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The Productivity Argument for Investing in Young Children

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ABSTRACT

The Productivity Argument for Investing in Young Children*

This paper presents a productivity argument for investing in disadvantaged young children. For such investment, there is no equity-efficiency tradeoff.

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This paper presents the case for investing more in young American children who grow up in disadvantaged environments. Figure 1 graphs time series of alternative measures of the percentage of children in disadvantaged families. The percentage of children born into, or living in, nontraditional families has increased greatly in the last 30 years.[1,2] Approximately 25% of children are now born into single parent homes. While the percentages of children living in poverty and born into poor families have fallen recently, they are still high, especially among certain subgroups.

Adverse environments place children at risk for social and economic failure. The accident of birth plays a powerful role in determining adult success.[3] Many have commented on this phenomenon, and most analyses have cast the issue of assisting children from disadvantaged families as a question of fairness or social justice.

This paper makes a different argument. We argue that, on productivity grounds, it makes sense to invest in young children from disadvantaged environments. Substantial evidence shows that these children are more likely to commit crime, have out-of-wedlock births and drop out of school. Early interventions that partially remediate the effects of adverse environments can reverse some of the harm of disadvantage and have a high economic return. They benefit not only the children themselves, but also their children, as well as society at large.

Investing in disadvantaged young children is a rare public policy with no equity-efficiency tradeoff. It reduces the inequality associated with the accident of birth and at the same time raises the productivity of society at large.

While a more rigorous analysis is necessary to obtain a better understanding of the effects of early intervention programs, their precise channels of influence, and their exact benefits and costs, the existing evidence is promising. An accumulating body of knowledge shows that early

childhood interventions for disadvantaged young children are more effective than interventions that come later in life. Because of the dynamic nature of the skill formation process, remediating the effects of early disadvantages at later ages is often prohibitively costly (see Carneiro, Cunha and Heckman and Cunha and Heckman, 2006). Skill begets skill; learning begets learning. Early disadvantage, if left untreated, leads to academic and social difficulties in later years. Advantages accumulate; so do disadvantages. A large body of evidence shows that post-school remediation programs like public job training and General Educational Development (GED) certification cannot compensate for a childhood of neglect for most people.

This evidence has dramatic consequences for the way we think about policy toward skill formation. Most current policies directed towards improving the skills of youth focus on schools as the locus of intervention. The *No Child Left Behind Act* uses mandates and punishments to encourage schools to remediate the educational deficits of disadvantaged children. School accountability schemes are used to motivate higher levels of achievement for children from disadvantaged environments.

While these initiatives are well-intentioned, their premise is faulty. Schools work with what parents give them. The 1966 Coleman Report on inequality in school achievement clearly documented that the major factor explaining the variation in the academic performance of children across U.S. schools is the variation in parental environments—*not* the variation in per pupil expenditure across schools or pupil-teacher ratios. Successful schools build on the efforts of successful families. Failed schools deal in large part with children from dysfunctional families that do not provide the enriched home environments enjoyed by middle class and upper middle class children. Since failure in school is linked to so many social pathologies, each with substantial social and economic costs, a policy of equality of opportunity in access to home environments (or their substitutes) is also a one that promotes productivity in schools, the

workplace, and society at large.

Rigorous statistical analysis is not needed to show that parents and their resources matter, although there is a large body of empirical evidence that supports this claim, as we document below. The issue that has stymied social policy is how to compensate for adverse family environments in the early years. One approach has been to reduce the material deprivation suffered by the poor with transfers from the state, as in Lyndon Johnson's War on Poverty. Another approach has been to bolster the family with programs outside the home. Sometimes children have been removed from the biological families, as in the case of the American Indians in the early twentieth century. Policies that have removed children from homes have had catastrophic consequences.[4]

An emerging body of evidence suggests that there is a better way to improve the early years of disadvantaged children. Enriched preschool centers available to disadvantaged children on a voluntary basis coupled with home visitation programs have a strong track record of promoting achievement for disadvantaged children. The economic return to these programs is high, especially when we consider alternative policies that target children from disadvantaged environments or the policies targeted to the young adults who emerge from them. We review the evidence on these programs and suggest that some version of them be used to supplement the resources of disadvantaged families with children.

