.

Abilities and Outcomes

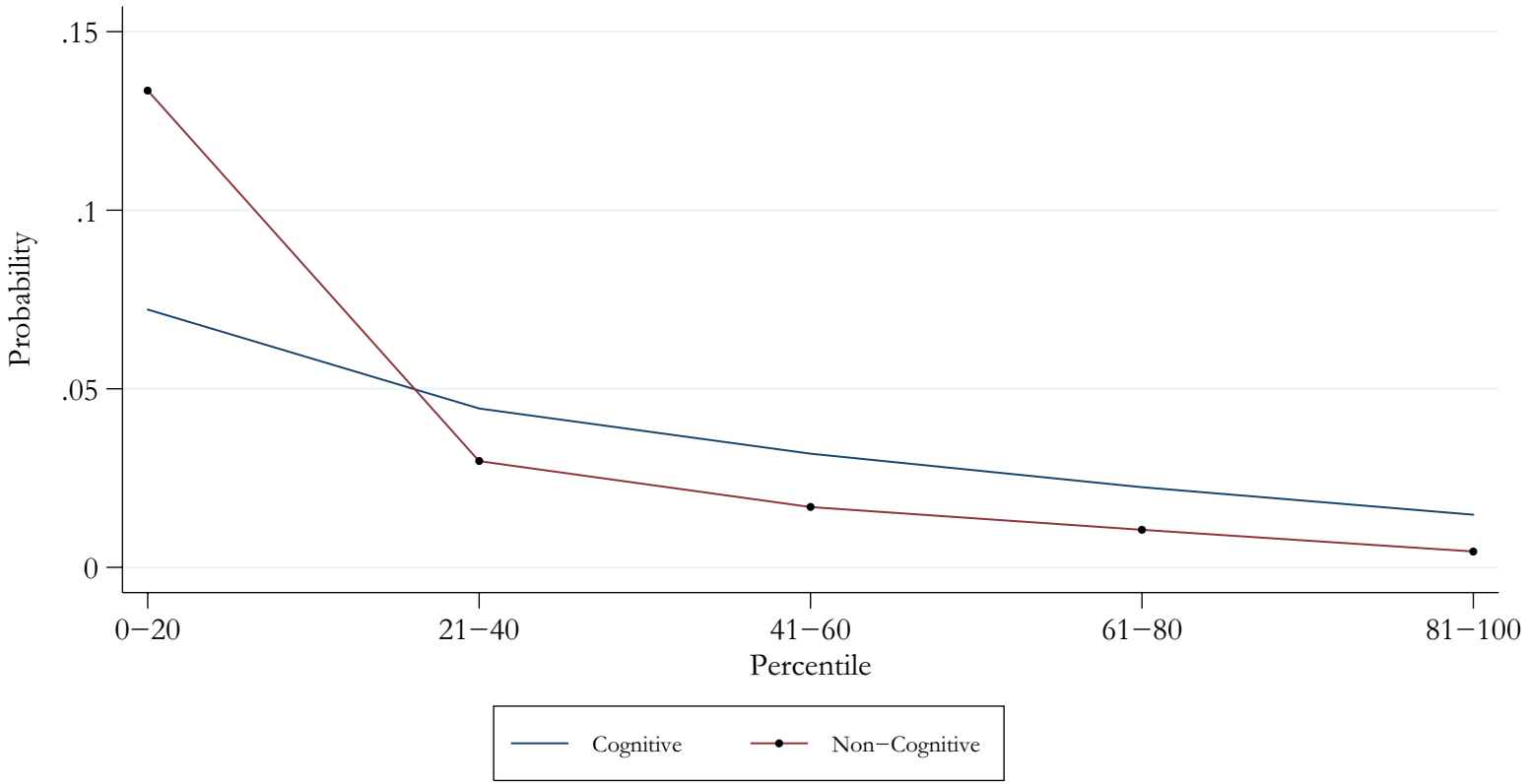
- Cognitive and noncognitive ability are important determinants of schooling and socioeconomic success.
- Schooling gaps in most Western societies have more to do with ability deficits than family finances in the school-going years.
- Those with higher abilities of both types are more likely to take post-school company job training.
- Look at effects of both cognitive and noncognitive skills on many measures of social performance.

Probability of being a 4-year college graduate, by ability



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).

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



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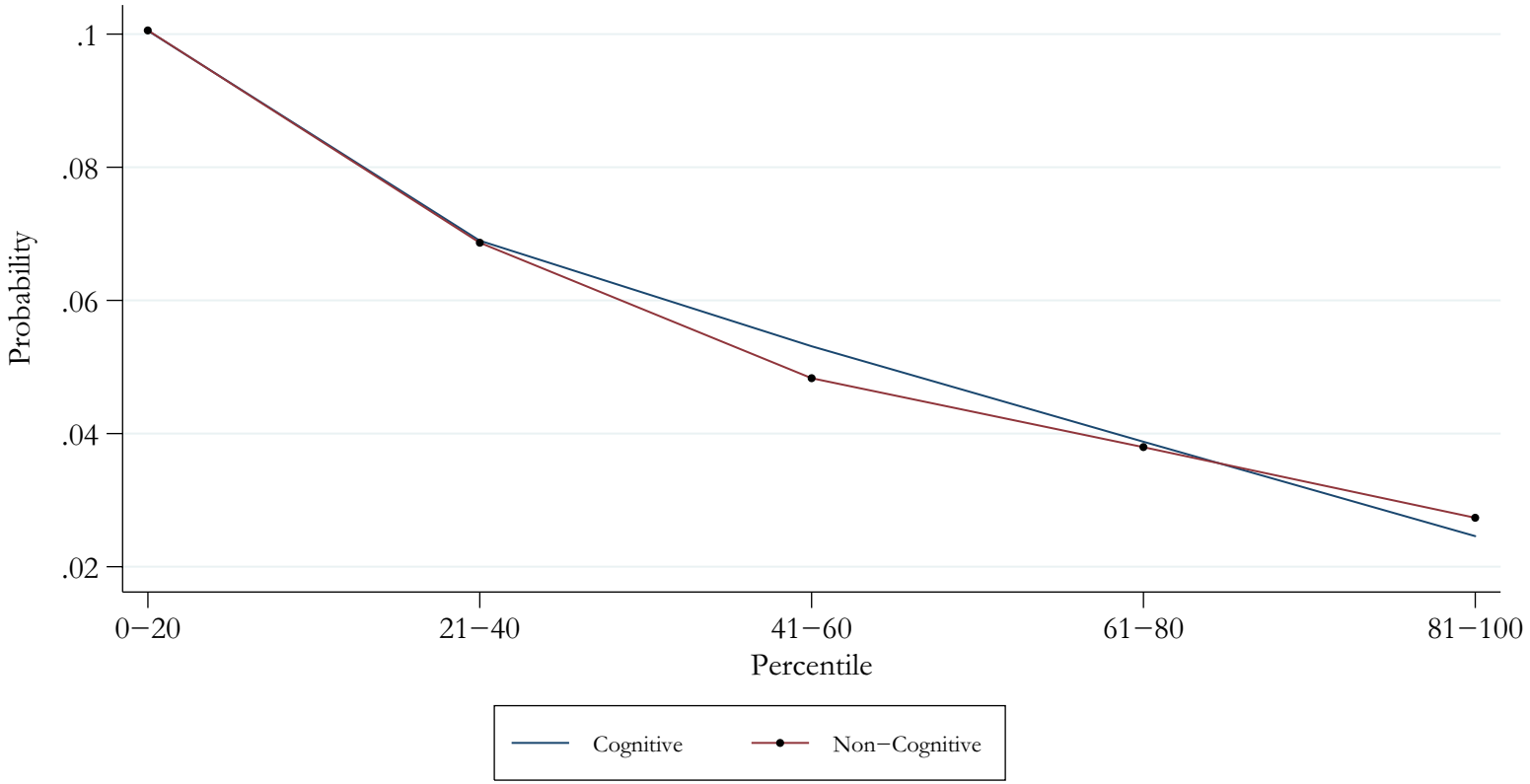
Probability of being single with children (females)



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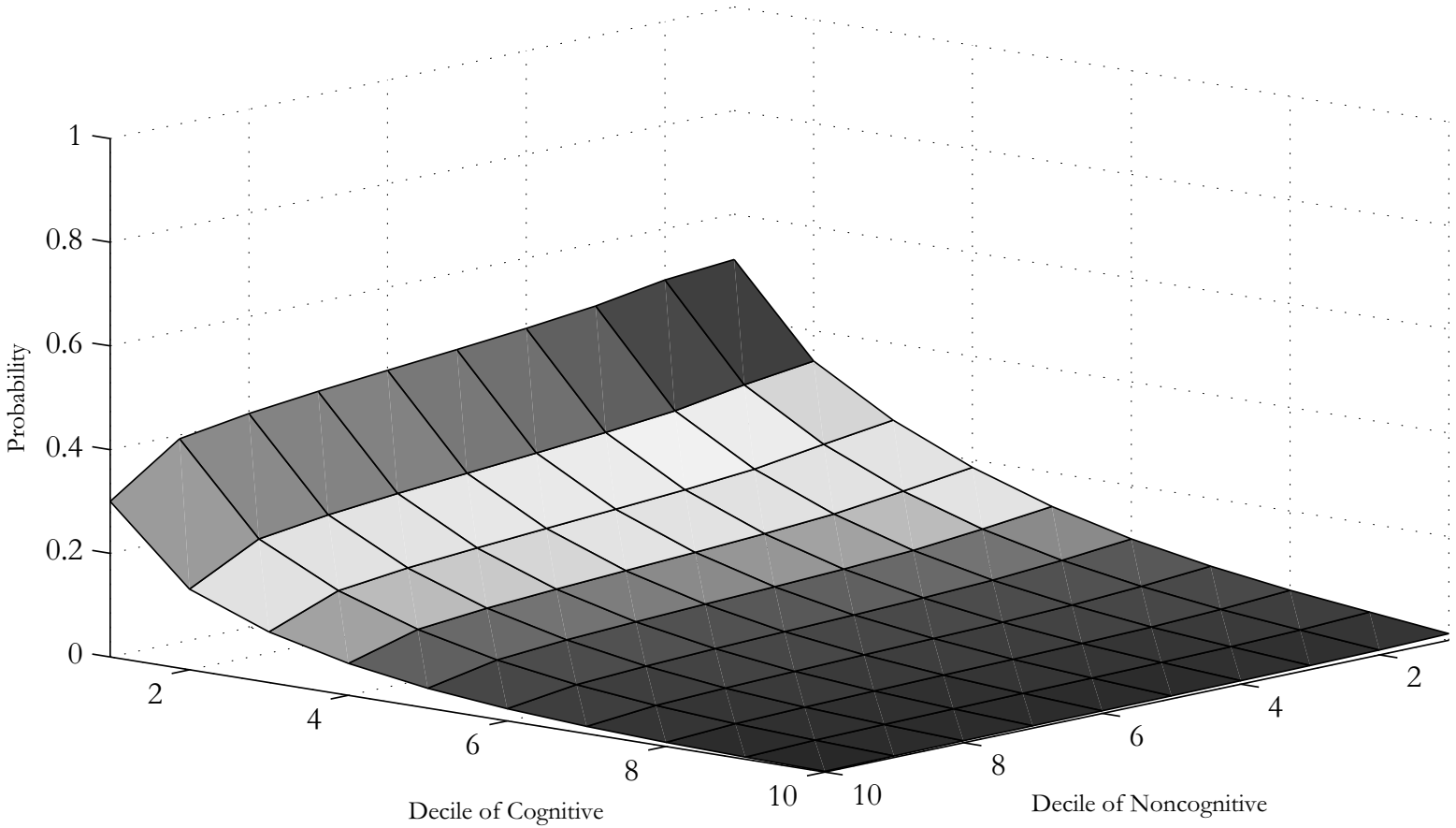
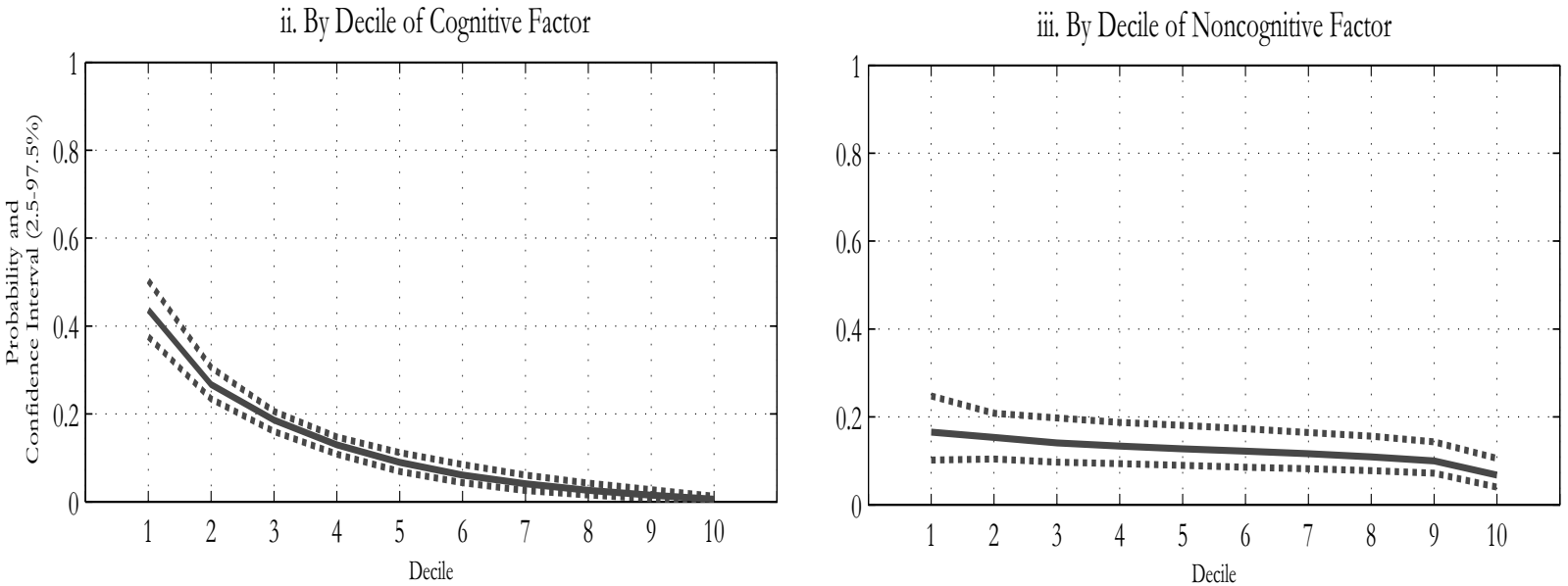
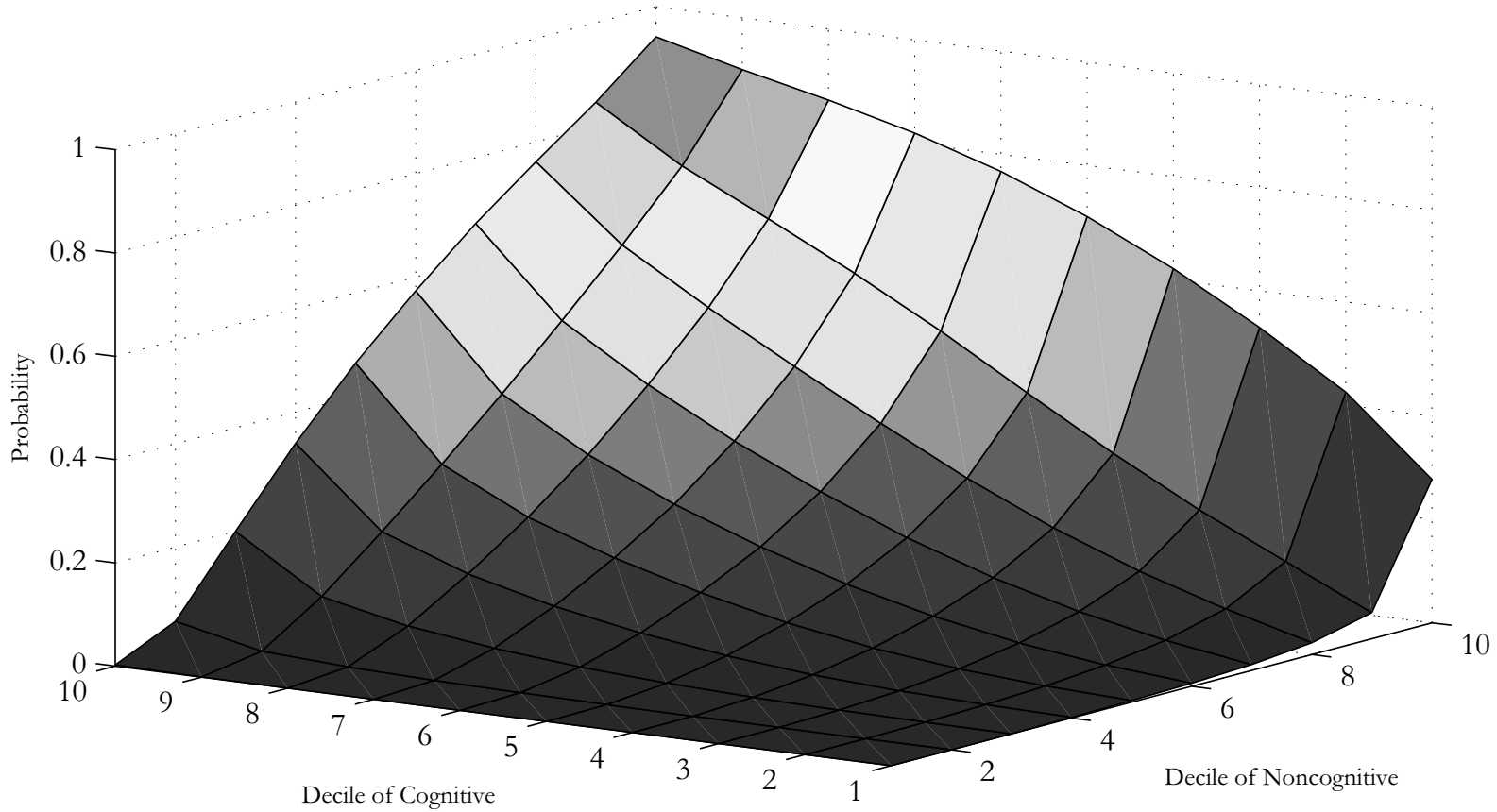
Probability of being a high school dropout by age 30 (males)