Our logic is simple and compelling. Education and human skill are major factors determining productivity, both in the workplace and in society. The family is a major producer of the skills and motivation required for producing successful students and workers. The most effective policy for improving the performance of schools is supplementing the childrearing resources of the disadvantaged families sending children to the schools. The family is a major determinant of child participation in crime and social deviance. A family supplementation policy

is a successful anti-crime policy.

Our emphasis on early childhood interventions does not deny the importance of schools or firms in producing human skill. Indeed, if proven early intervention programs are adopted, schools will be more effective, firms will have better workers to employ and train, and the prison population will decline. At lower cost to society, bolstered families will produce better educated students, more trained workers and better citizens.

This paper proceeds in the following way. We first discuss the problem of the supply of skills to the American economy. Growth in both the quantity and the quality of the labor force traditionally has been a major source of U.S. output growth. Given current trends, U.S. growth prospects are poor. Labor force growth is slowing, especially that of young and skilled workers who are a source of vitality for the entire economy. The composition of the future workforce will shift towards workers from relatively more dysfunctional families with commensurately worse skills.

We next discuss the problem of crime in America. Even though the crime rate has fallen in recent years, the levels and costs of crime are still very high. The damage to victims and the resources spent on preventing crime and on incarcerating criminals are large. Early intervention programs targeted towards disadvantaged families reduce participation in crime. On purely economic grounds, the case for early childhood intervention is strong.

After describing these two major social problems that impair the productivity of American society, we summarize trends in adverse child environments. We summarize a vast literature in social science that establishes that dysfunctional and disadvantaged families are major producers of cognitive and behavioral deficits that lead to adverse teenage and adult social and economic outcomes. The effects of disadvantage appear early and persist. Remediating these disadvantages at later ages is costly. Human abilities affect lifetime performance and are shaped

early in the life of the child. Early interventions promote cumulative improvements. Enriched interventions targeted towards children in disadvantaged environments are cost-effective remedies for reducing crime and the factors that breed crime, and raising productivity in schools and in the workplace.

We then move on to summarize the findings of the literature on the economics of child development that demonstrates the importance of both cognitive and noncognitive abilities in shaping child educational and economic outcomes. Both types of abilities are major determinants of the economic return to education.

Both cognitive and noncognitive abilities are shaped early in life and early differences in abilities persist. Gaps in college attendance across socioeconomic groups are largely shaped by abilities formed in the early years. Gaps in child ability across families of different income levels are associated with parental environments and parenting practices. Early interventions can partially remediate these deficits. Later interventions are much less effective. At current levels of investment, American society over-invests in public job training and formal education and under-invests in early education for disadvantaged children.

We summarize the evidence from a variety of early intervention programs targeted toward disadvantaged children and focus on three early interventions that followed participants into adulthood. Some of these interventions are evaluated by the method of random assignment. Early interventions reduce crimes, promote high school graduation and college attendance, reduce grade repetition and special education costs, and help prevent teenage births. They raise achievement as measured by test scores. Very early interventions also appear to raise IQ, especially for girls. Cost-benefit analyses of these programs reported in the literature show that they are cost effective. Estimated rates of return are 16%: 4% for participants and 12% for society at large. The paper concludes with a summary of the argument and some specific policy

recommendations.

Human Capital and Economic Performance

Education and skill are central to the performance of a modern economy. The emergence of new technologies has raised the demand for highly skilled workers who are qualified to use them. A wage premium for skilled labor emerged in many countries in the early 80s, and wage inequality grew as the economic return to education (the economic benefit of attending school) rose, especially in countries like the U.S. where the supply response to the increasing wage premium was weak.[5] Not only did the wages of the skilled rise, but those with the least ability and education earn less today than comparable workers would have earned thirty years ago.

Workforce Trends

Table 1, taken from Ellwood, highlights the problems facing the American labor market in the next two decades. The first column of the table presents the distribution of the American workforce among age and race-ethnicity categories in 1980. The second column shows the growth in the categories from 1980 to 2000 and the third column shows the labor force as of 2000. The fourth column shows the projected growth in the labor force in the next twenty years by category. With the possible exception of the numbers for immigrants, these are reliable projections because there is little emigration and the groups being projected are already alive. The immigration projections come from a carefully executed U.S. Census study. The labor force is aging and young replacements for old workers are increasingly in short supply compared to the 1980s.[6] The aging of the American workforce raises serious problems for the future of American productivity growth.