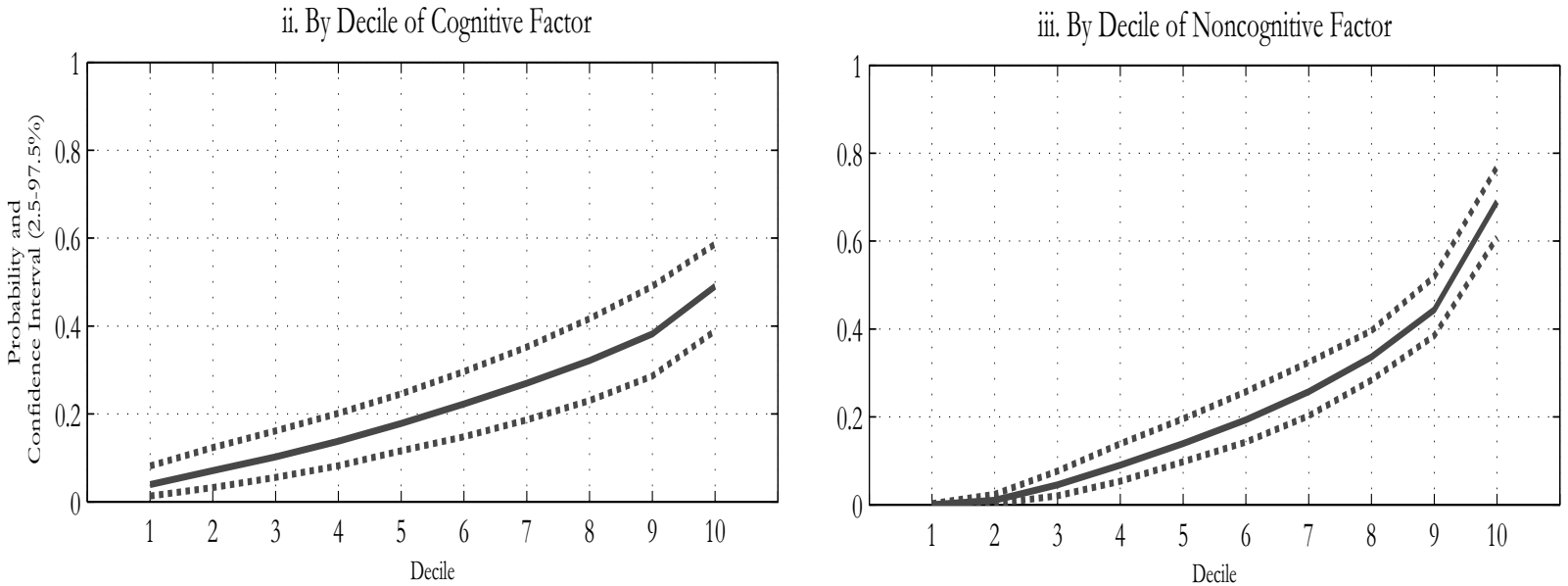




Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws).

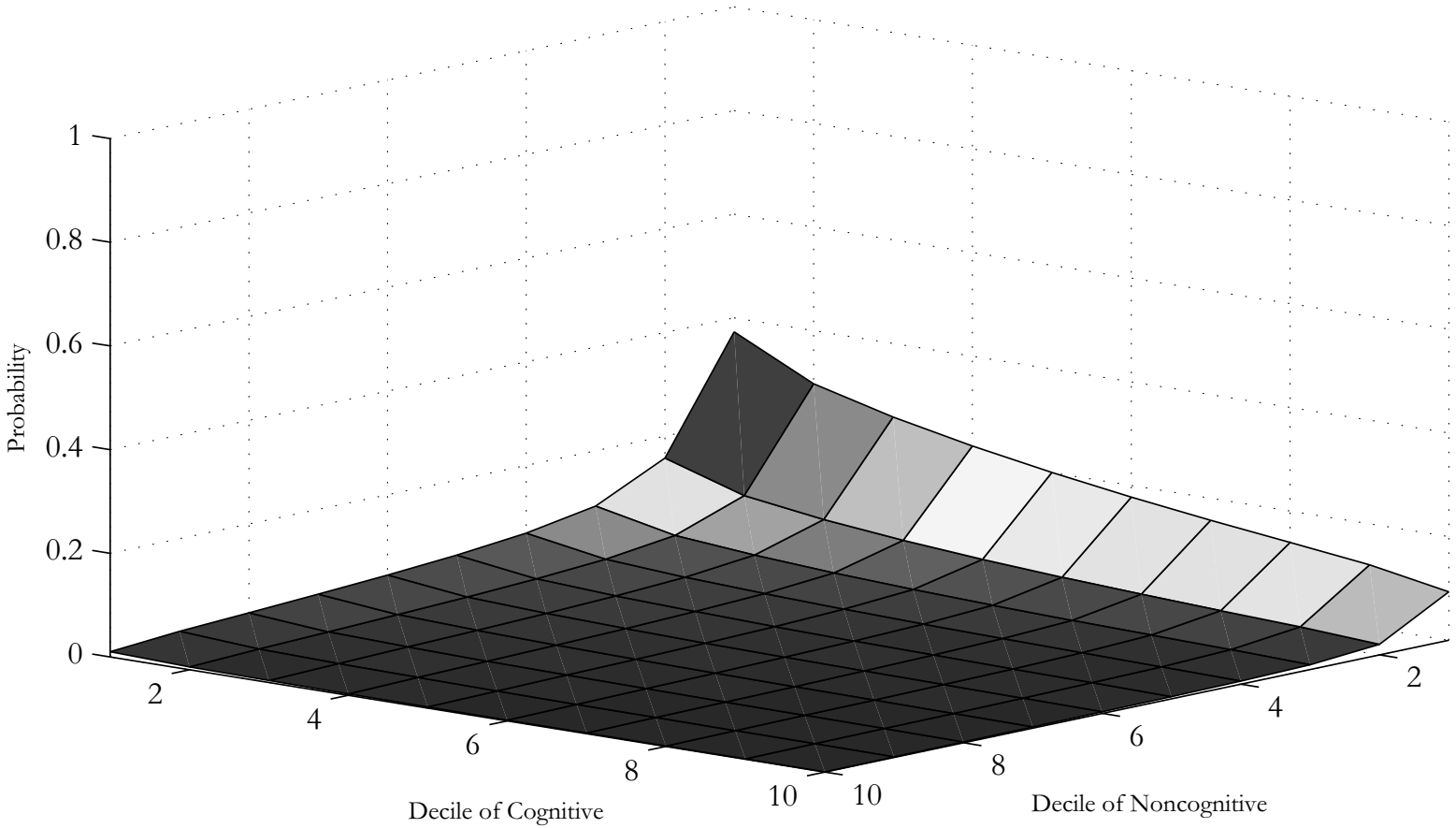
Probability of being a 4-year college graduate by age 30 (males)

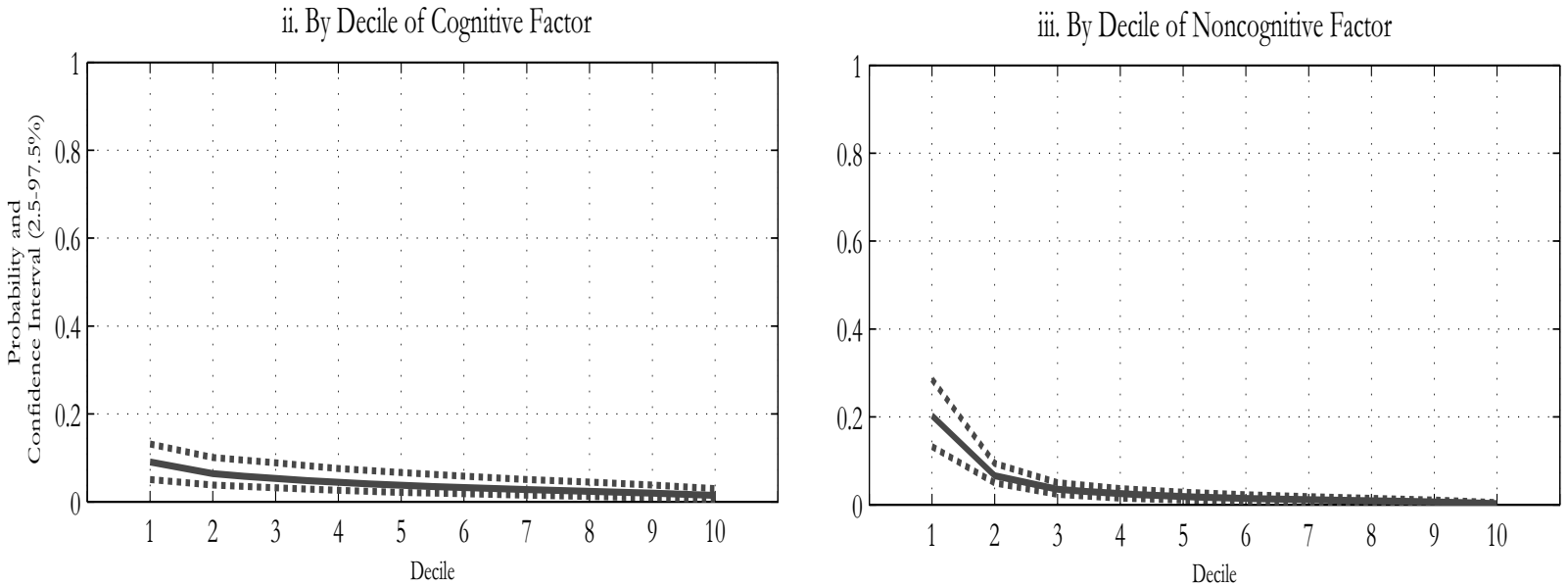




Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws).

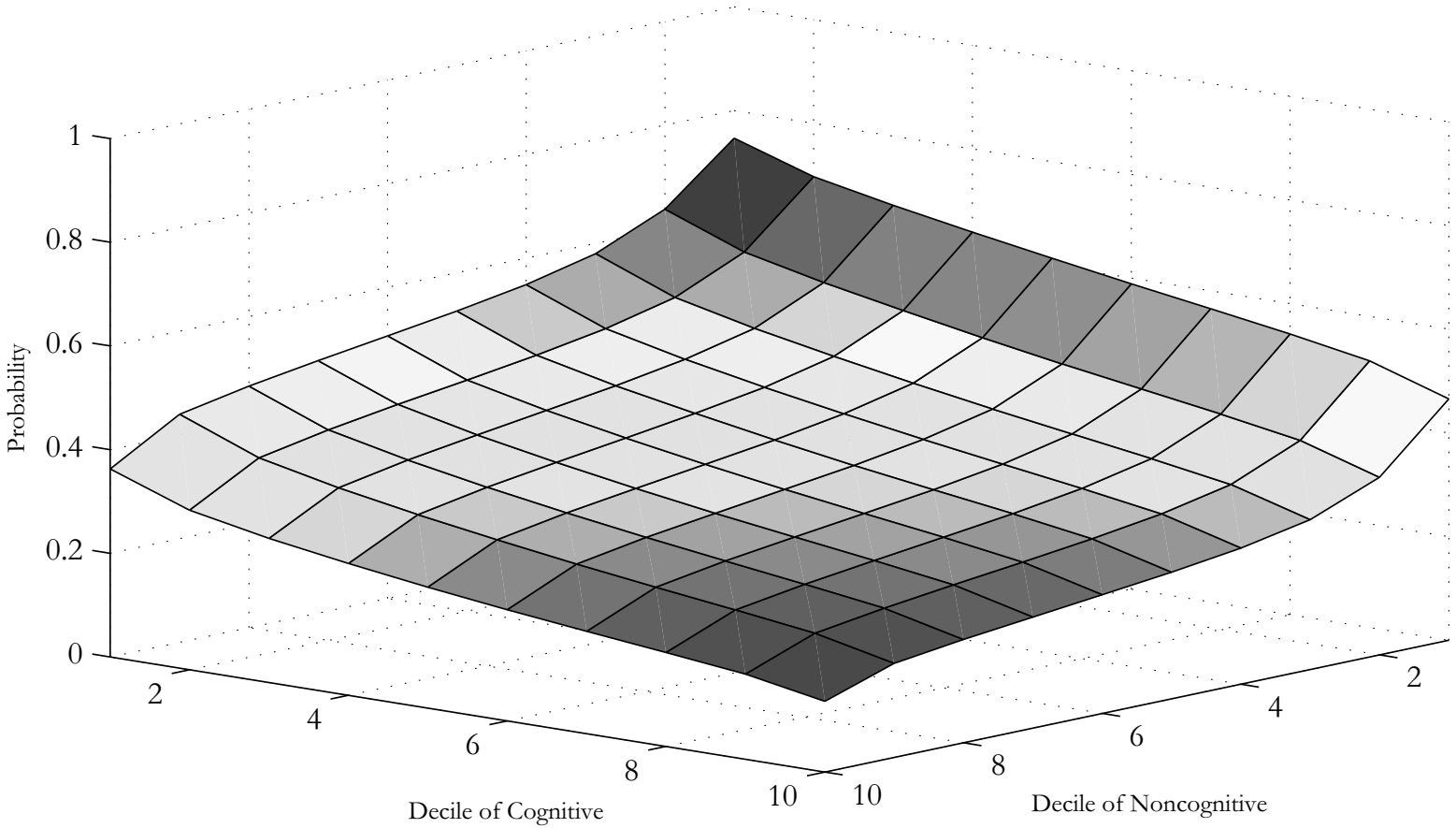
Probability of incarceration by age 30 (males)

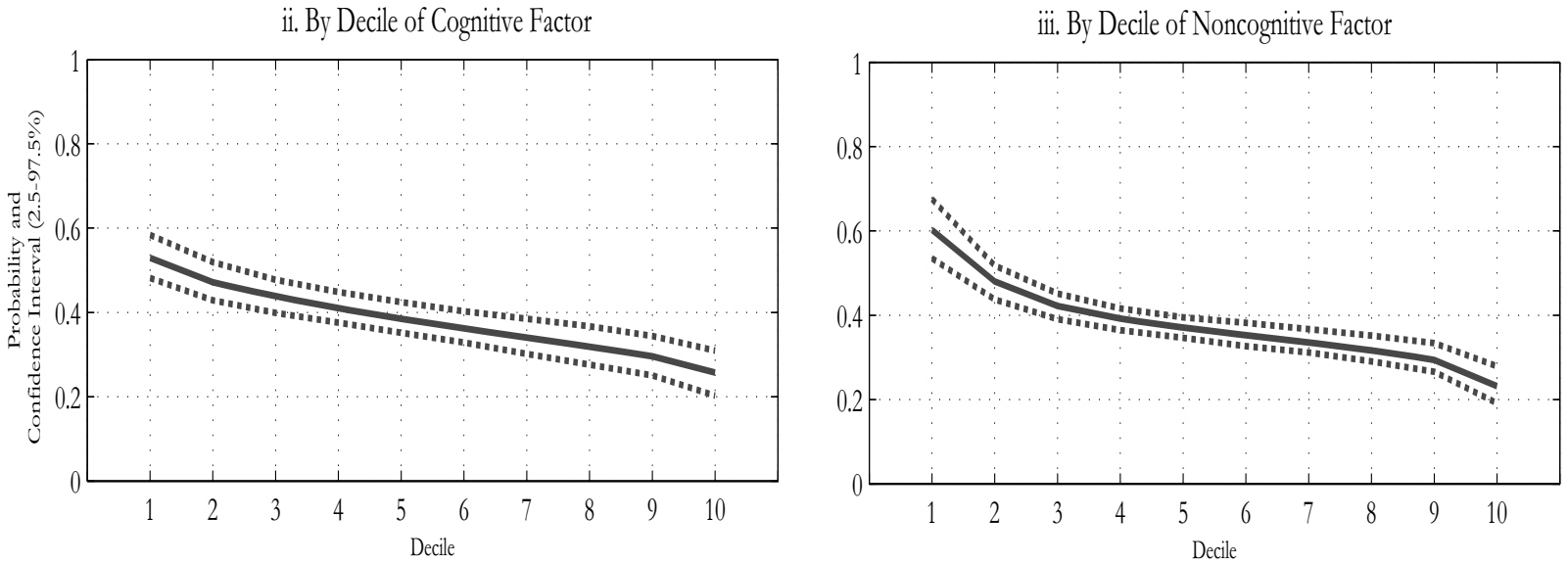




Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws).