The workforce of prime-age workers, fueled by the entry of Baby Boomers, propelled

U.S. economic growth in 1980–2000. However, we cannot count on this source of growth in the next twenty years. Indeed, the largest components of growth in the workforce will come from older workers as the Baby Boom cohort ages. Hence, a major source of vitality in the U.S. workforce will be lost. Future workforce growth will come from older workers and from demographic groups in which, for a variety of reasons, dysfunctional and disadvantaged families are more prevalent (See the middle rows of the table 1 and the discussion below).

On top of these trends in the number of workers by age, there is stagnation in educational attendance rates. Figure 2 shows the distribution of educational attainment among 30-year-olds by year. College-going rates have stalled out for cohorts of Americans born after 1950. This is not a consequence of immigration of unskilled workers. It is a phenomenon found among native-born Americans. Currently, 17% of all new high school credentials issued are GEDs.[7] Heckman and LaFontaine (2006) document that the high school dropout rate has increased over time if one counts GEDs as dropouts, as one should, because GEDs earn the same wages as dropouts, and graduate from college at the same rate as dropouts.

The growth in the quality of the workforce, which was a mainstay of economic growth until recently, has diminished. Assuming that these trends continue, the U.S. economy will add many fewer educated persons to the workforce in the next two decades than it did in the past two decades (see table 2). Jorgenson, Ho, and Stiroh estimate that the average annual rate of growth of college labor supply was 4.5% in 1977, but fell to 1.75% in 1990–2000. These trends are predicted to continue, or possibly worsen.

The slowdown in labor force quality growth has already hurt American productivity growth. Delong, Katz, and Goldin estimate that increases in educational attainment boosted the effective quality of the workforce by 0.5% a year over 1915–2000, and thus contributed an average of 0.35 percentage points per year to economic growth over that period.[8] The slower

growth in educational attainment of the workforce substantially reduced productivity growth in recent years compared to its performance in the period 1915–1980. Based on current trends, these authors project that the annual rate of productivity growth attributable to education—0.35 from 1980 through 2000—will decline by half or more (to between 0.17 and 0.06 percent) in the next two decades. This will reduce the productivity growth of labor by a substantial 0.18–0.29 percentage points per year and will be a drag on real wage growth and fiscal revenues.

Literacy and Numeracy

The skills of the U.S. labor force are poor. The U.S. has a thick lower tail of essentially illiterate and innumerate persons, who are a drag on productivity and a source of social and economic problems. We use data from the International Adult Literacy Survey (IALS) to examine literacy and numeracy of working age adults (age 16-65).[9] Document literacy is defined as the ability to locate and use information from timetables, graphs, charts and forms. Figure 3 presents data on document literacy. Tests for prose literacy and quantitative literacy produce the same pattern.[10]

Level 1 performance is essentially functional illiteracy or innumeracy. It represents the inability to determine the correct amount of medicine from information on a bottle of pills. People who perform at Level 1 can make limited use of texts that are simple and uncomplicated. They are only able to locate information in text or data as long as there is no distracting information around the correct answer. On the quantitative scale, they can only carry out relatively straightforward operations such as simple addition. Roughly 20% of U.S. workers fall into this category on each test, a much higher fraction than in some of the leading European countries. This is a major drag on U.S. competitiveness[11] and a source of social problems.

Crime

Crime is a major burden on American society. Anderson (1999) estimates that the net cost of crime (after netting out transfers) is over $1.3 trillion per year in 2004 dollars. The *per capita* cost is $4,818, in the same dollars. This figure includes crime-induced production (of personal protection devices, trafficking of drugs and operation of correctional facilities) which costs $464 billion per year; opportunity costs (production foregone by incarcerated offenders, valued at their estimated wage, time spent locking and installing locks, and so forth) of $152 billion per year; and the value of risks to life and health (pain, suffering and mental distress associated with health losses) of $672 billion annually (table 3). This includes time lost from work by victims as well as value of life lost to murders. Some of these items like the valuation of life require controversial judgments. Even ignoring any transfer component or any risks to life and health, the cost of crime is over $600 billion per year. Although such calculations are necessarily imprecise and there is disagreement over the exact costs, there is widespread agreement that the costs of crime are substantial.