Probability of daily smoking by age 18 (males)





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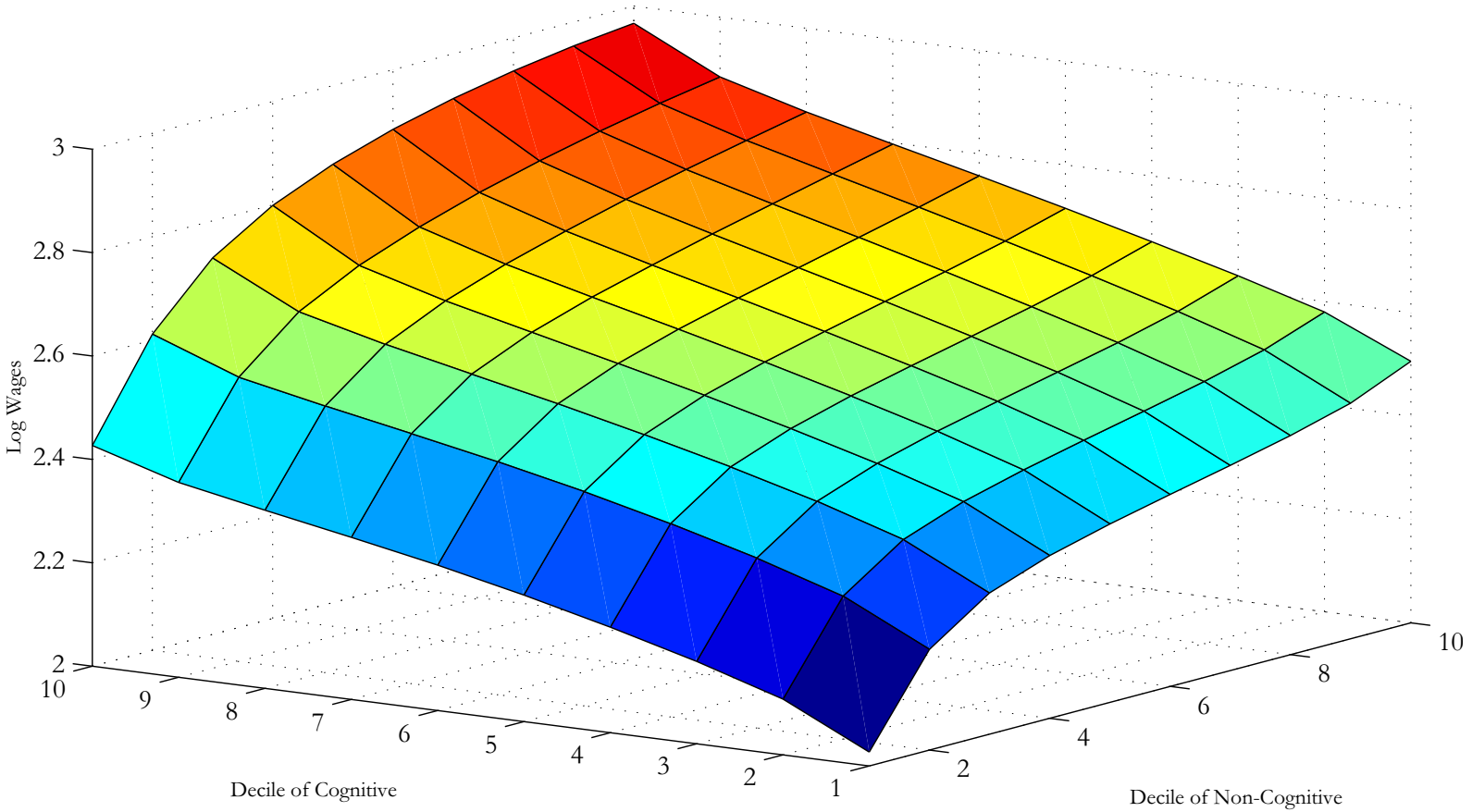
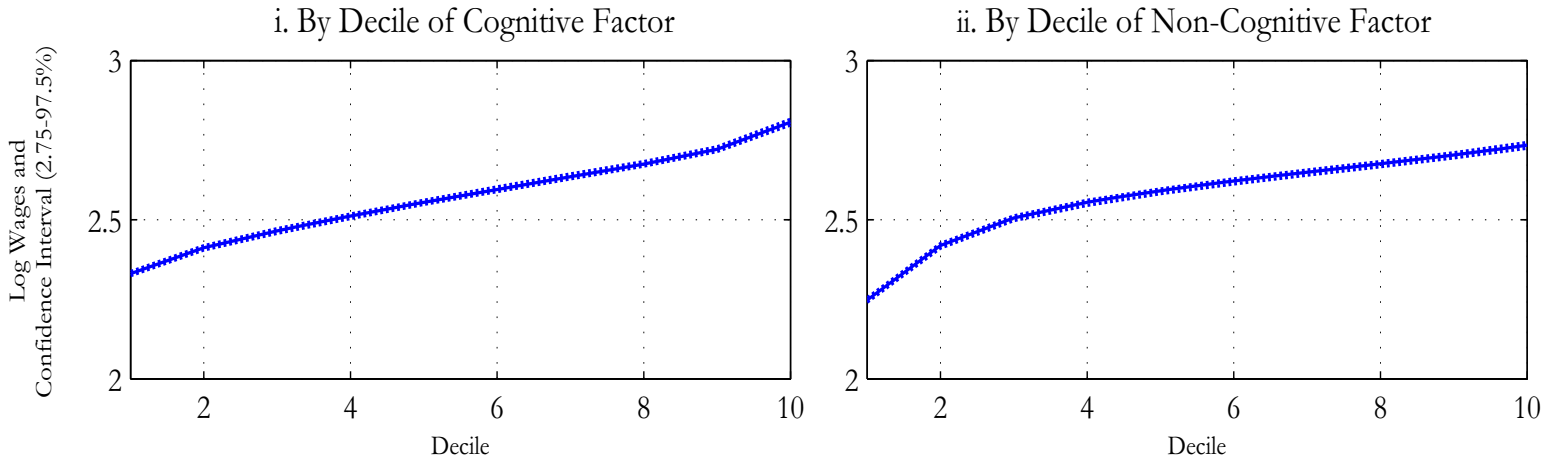
Mean log wages by age 30 (males)





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).

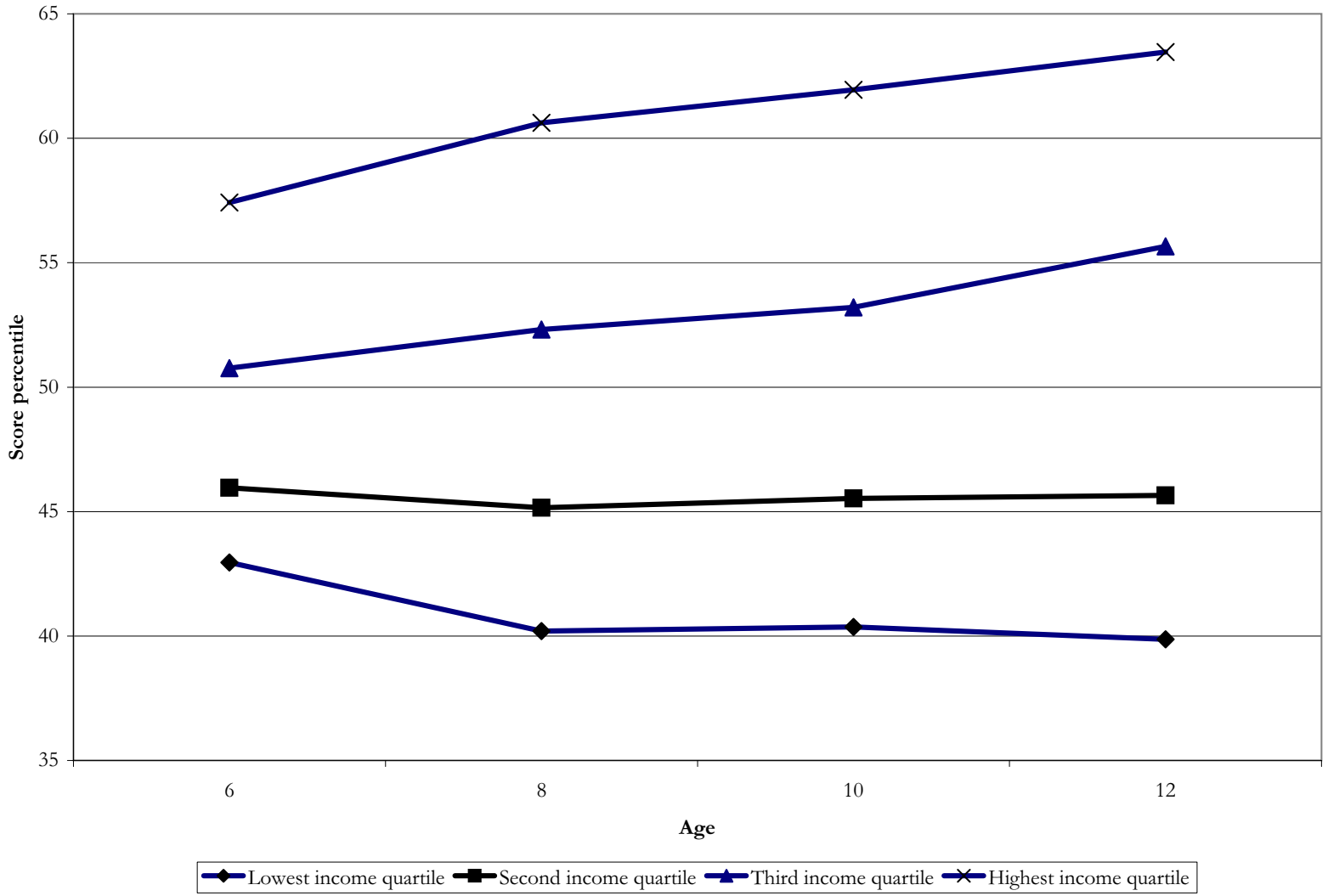
Abilities and Outcomes

- Many other aspects of social performance are attributable to cognitive and noncognitive abilities.

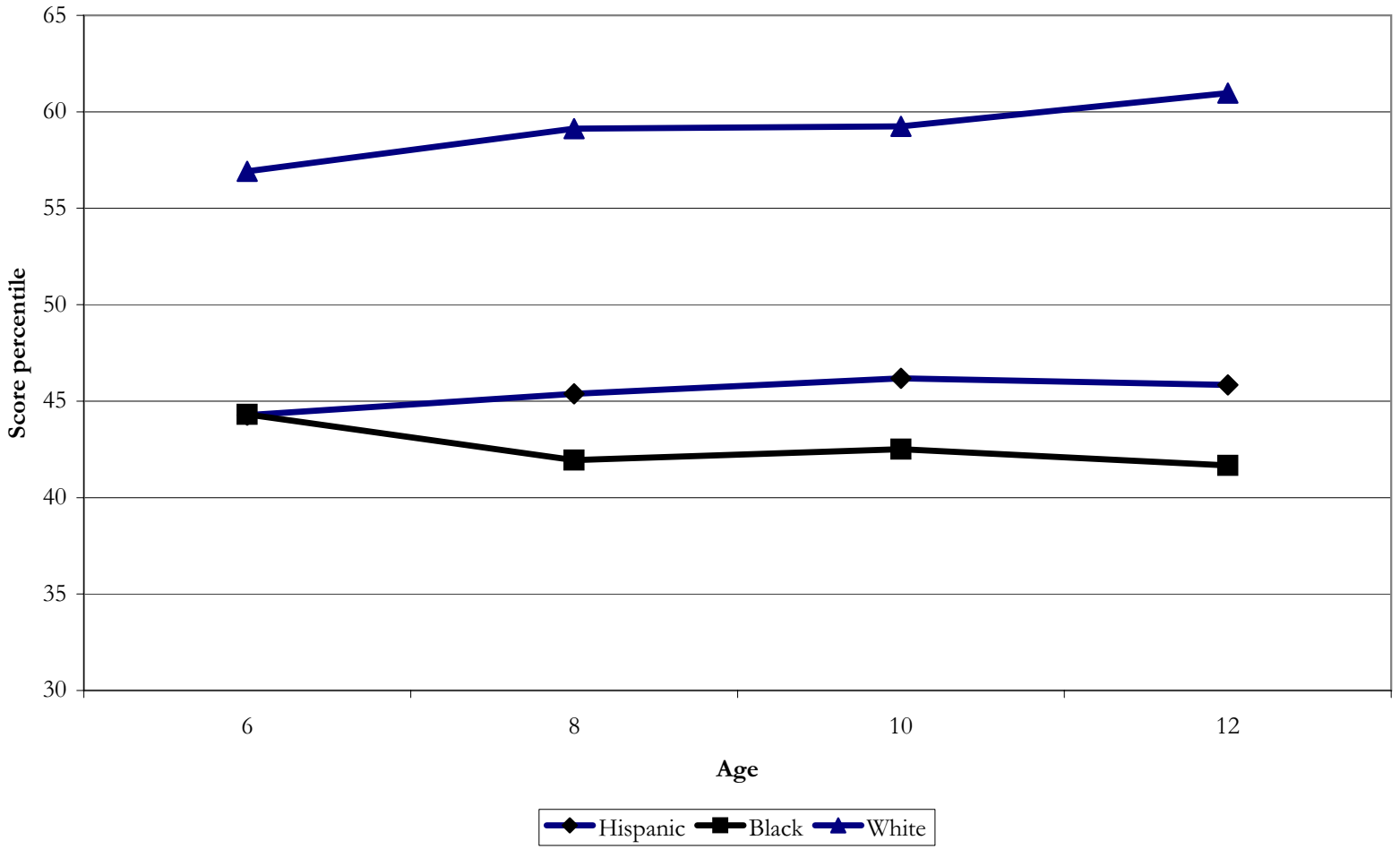
Gaps in Ability Open Up Early and Persist

- Gaps in ranks on achievement tests across race groups and across income groups open up early, before schools can have any effect.
- Absolute levels of test scores grow. Percentage ranks are stable.
- Schools add knowledge.
- But gaps open up as early as they are measured.
- In a statistical sense, gaps can be closed by controlling for family traits.
- Consistent with Coleman Report (1966).

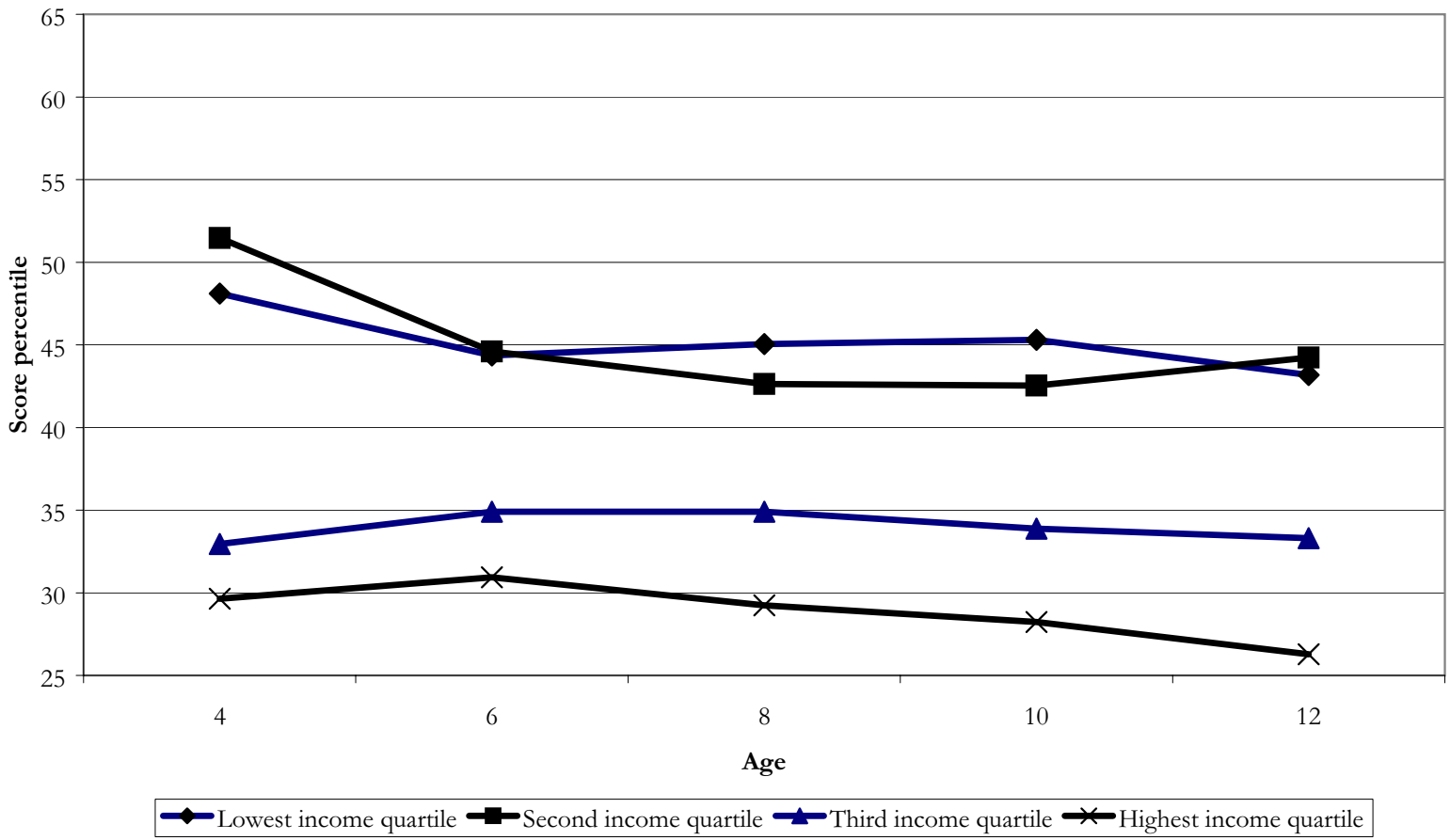
Average percentile rank on PIAT-Math score, by income quartile



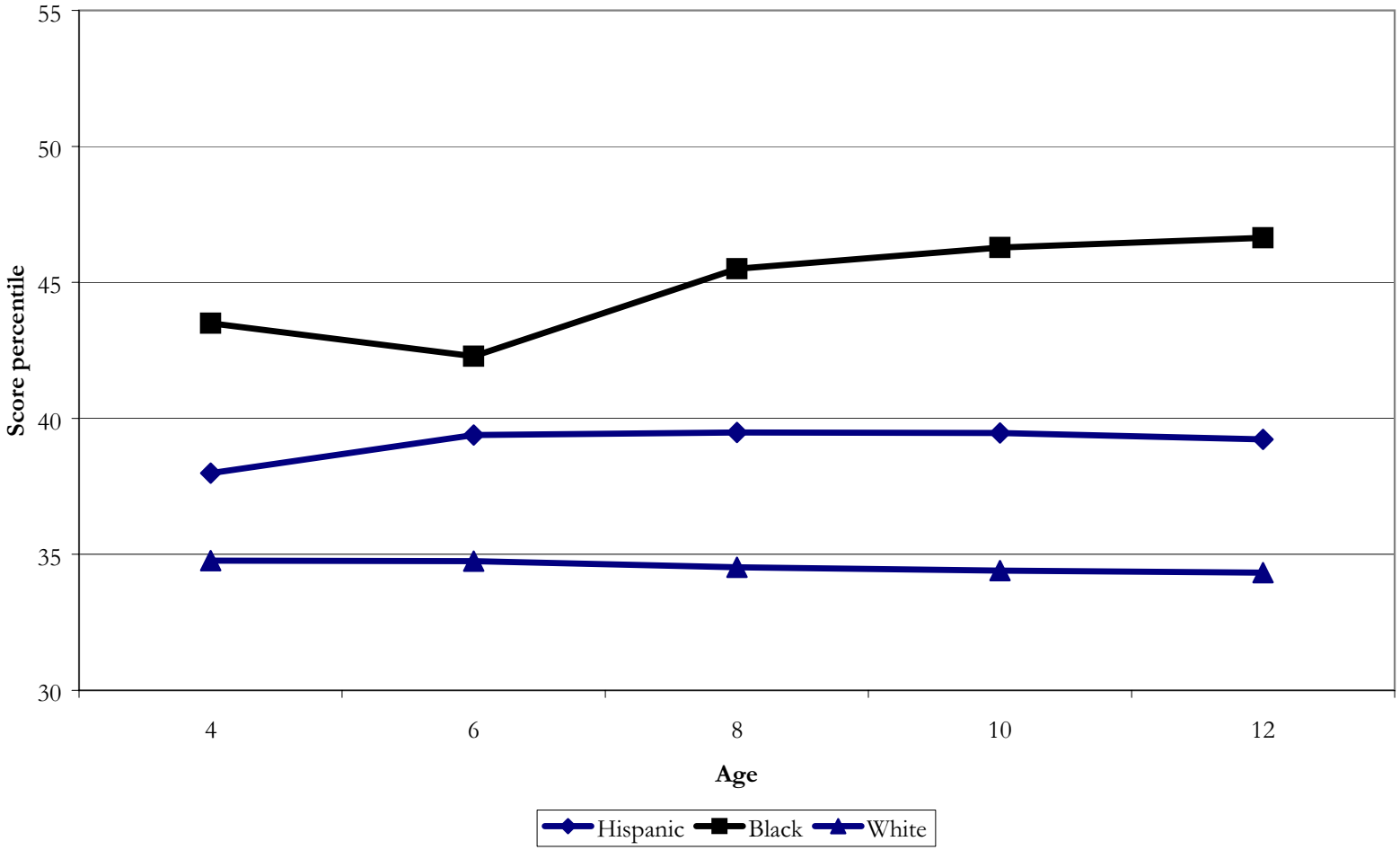
Average percentile rank on PIAT-Math score, by race



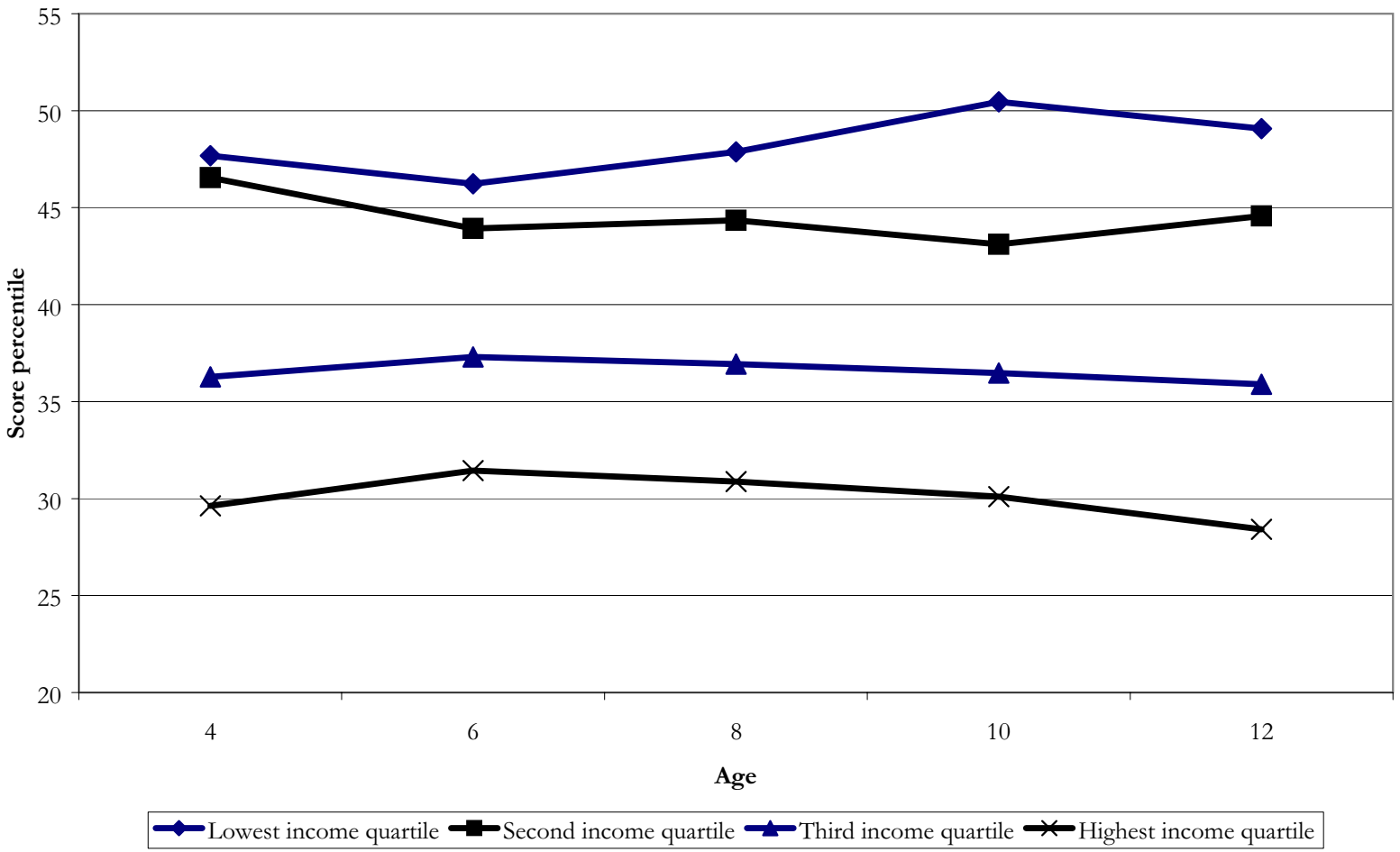
Average percentile rank on anti-social score, by income quartile (whites)



Average percentile rank on anti-social score, by race



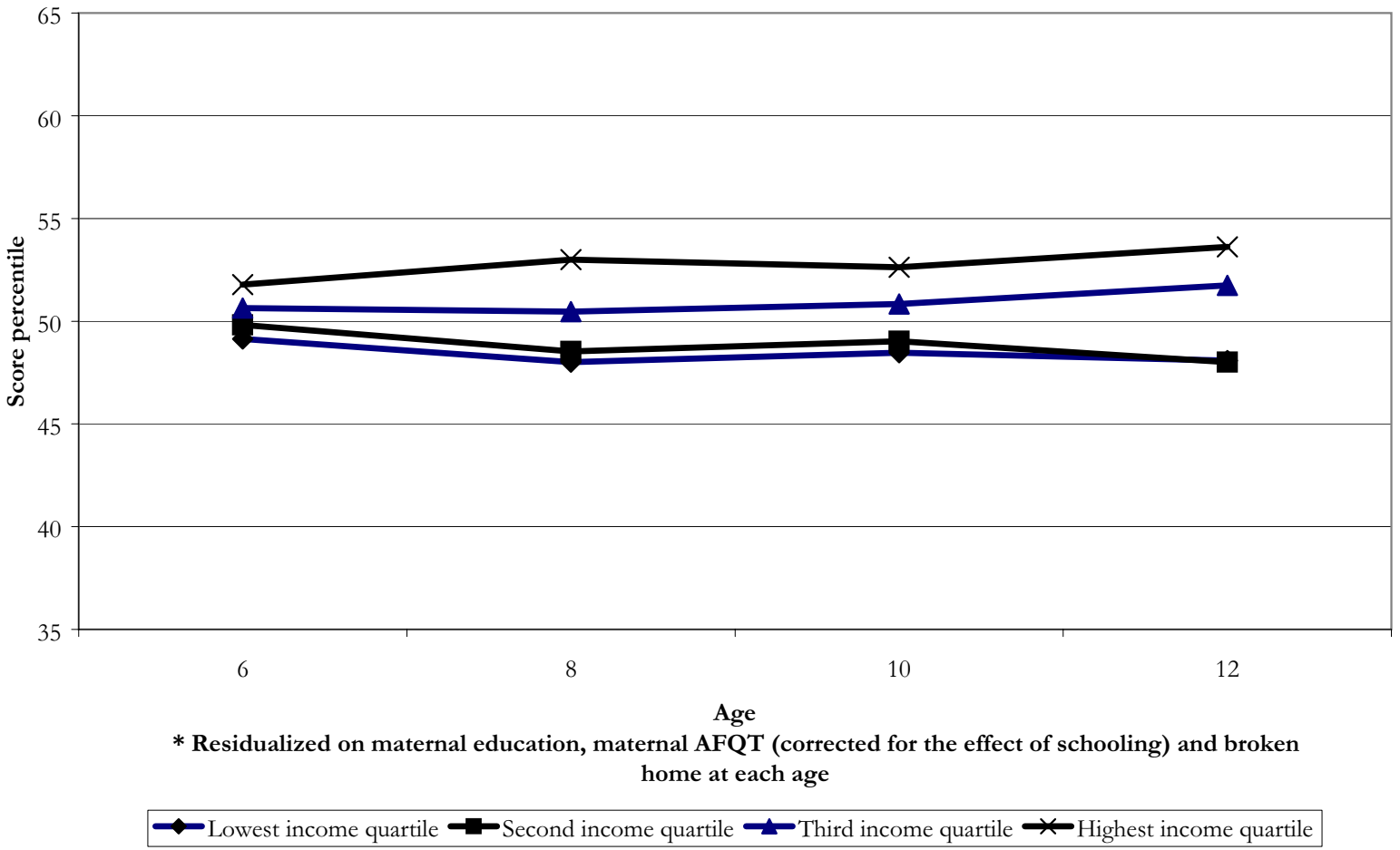
Average percentile rank on anti-social score, by income quartile



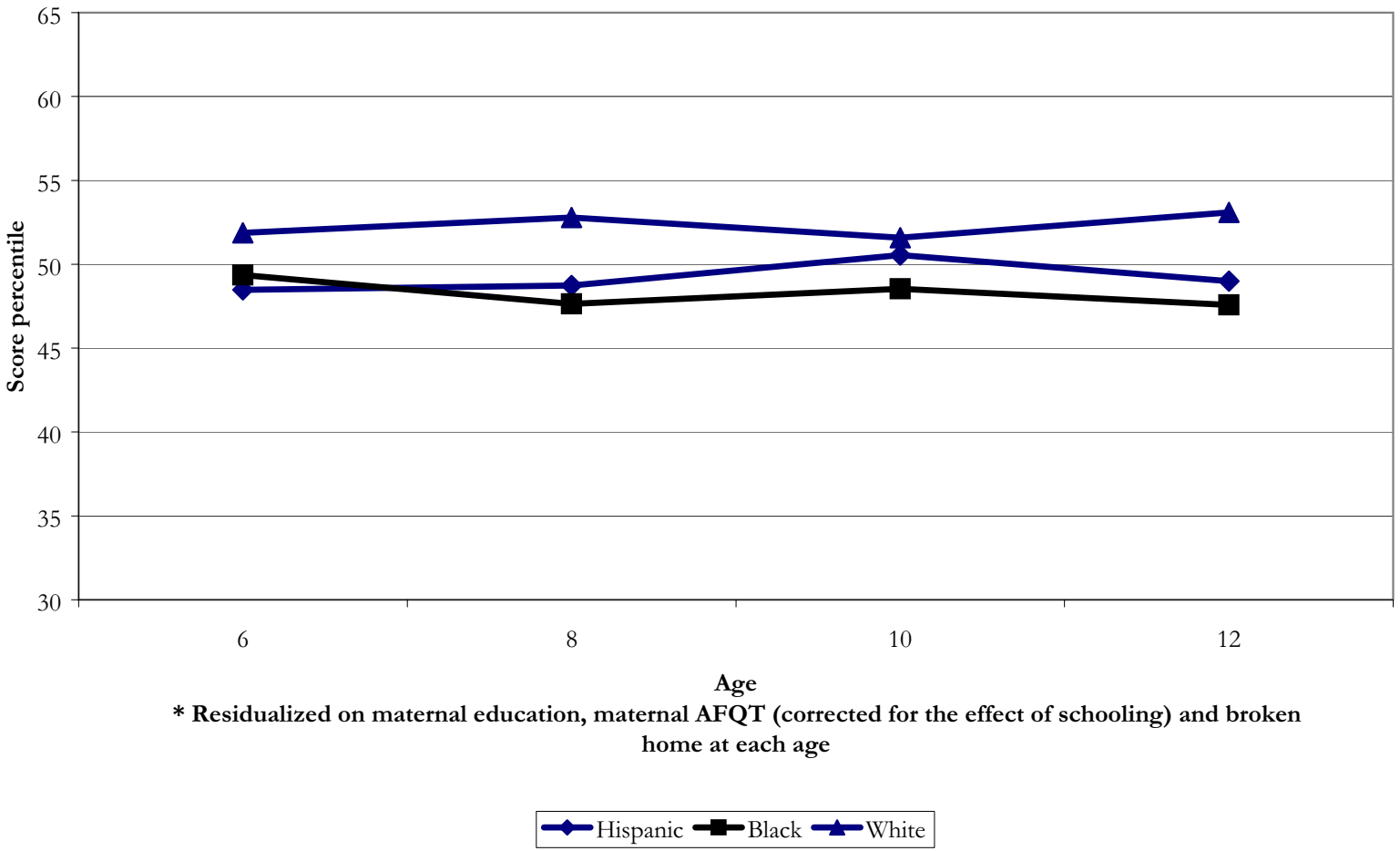
Gaps in Ability Open Up Early and Persist

- Controlling for early family environments eliminates much of the gap in ranks.