Even though crime rates have recently declined somewhat, their levels remain high (see figure 4a). The adult correctional populations (in prison or local jail, on probation or on parole) continue to grow despite the drop in measured crime rates (see figure 4b). The size of the population under correctional supervision has continued to increase for all groups, as has the percentage of each group under supervision. Nine percent of blacks were under the supervision of the criminal justice system in some form in 1997, although recently this adverse trend has slowed. Incarceration rates have risen steadily since 1980 and only slowed in the late 1990s. The inmate population has risen steadily until recently.[12] Expenditures on prisons, police and the judicial system continue to grow despite the drop in measured crime rates (see figure 4c).

These statistics do not convey the full scope of the problem. According to the Bureau of

Justice Statistics (2004), as of the end of 2001, there were an estimated 5.6 million adults who had ever served time in State or Federal prison--4.3 million former prisoners and 1.3 million adults in prison. Nearly a third of former prisoners were still under correctional supervision, including 731,000 on parole, 437,000 on probation, and 166,000 in local jails. In 2001, an estimated 2.7% of adults in the U.S. had served time in prison, up from 1.8% in 1991 and 1.3% in 1974. The prevalence of imprisonment in 2001 was higher for Black males (16.6%) and Hispanic males (7.7%) than for White males (2.6%). It was also higher for Black females (1.7%) and Hispanic females (0.7%) than White females (0.3%). Nearly two-thirds of the 3.8 million increase in the number of adults ever incarcerated between 1974 and 2001 occurred as a result of an increase in first incarceration rates; one-third occurred as a result of an increase in the number of residents age 18 and older. If recent incarceration rates remain unchanged, an estimated one of every 15 persons (6.6%) will serve time in a prison during his or her lifetime.

The lifetime chances of a person going to prison are higher for men (11.3%) than women (1.8%), and for Blacks (18.6%) and Hispanics (10%) than Whites (3.4%). Based on current rates of first incarceration, an estimated 32% of black males will enter state or federal prison during their lifetime, compared to 17% of Hispanic males and 5.9% of White males.

What Can We Do about This Problem?

It is now well established that education reduces crime. Figure 5, from Lochner and Moretti, displays this relationship, reported separately for blacks and whites. Increasing high school graduation rates is a major crime prevention strategy. Risk factors promoting crime include poor family backgrounds, which also promote high school drop out. Poorly educated teenage mothers in low-income families are much more likely to produce children who participate in crime.[13] We discuss the evidence on the impact of family background on child

participation in crime in the next section. Although analysts do not agree on which specific aspects of adverse family environments most affect crime, they all agree that there is a strong empirical relationship between early adverse environments and child participation in crime later on in life.

Some of the most convincing estimates of the impact of adverse early environments on participation in crime come from interventions designed to remedy those environments. Table 4 presents a summary of the impacts of a variety of early childhood intervention programs on participation in crime. We discuss some of these programs in much greater detail in below. Here we summarize some findings relevant to crime.

Many of these programs were evaluated by the method of random assignment. Children from disadvantaged populations were randomly assigned, at early ages, to the enriched child development programs described in the third column of the table. Most interventions were for children in the pre-kindergarten years. Both the experimental treatment group and the controls were followed over time, often for many years after the intervention. The Perry Preschool program, which we discuss in detail below, followed the intervention and control children for more than 30 years after the intervention. Over that time, the Perry students averaged significantly fewer lifetime arrests than the comparison group, including arrests for dealing and producing drugs. This effect was especially pronounced for males. The Abecedarian program appears to be anomalous, because it did not reduce crime in the treatment group compared to the control group. It was administered to a population in a low-crime region in the South. Most studies show dramatic reductions in criminality and participation in the criminal justice system for treatment group members. Enriched environments reduce crime. Impoverished environments promote crime.

Lochner and Moretti present convincing non-experimental evidence that increasing

educational attainment reduces crime and that the inverse relationship between crime and education in figure 5 is not a correlational artifact arising from unobserved variables that are common to both crime and education. Using Census data, they show that one more year of schooling reduces the probability of incarceration by 0.37 percentage points for blacks, and 0.1 for whites.[14] To put this evidence in perspective, 23% of the black-white difference in average incarceration rates can be explained by the differences in education between these groups. Using the FBI's Uniform Crime Reports, they find that the greatest impacts of education are associated with reducing arrests for murder, assault, and motor vehicle theft.