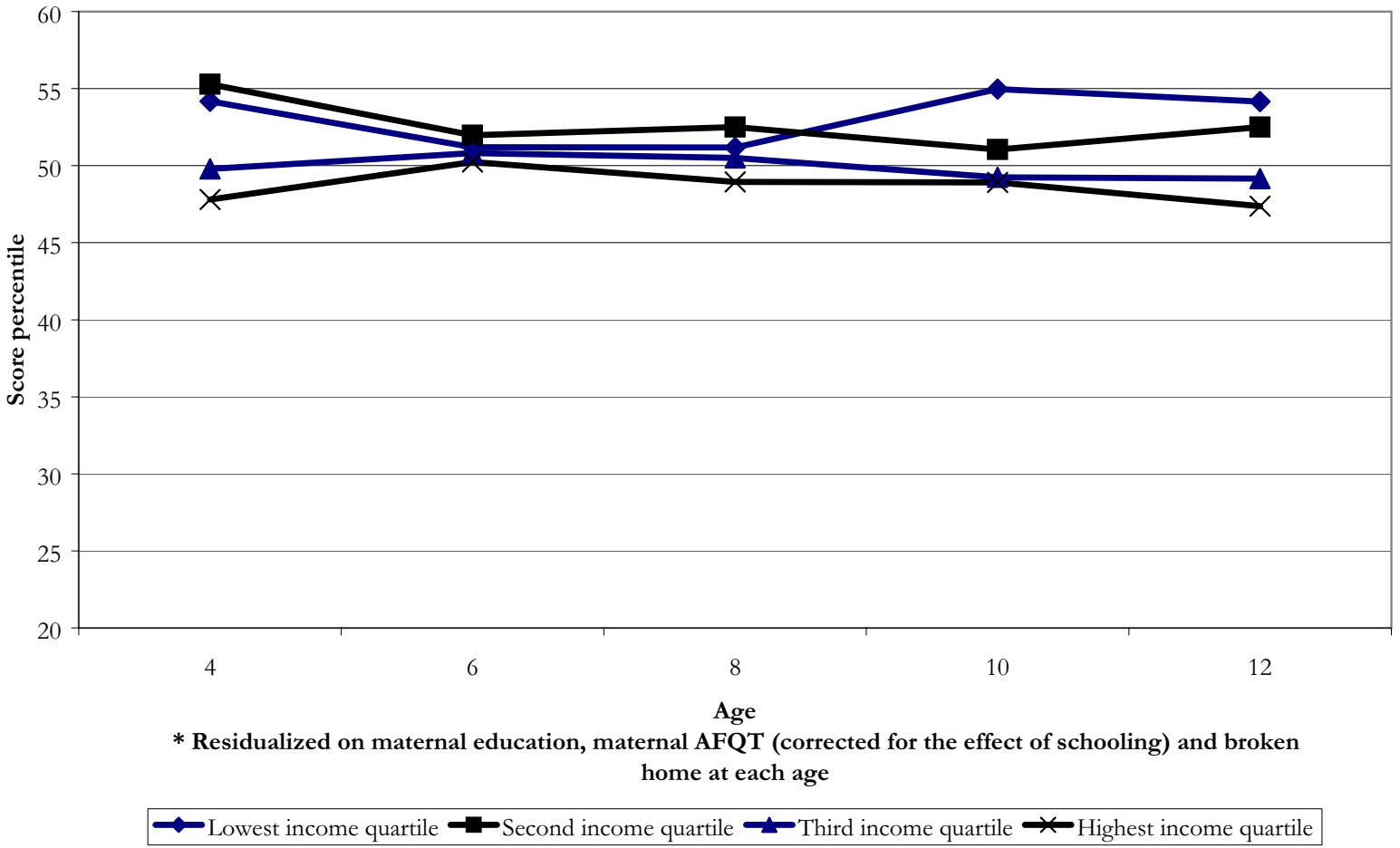
Residualized average PIAT-Math score percentiles, by income quartile



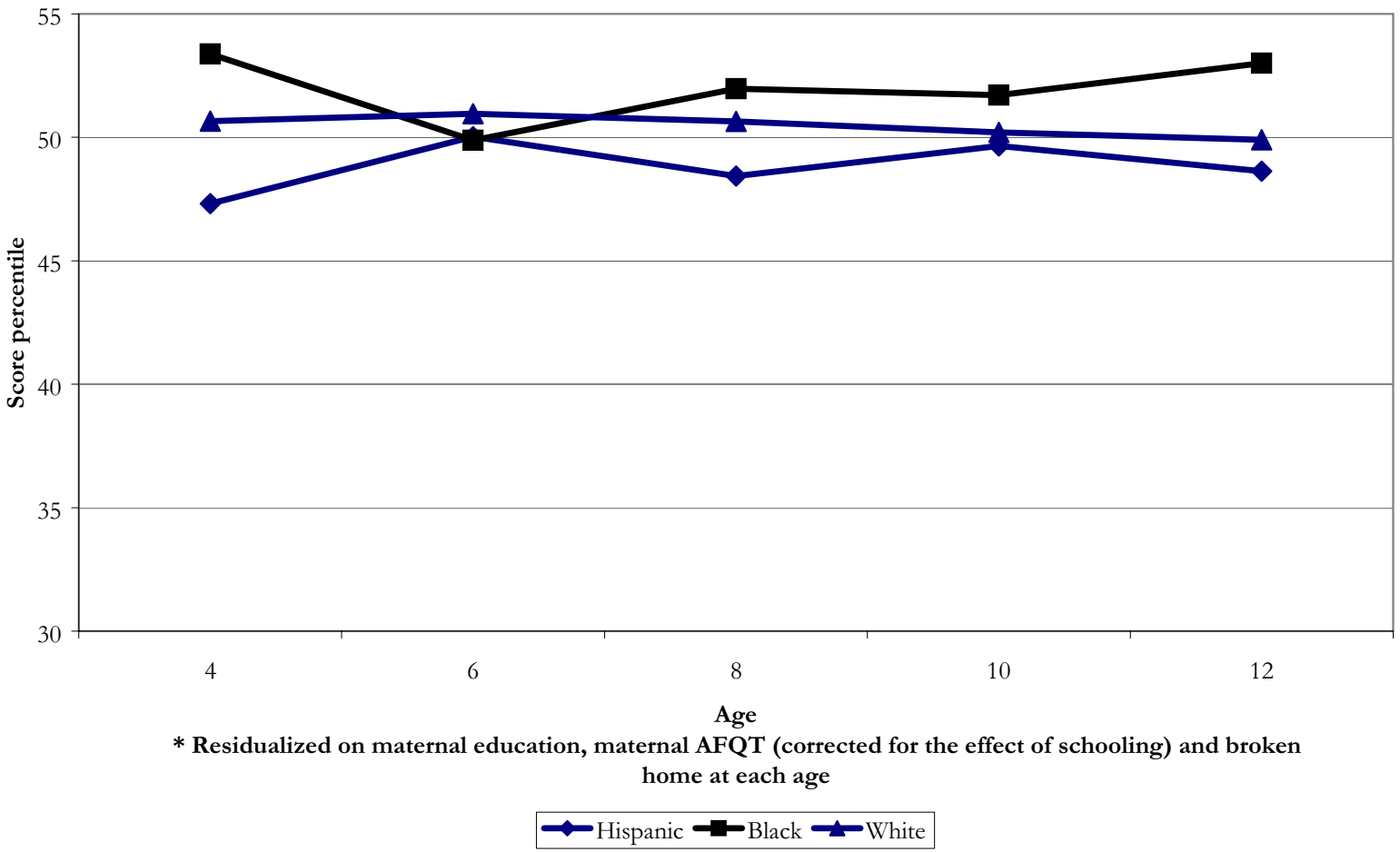
Residualized average PIAT-Math score percentiles, by race



Residualized average anti-social score percentile, by income quartile



Residualized average anti-social score percentile, by race



How to Explain This?

- How do these early differences in abilities arise?
- Is the difference due to genetics?
- Herrnstein and Murray claimed so in The Bell Curve.
- They used an achievement test score measurement at age 14 to show that genes were all important.
- They also implicitly claimed that compensation for early deficits was not possible.
- The measure of "IQ" they use has been shown to be affected by schooling and family environments.
- But possibly, with better measures, they are right.

How to Explain This?

- Evidence on epigenetics suggests that the genes *vs.* environment distinction is obsolete.
  - A large body of recent work suggests that gene-environmental interactions are central to explaining human (and animal) development.
  - MOA gene expression is modified by the environment.
  - Suomi: short allele / long allele species are affected differently by the environment.
  - Turkheimer (2003) on behavioral genetics.

Evidence from Early Interventions with Long Term Follow-up

- Evidence that shows that family backgrounds eliminate test score gaps across socioeconomic groups is correlational in nature.
- Correlational evidence is always suspect.
- We cannot know the true causal effect without making identifying assumptions because of some possible unmeasured third common cause affecting measured family background and outcomes.
- There is evidence from experimental interventions that avoids some of the interpretive problems with the correlational evidence.
- There is related evidence available from animal experiments where there is greater latitude for intervention.

- The most reliable data on humans come from experiments that provide substantial enrichment of the early environments of children born into low-income families.
- Two of these investigations, the Perry Preschool Program and the Abecedarian Program, are the most informative for the purposes of this discussion because they employed a random assignment design and collected long-term follow-up data.

- These longitudinal studies demonstrate substantial, positive effects of early environmental enrichment on a range of cognitive and "non-cognitive" skills, schooling achievement, job performance, and social behaviors, long after the intervention ends.
- Data from non-controlled assessments of Head Start and the Chicago Child-Parent Centers programs suggest similar conclusions. The data from Head Start represent only short-term effects.

Early Intervention Programs for Disadvantaged Children

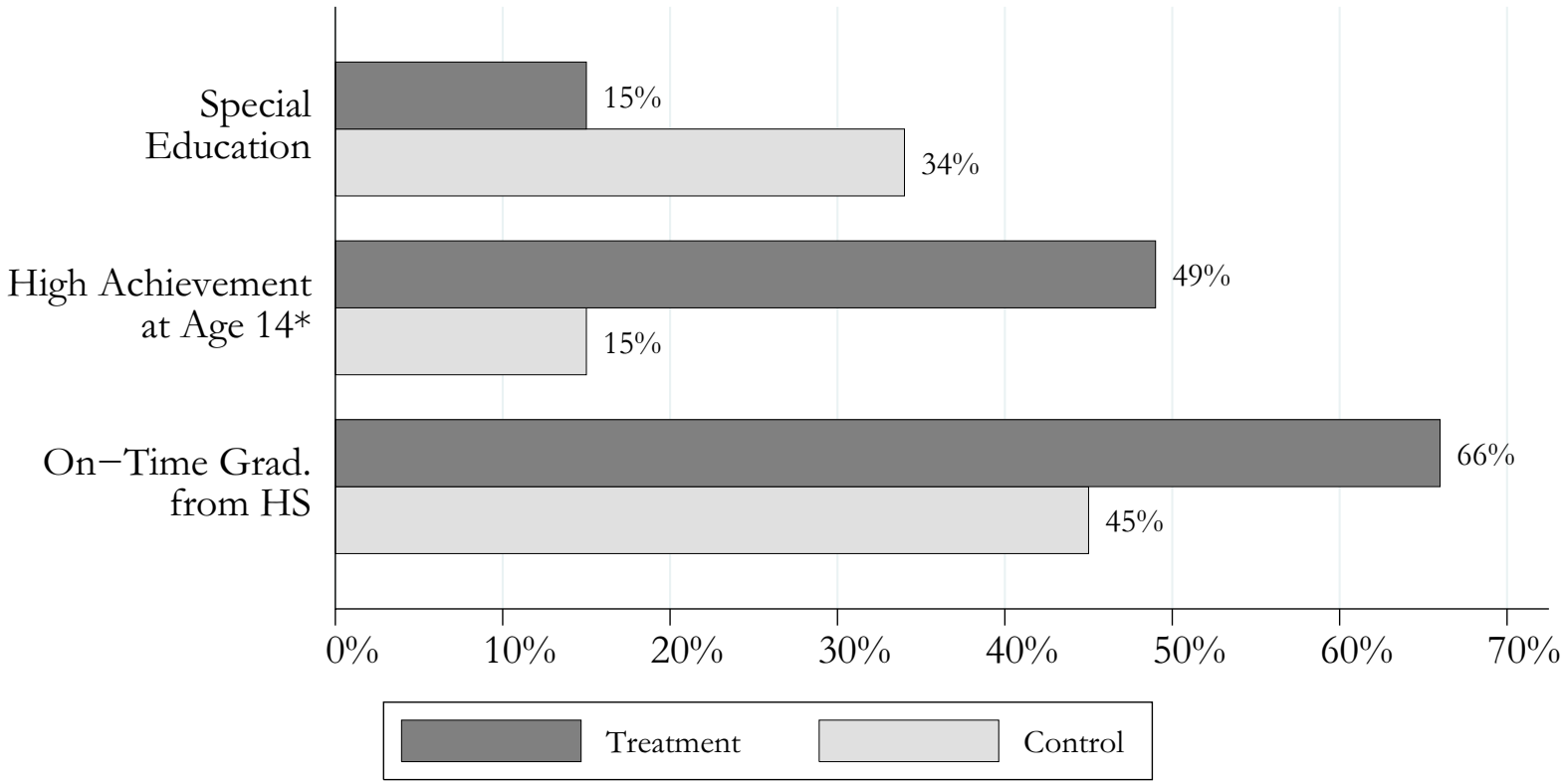
- The Perry Program was an intensive preschool program that was administered to 58 disadvantaged, black children in Ypsilanti, Michigan between 1962 and 1967.
- The treatment consisted of a daily 2.5 hour classroom session on weekday mornings and a weekly 90 minute home visit by the teacher on weekday afternoons. The length of each preschool year was 30 weeks.
- The control and treatment groups have been followed through age 40.

- The Abecedarian Program involved 111 disadvantaged children, born between 1972 and 1977, whose families scored high on a risk index. The mean age at entry was 4.4 months.
- The program was a year-round, full-day intervention that continued through age 8. The children are followed up until age 21, and the project is ongoing.

- In both the Perry and Abecedarian Programs there was a consistent pattern of successful outcomes for treatment group members compared with control group members.
- For the Perry Program, an initial increase in IQ disappeared gradually over 4 years following the intervention, as has been observed in other studies.

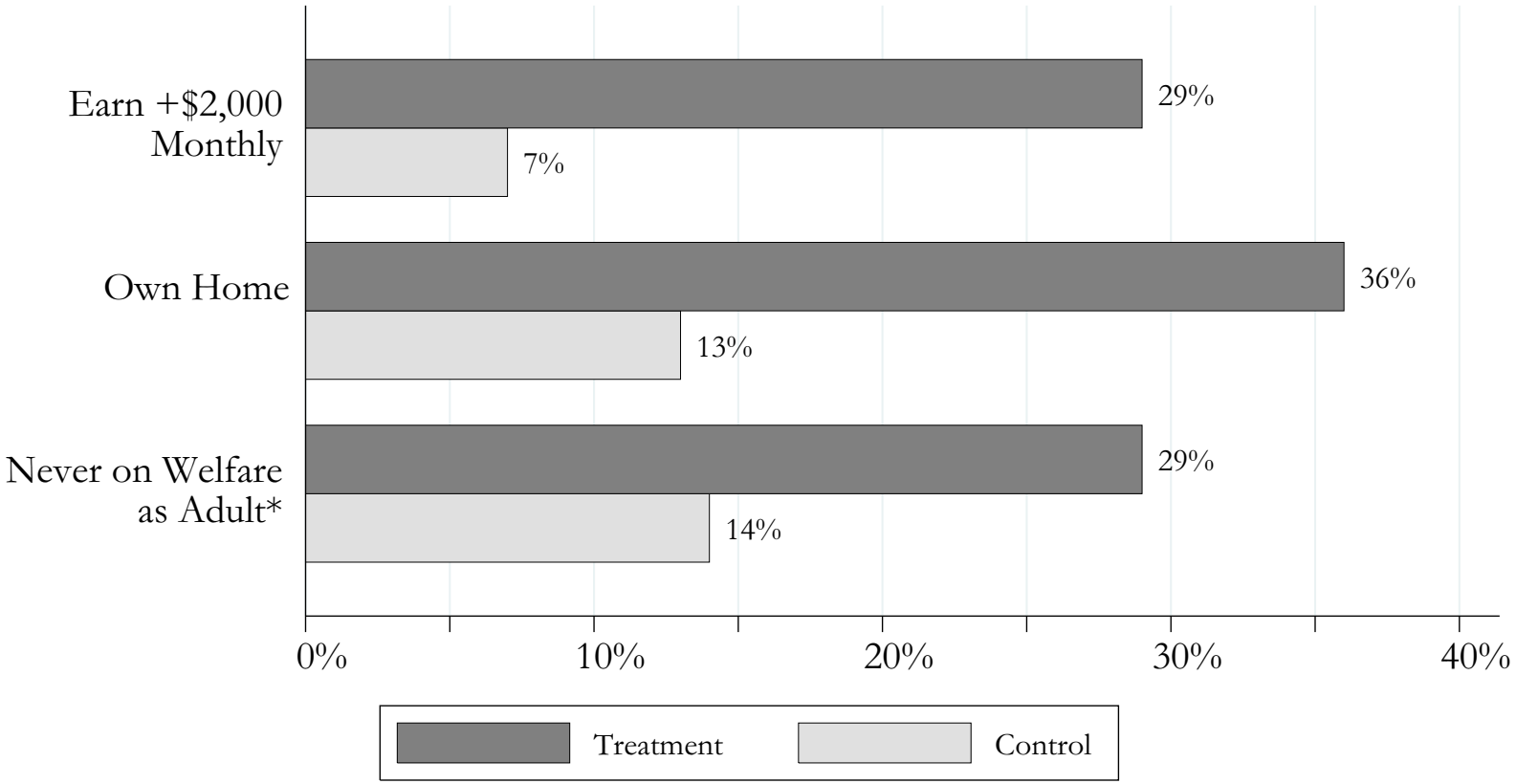
- However, in the more intensive Abecedarian Program, which intervened earlier (starting at age 4 months) and lasted longer (until age 8), the gain in IQ persisted into adulthood (21 years old).
- This early and persistent increase in IQ is important because IQ is a strong predictor of socioeconomic success.
- Positive effects of these interventions were also documented for a wide range of social behaviors.
- At the oldest ages tested (Perry: 40 yrs; Abecedarian: 21 yrs), individuals scored higher on achievement tests, reached higher levels of education, required less special education, earned higher wages, were more likely to own a home, and were less likely to go on welfare or be incarcerated than individuals from the control groups.

Perry preschool program: educational effects, by treatment group



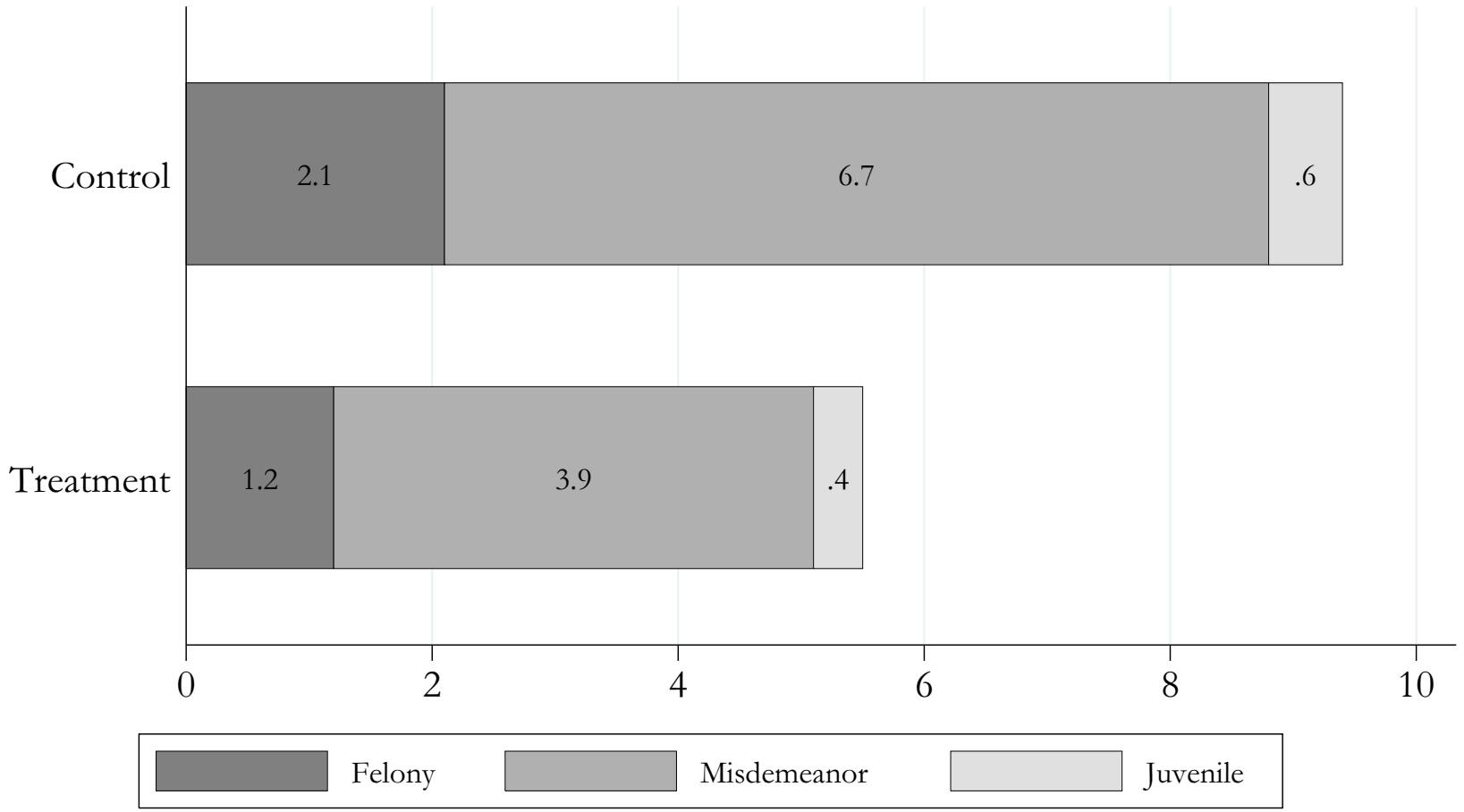
Source: Barnett (2004).
Notes: *High achievement defined as performance at or above the lowest 10th percentile on the California Achievement Test (1970).

Perry preschool program: economic effects at age 27, by treatment group



Source: Barnett (2004). *Updated through Age 40 using recent Perry Preschool Program data, derived from self−report and all available state records.

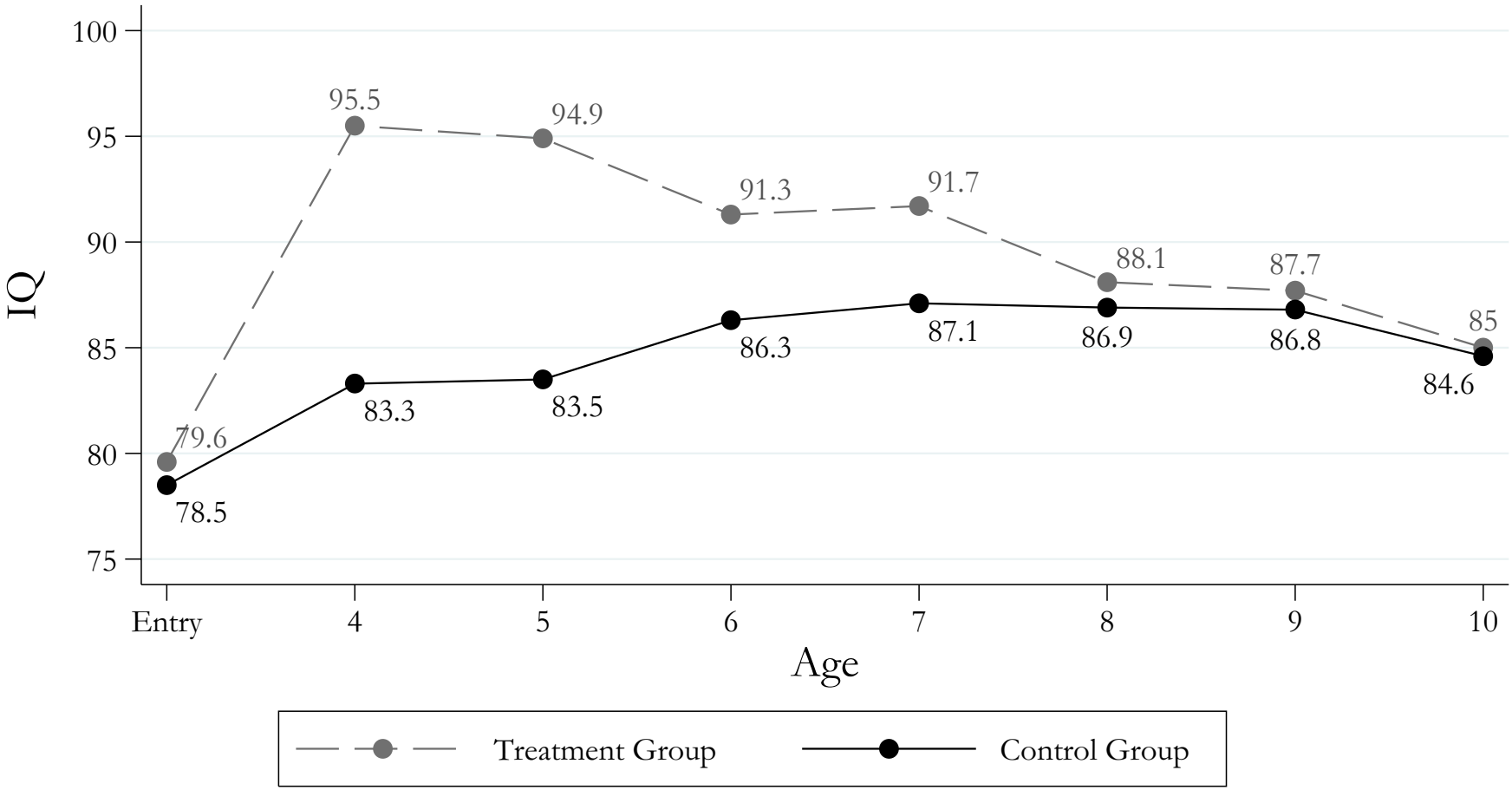
Perry preschool program: arrests per person before age 40, by treatment group



Source: Perry Preschool Program. Juvenile arrests are defined as arrests prior to age 19.

- Perry did not raise IQ.
- It raised noncognitive skills.

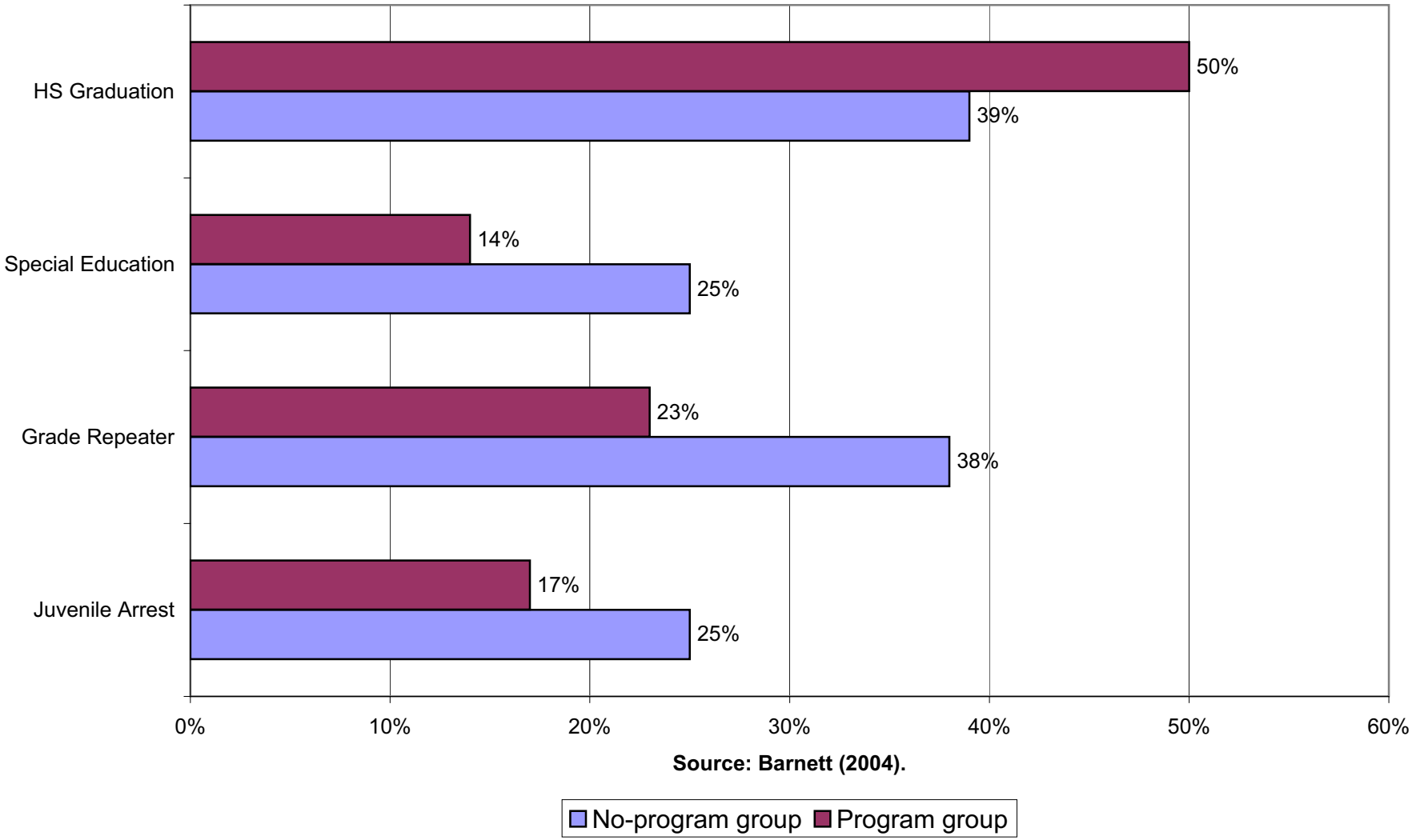
Perry preschool program: IQ, by age and treatment group



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

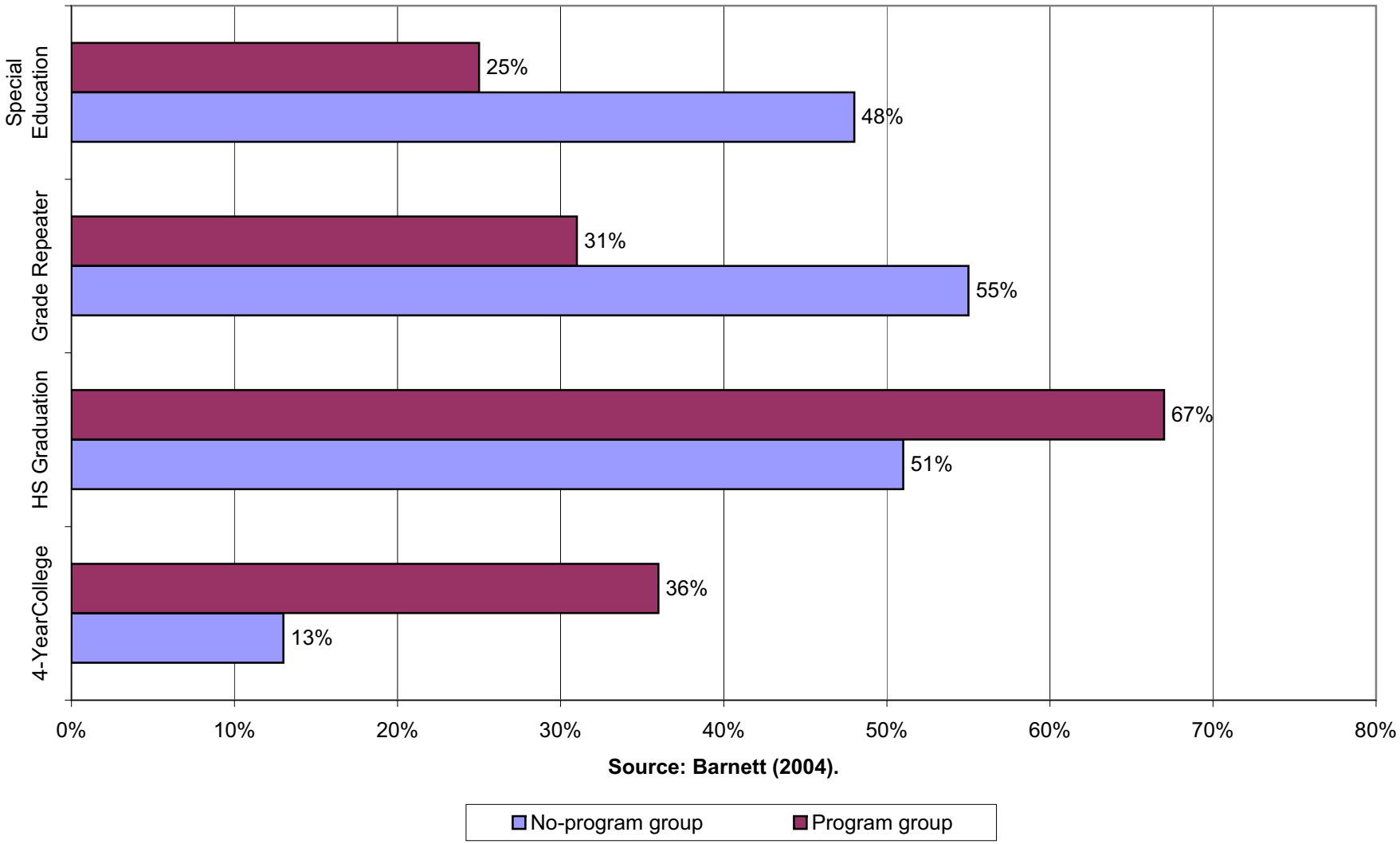
Other similar programs with family supplements are also effective

Academic and social benefits at school exit for CPC participants

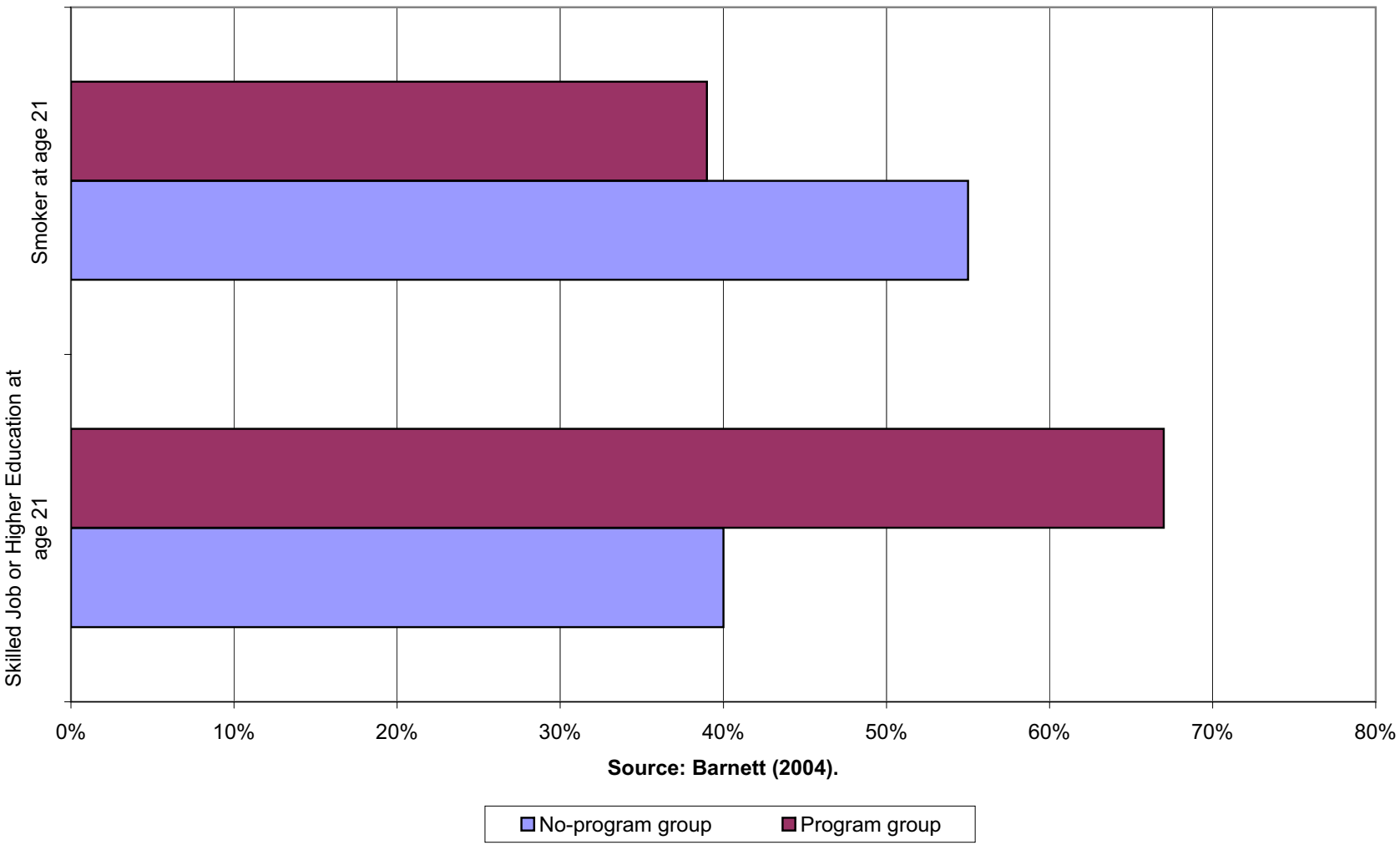


Source: Barnett (2004).

Abecedarian academic outcomes

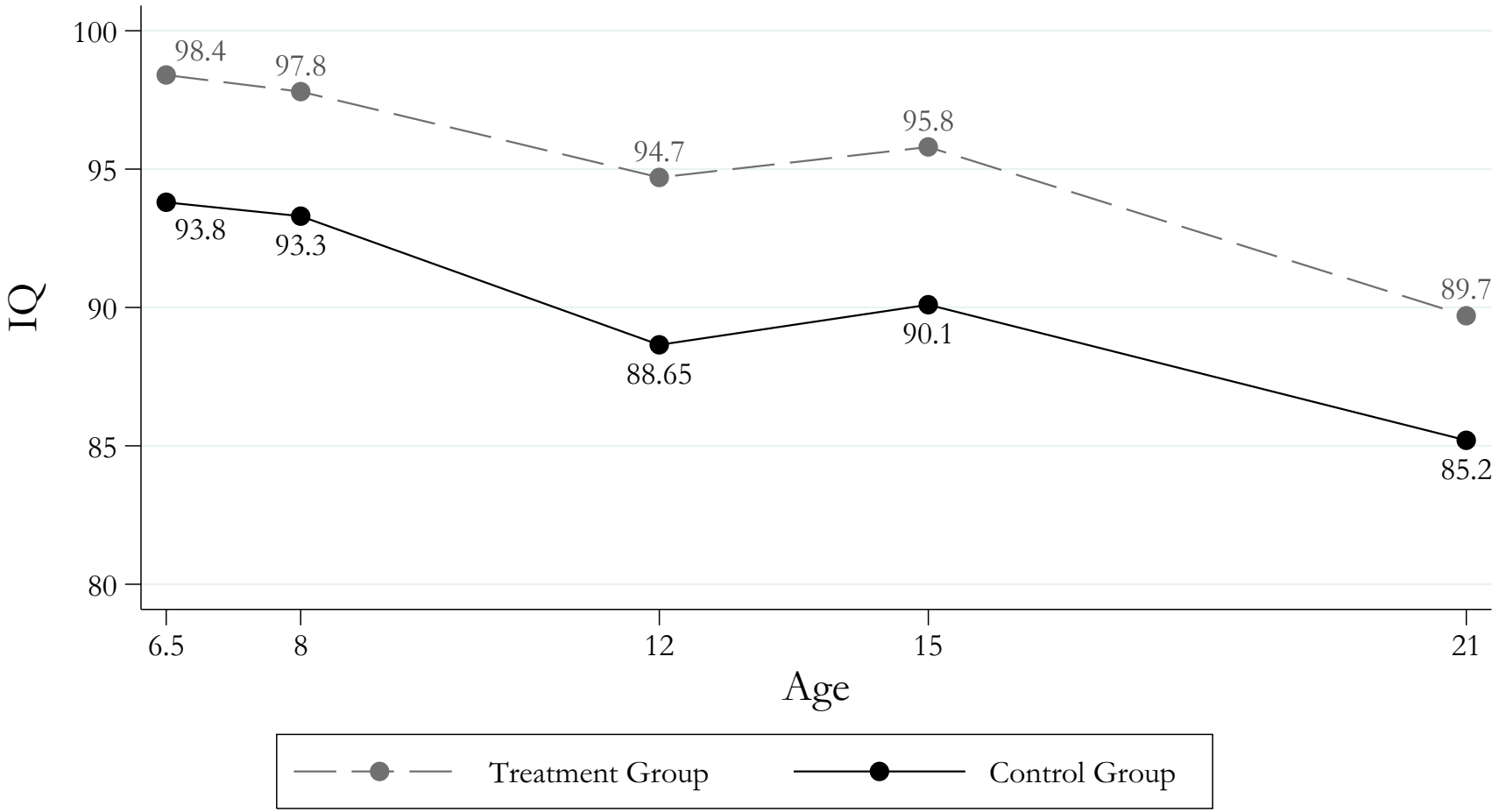


Other benefits of Abecedarian



- Intervening intensively and at an early enough age can actually raise IQs of the participants.

Abecedarian program: IQ, by age and treatment group



Source: Barnett (2004).

- Many studies claim that these aspects of behavior translate directly or indirectly into a high economic return. One estimated rate of return (the return per dollar of cost) to the Perry Program is in excess of 17%.
- The evidence from these intervention studies shows that skills beget skills.
- That is, all capabilities are built on a foundation of capacities that are developed earlier.
- Later remediation is costly.

- These findings stem from two characteristics that are intrinsic to the nature of learning:
  - Early learning confers value on acquired skills, which leads to self-reinforcing motivation to learn more;
  - Early mastery of a range of cognitive, social, and emotional competencies makes learning at later ages more efficient and therefore easier and more likely to continue.

The Dynamics and Neuroscience of Skill Formation

- To capture the second effect, look at the technology of skill formation.

$$\underset{\substack{\uparrow \\ \text{Skill at} \\ \text{time } t+1}}{S_{t+1}} = \underset{\substack{\uparrow \\ \text{Skill at} \\ \text{time } t}}{f(S_t,} \quad \underset{\substack{\uparrow \\ \text{Investment}}}{I_t)}$$

Two polar cases

- "Leontief cases" and perfect substitution.

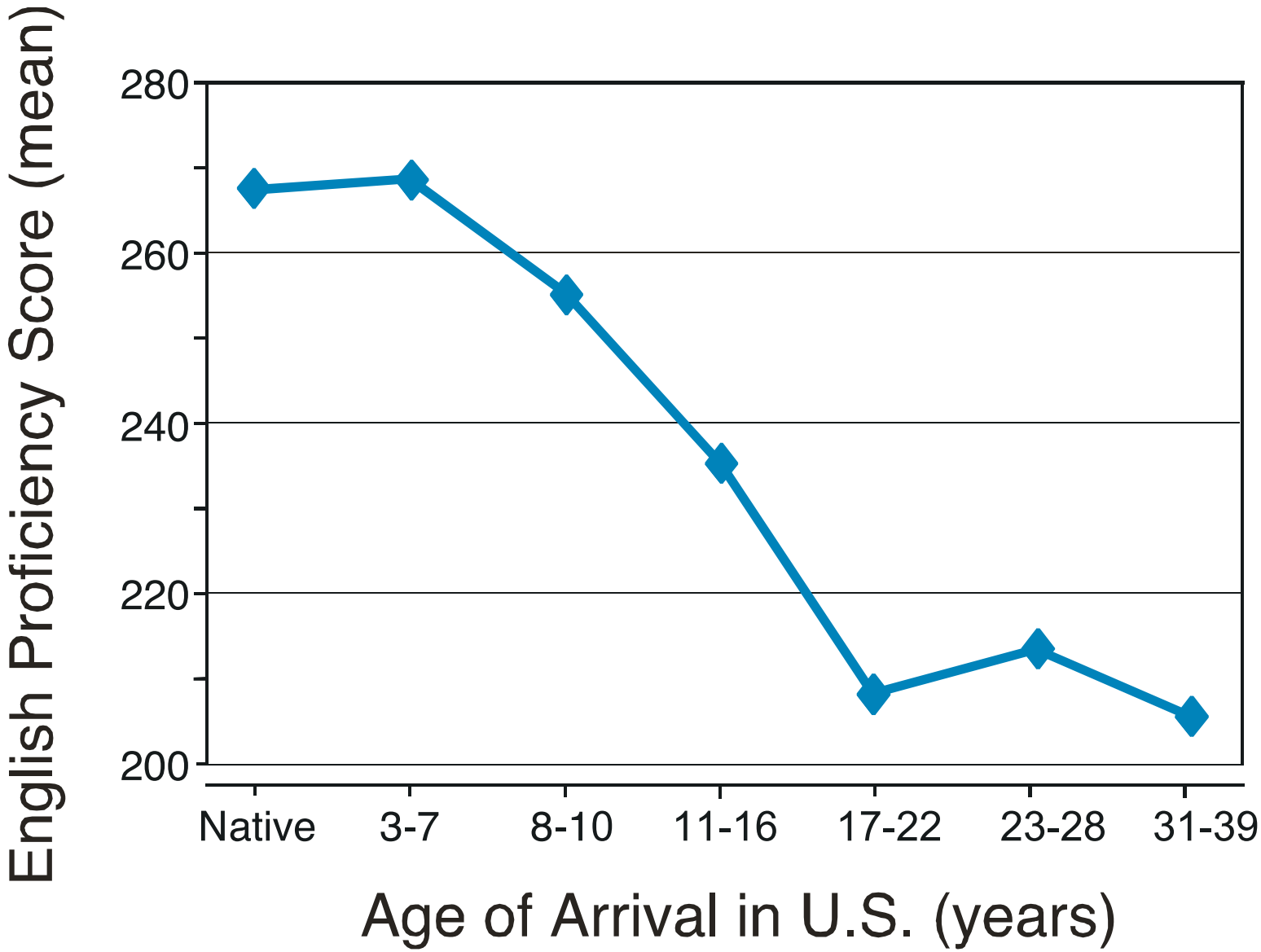
$$S_{t+1} = \min(S_t, I_t)$$

- A polar opposite is the case of perfect substitutes

$$S_{t+1} = a\,S_t + b\,I_t$$

- Captures notions of critical and sensitive periods.
- Language in humans is an example of the importance of sensitive periods.

Second language learning



Legend

Sensitive period for second language acquisition. English language proficiency scores as a function of age of arrival in the United States for a group of Chinese and Korean adult immigrants ($n = 46$). All subjects were students or faculty at the University of Illinois and had been in the U.S. for at least 10 years prior to testing. The test measured a variety of grammatic judgements. From Johnson and Newport (1989).

Romanian adoption study supports this notion

	Within-UK Adoptees	Romanian Orphans		
Age of Adoption (Months):	6	Before 6	Age 6-24	Age 24-42
Weight at Adoption	-	-2.1	-2.3	-
	-	(1.7)	(1.7)	-
Height at Adoption	-	-1.8	-2.2	-
	-	(1.6)	(2.4)	-
Denver Developmental	-	76.5	48.1	-
Scale at Adoption	-	(48.1)	(25.4)	-

See Rutter et al. (1998) and O'Connor et al. (2000) for more details on the analysis.

Romanian adoption study supports this notion

	Within-UK Adoptees	Romanian Orphans		
Age of Adoption (Months):	6	Before 6	Age 6-24	Age 24-42
Weight at Age 4	0.45	-0.02	0.04	-
	(0.79)	(0.92)	(0.94)	-
Height at Age 4	0.25	-0.29	-0.36	-
	(0.91)	(0.89)	(1.02)	-
Denver Developmental Scale at Age 4	117.7	115.7	96.7	-
	(24.3)	(23.4)	(21.3)	-
McCarthy GCI at Age 4	109.4	105.9	91.7	-
	(14.8)	(17.9)	(18.0)	-

See Rutter et al. (1998) and O'Connor et al. (2000) for more details on the analysis.

Romanian adoption study supports this notion

	Within-UK Adoptees	Romanian Orphans		
Age of Adoption (Months):	6	Before 6	Age 6-24	Age 24-42
Weight at Age 6	0.30 (0.90)	0.02 (0.97)	-0.25 (0.96)	-0.85 (0.98)
Percentage with Denver Developmental Scale at Age 6 Below 70	2 (1)	0 (0)	5 (2)	18 (7)
McCarthy GCI at Age 6	117 (17.8)	114 (18.3)	99 (19.2)	90 (23.8)

See Rutter et al. (1998) and O'Connor et al. (2000) for more details on the analysis.

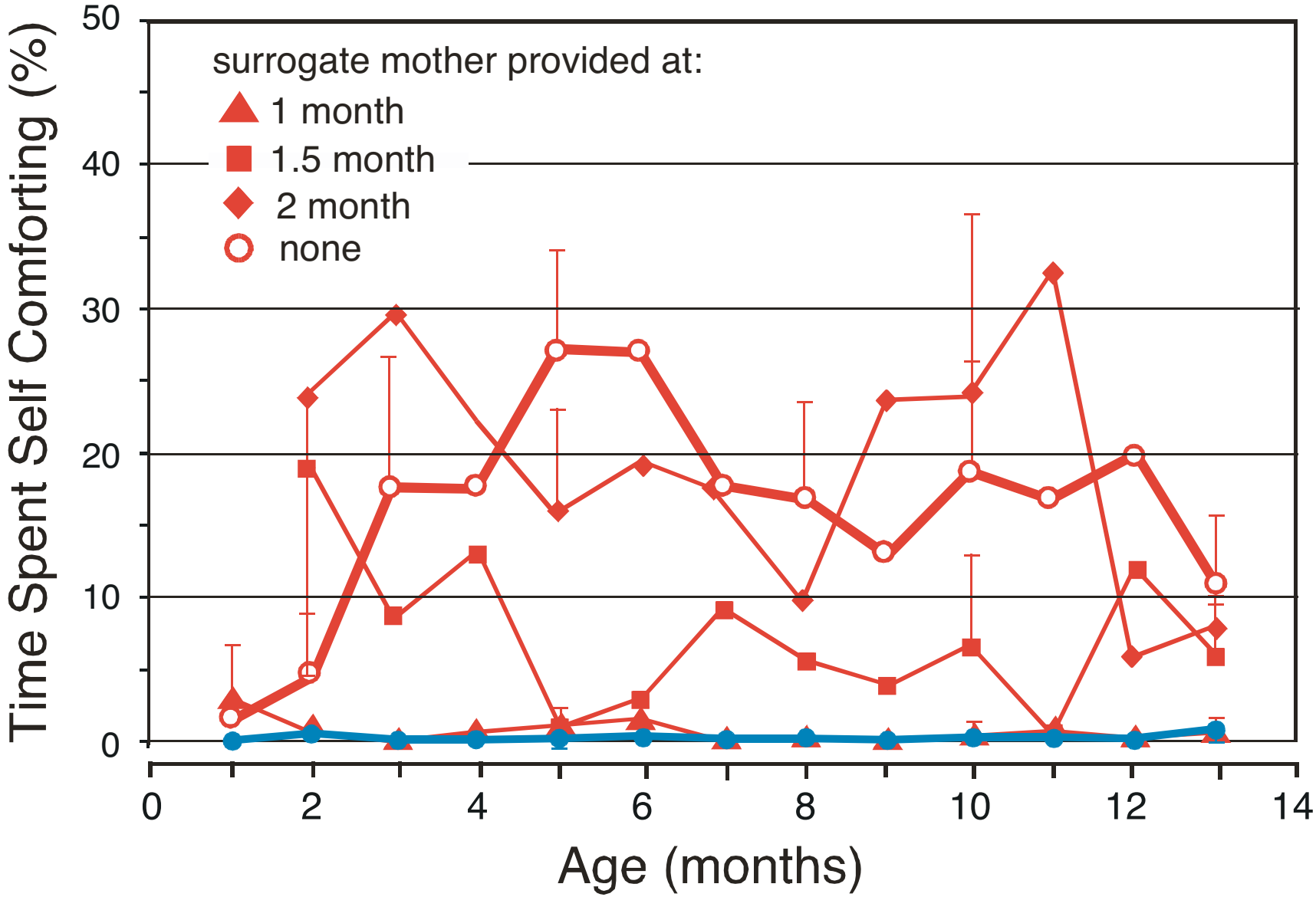
Romanian adoption study (legend)

Standard deviations are reported below in parentheses. All anthropomorphic measurements are standardized using UK age-specific distributions. The Denver Developmental Scale is based on specific behaviors (e.g., standing while holding on to something, lifting the head, making meaningful "da-da" sounds). Due to ceiling effects, the Denver scale is not meaningful at age 6, so O'Connor et al. (2000) use the percentage with impairment (defined as a score below 70) as the test criterion. The GCI is the total score on the McCarthy Scales of Children's Abilities. It summarizes verbal, quantitative, perceptual and memory performance. See Rutter et al. (1998) and O'Connor et al. (2000) for more details on the analysis.

Similar results found in animal studies

- Experimental evidence on macaque monkey population supports this conclusion.
- Draw on the work of Judy Cameron, Oregon National Primate Research Center.

Studies of Monkeys



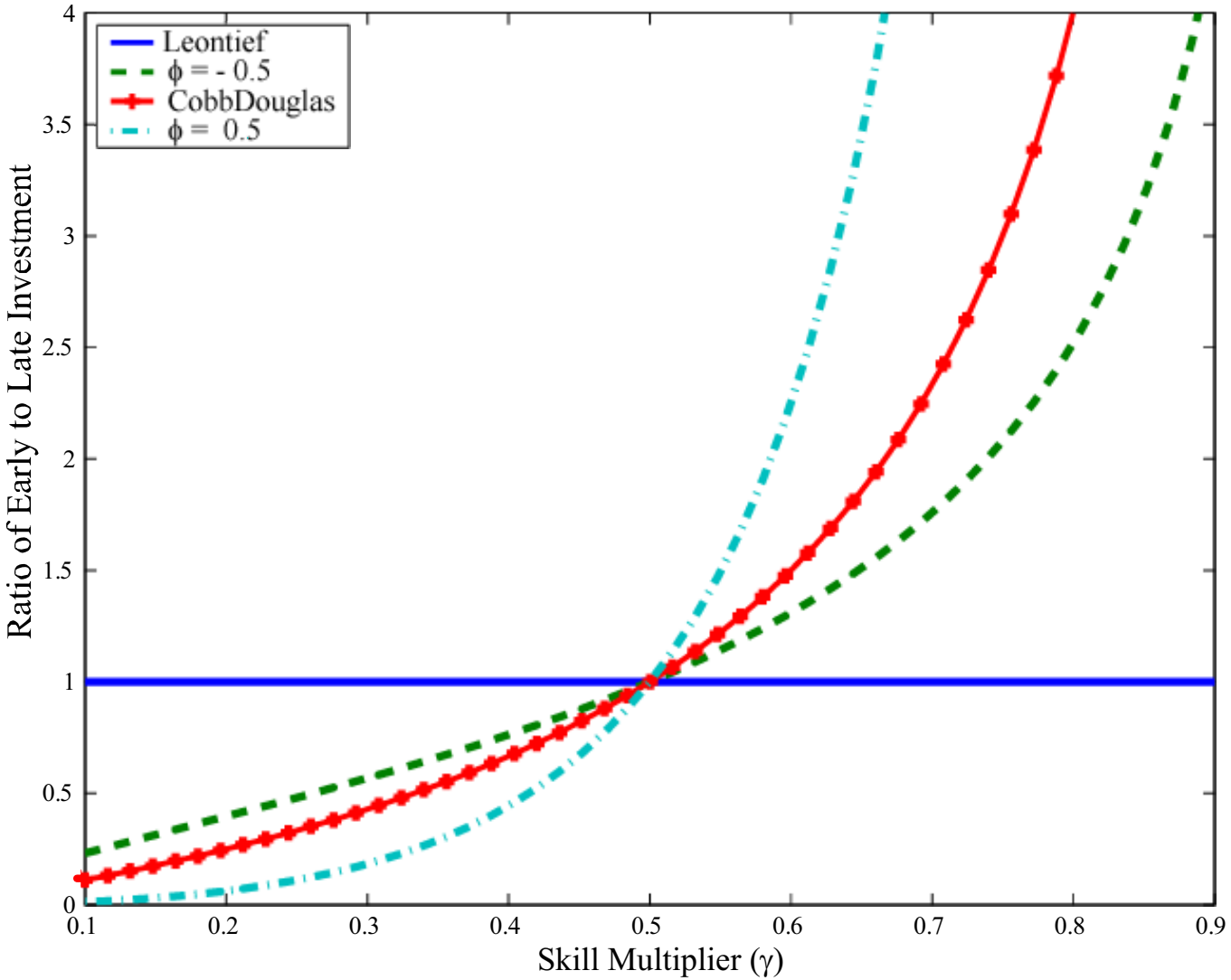
A model of critical and sensitive periods

- Consider a simple model — two periods of childhood (taken from Cunha and Heckman, 2006).
- Human Capital S_2 in Period 2:

$$S_2 = \left[\gamma I_1^{\phi} + (1-\gamma)\, I_2^{\phi}\right]^{\frac{1}{\phi}}$$

- I_1 is early investment; I_2 is late investment.
- γ is a "skill multiplier": a measure of how much early investment affects productivity of later investment.

The ratio of early to late investment in human capital as a function of the skill multiplier for different values of complementarity



Legend

This figure shows the optimal ratio of early to late investments, $\frac{I_1}{I_2}$, as a function of the skill multiplier parameter γ, for different values of the complementarity parameter ϕ, assuming that the interest rate r is zero. The optimal ratio $\frac{I_1}{I_2}$ is the solution of the parental problem of maximizing the present value of the child's wealth through investments in human capital, h, and transfers of risk-free bonds, b. In order to do that, parents have to decide how to allocate a total of M dollars into early and late investments in human capital, I_1 and I_2, respectively, and risk-free bonds. Let q denote the present value as of period "3" of the future prices of one efficiency unit of human capital: $q = \sum_{t=3}^{T} \frac{w_t}{(1+r)^{t-3}}$. The parents solve

$$\max \left(\frac{1}{1+r}\right)^2 [qh + b]$$

subject to the budget constraint

$$I_1 + \frac{I_2}{(1+r)} + \frac{b}{(1+r)^2} = M$$

and the technology of skill formation:

$$h = \left[\gamma I_1^{\phi} + (1-\gamma) I_2^{\phi}\right]^{\frac{\rho}{\phi}}$$

for $0 < \rho < 1$, $0 \leq \gamma \leq 1$, and $\phi \leq 1$. From the first-order conditions it follows that $\frac{I_1}{I_2} = \left[\frac{\gamma}{(1-\gamma)(1+r)}\right]^{\frac{1}{1-\phi}}$. This ratio is plotted in this figure when $\phi \to -\infty$ (Leontief), $\phi = -0.5$, $\phi = 0$ (Cobb-Douglas) and $\phi = 0.5$ and for values of the skill multiplier γ between 0.1 and 0.9.

Recent work by Cunha and Heckman estimates this technology and shows the relative effectiveness of early and late interventions.

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

	Baseline	Changing Initial Conditions - Moving Children to the 4th Decile of Distribution of Skills only through Early Investment	Adolescent Intervention: Moving Investments at Last Transition from 1st to 9th Decile
High School Graduation	0.4109	0.6579	0.6391
Enrollment in College	0.0448	0.1264	0.1165
Conviction	0.2276	0.1710	0.1773
Probation	0.2152	0.1487	0.1562
Welfare	0.1767	0.0905	0.0968

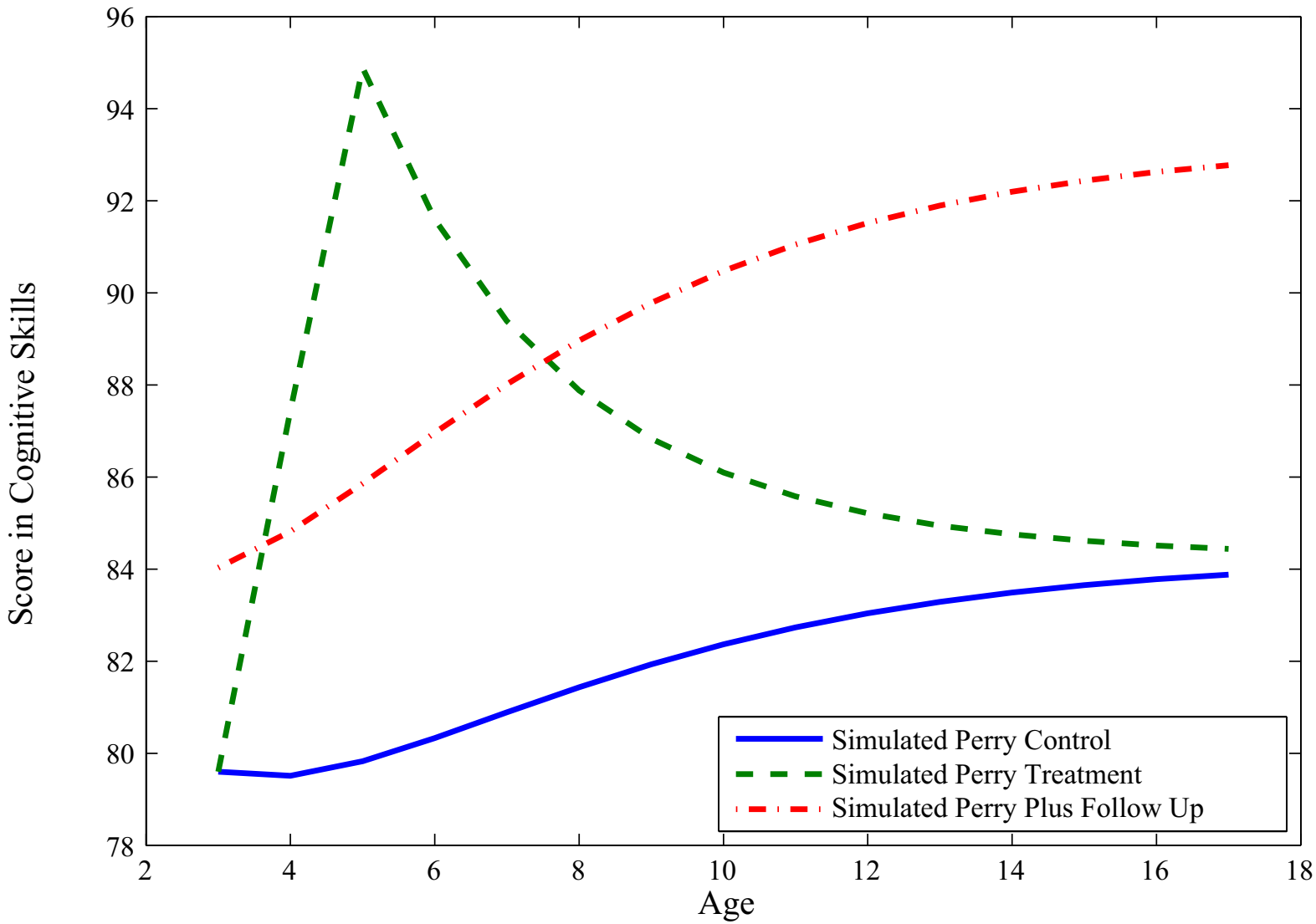
Source: Cunha and Heckman (2006)

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

	Baseline	Changing Initial Conditions - Moving Children to the 4th Decile of Distribution of Skills	Changing Initial Conditions and Performing Adolescent Intervention	Changing Initial Conditions and Performing a Balanced Intervention
High School Graduation	0.4109	0.6579	0.8477	0.9135
Enrollment in College	0.0448	0.1264	0.2724	0.3755
Conviction	0.2276	0.1710	0.1272	0.1083
Probation	0.2152	0.1487	0.1009	0.0815
Welfare	0.1767	0.0905	0.0415	0.0259

Source: Cunha and Heckman (2006)

Using the estimated technology to simulate balanced interventions

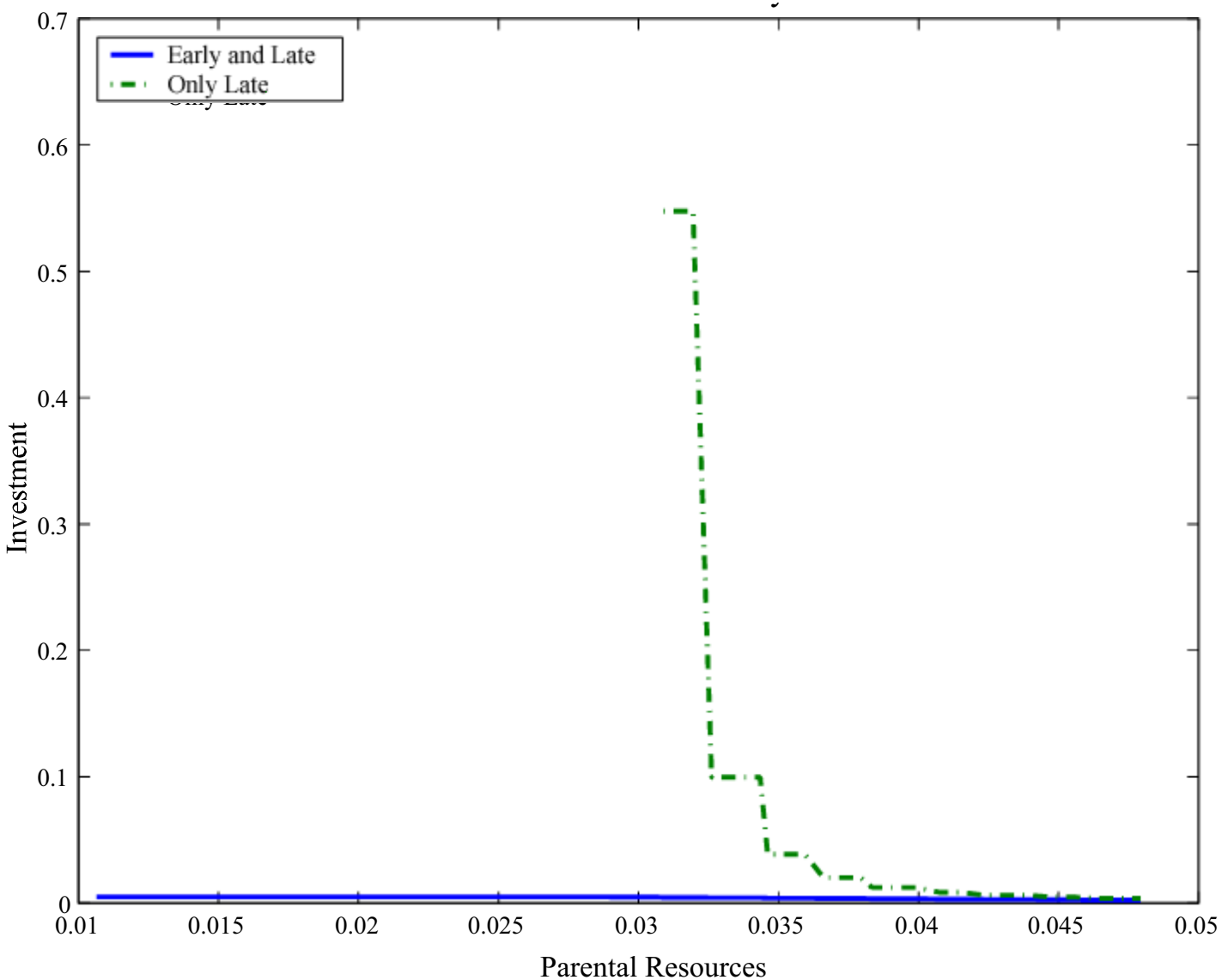


- The evidence strongly supports the economic efficiency of early initial investment that is sustained.
- Optimal distribution of investment:
  - Invest early? Yes.
  - But must be followed up to be effective.
- This is a consequence of dynamic complementarity.
- Later remediation is possible but to attain what is accomplished by early investment is much more costly (35–50%).
- If we start at too low a level, later skill investment is economically inefficient.

This model is embedded in an Aiyagari/Laitner economy

- We extend the analysis to account for
  1. Idiosyncratic uncertainty,
  2. Lifetime liquidity constraints (i.e., parents cannot leave debts to their children).
- Using these tools we develop optimal life cycle policies.
- We seek to determine the costs of delay in providing enriched early environments. Specifically we show the costs of remediation of adverse early environments.
- If early investment is sufficiently small, there is no economically efficient compensatory later investment.
- Better to give the child a bond or a bank account.

The cost of remediation of late vs. early and late interventions



The cost of remediation of late vs. early and late interventions

This figure is from Cunha and Heckman (2004), and is based on estimates reported above: $\rho = 0.7012$, $\gamma = 0.8649$, and $\phi = -0.4108$, shows the costs of remediation when the government makes up for parental deficits in investments due to binding lifetime credit constraints. Formally, the young parents solve $V_1(h, b, \varepsilon) = \max\{u(c_y) + \beta E[V_2(h, s, I_1, \eta)|\varepsilon]\}$, subject to the young budget constraint $c_y + I_1 + \frac{s}{1+r} = wh\varepsilon + b$, and the natural borrowing limit $s \geq -wh\eta_{\min}$. When old, the parents solve $V_2(h, s, I_1, \eta) = \max\{u(c_o) + \beta E[V_2(h', b', \varepsilon')|\eta]\}$, subject to the budget constraint when old, $c_o + I_2 + \frac{b'}{1+r} = wh\eta + s$; the constraint that prevents parents from extracting resources from their children, $b' \geq 0$; and the technology of skill formation. This figure plots the remediation costs for parents that receive no bequest in risk-free bonds, so that $b = 0$. The goal is to calculate the short-run costs of implementing a policy that attains the counterfactual human capital stock of the child if parents had access to full insurance against realizations of idiosyncratic shocks. There are two ways the government can pursue this policy. In the first case, the government provides educational goods and services in both early and late investment periods. In the second case, the government intervenes only during the late investment period. The message is clear: when the government intervenes only in the late period, remediation costs are much higher than when the government acts in both periods for all levels of parental income. Furthermore, for parents with very low income, there is no amount of government-provided educational goods and services that can attain the objective of the policy. In this figure, it is assumed that the government policy is unexpected when parents allocate resources to investments. See Cunha (2004) for long-run effects of government remediation policies.

Summary

- Skills matter.
- More than smarts is required.
- A lot of social policy focuses only on smarts.
- Skill gaps emerge early and can be traced in part to adverse early environments.

Summary

- Schools and tuition do not matter as much as is often thought.
- Late remediation not very effective.
- Remediation can work, but is costly.
- Social policy should be directed toward the malleable early years.
- Evidence from human and animal species supports this conclusion.