Lochner and Moretti also calculate the social savings from crime reduction associated with completing secondary education. They show that a 1% increase in the high school graduation rate would yield $1.8 billion dollars in social benefits in 2004 dollars. This increase would reduce the number of crimes by more than 94,000 each year (see table 5). The social benefits include reduced losses in productivity and wages, lower medical costs, and smaller quality-of-life reductions stemming from crime.[15] They also include reductions in costs of incarceration.[16]

High school graduation confers an extra benefit of 14-26% beyond private returns captured by the high school graduate wages that are pocketed by graduates. This is an important benefit of education beyond its private return that suggests overall under-investment in the population of disadvantaged children at risk for committing crime. Completing high school raises a student's wages by about $10,372 per year (in 2004 dollars), and the direct cost of completing one year of secondary school is approximately $8,000 per student in 1997 (in 2004 dollars). Looking only at the savings from reduced crime, the return is $1,638-$2,967 per year, so that expenditure is cost effective even if we ignore the direct benefits in earnings and even if we assume that the benefits decline as the youths grow older.

Comparing the effect of educational expenditure with the effect of hiring an additional police officer suggests that promoting education may be a better strategy. Using a somewhat different framework, Levitt claims that an additional sworn police officer in a large U.S. city would reduce annual costs from crime by about $200,000 dollars at a public cost of $80,000 per year. These are recurrent annual costs.

Lochner and Moretti estimate that in steady state it would cost $15,000 per year in terms of direct costs to produce enough high school graduates to reduce crime by the same amount. This cost ignores foregone earnings in high school but it also ignores all of the benefits from high school graduation documented in Heckman, Lochner, and Todd. If Levitt's estimate is correct, educational policy is far more effective per dollar spent than expenditure on police.[17,18]

Trends in Children's Home Environments and the Consequences of Adverse Environments

Demographers have documented that over the past forty years, the aggregate birth rate has declined, but in the past few decades relatively more of all American children born are born into adverse environments. The definition of adversity varies among studies, but the measures used are strongly interrelated. Most scholars recognize that absence of a father, low levels of financial resources, low parental education and ability, a lack of cognitive and emotional stimulation, and poor parenting skills are characteristics of adverse environments. Determining the relative importance of these factors is an ongoing debate. Each seems to play a factor in affecting child outcomes.

Family Structure

Fewer children are living with two parents who are married. In 2003, 68% of children

under 18 lived with two married parents, down from 77% in 1980.[19] This percentage has remained stable since 1995, after trending downward for many years. The percentage of children who live with only one parent, or in a home where the parents are not married, increased by 8% since 1980 to 28%. The percentage of children who live with no parents remained roughly constant around 3-4% during this period. The source of single parenthood has also changed. Relatively more children are living with a single parent who has never been married (see figure 6a).

The aggregate trends conceal a great deal of variation across demographic groups. In 2003, 77% of non-Hispanic White children lived with two married parents, while 20% lived with only one parent or with unmarried parents. The corresponding percentages for Blacks were 36% and 56%. For Hispanics, it was 65% and 31%.[20] Among Blacks, the percentage of children living with a never-married parent has increased dramatically over time.[21]

Non-Marital Childbearing

Since the 1965 Moynihan Report, many analysts have focused on family structure—the absence of a parent and the attendant decline in financial, emotional and cognitive resources—as an important source of social problems.[22] Over time, while the birth rate has fallen, births to unmarried women have risen until very recently.

After rising dramatically since 1940, out-of-wedlock childbearing leveled off in the 1990s but remains at a very high level.[23] The number of births to unmarried women increased from 1.17 to 1.3 million between 1990 and 1999. The birthrate for unmarried women increased from 43.8 births per 1,000 unmarried women aged 15-44 years in 1990 to 46.9 in 1994, before falling back to 43.9 in 1999.[24] The percentage of all births to unmarried women has risen from 28% in 1990 to 33% in 1999, though it has been roughly constant at 32-33% since 1994. To put these

numbers in perspective, in 1940, this number was 3.8%.

The birth rate for unmarried Black women has been higher than that of White unmarried women (including Hispanic women), but this gap has narrowed in recent years because the birth rate has grown at a faster pace for unmarried White women.[25] In 1970, the rate for unmarried Black women was roughly 7 times the rate for unmarried White women—96 per 1,000 *versus* 14 per 1,000. By 1998, the gap was reduced by 70%; it became 73 *versus* 38 per 1,000.

Unfortunately, the birthrate for unmarried Hispanic women is only available for the 1990s, but it is the highest among the three demographic groups. In 1990, the birthrate for unmarried Hispanic women was 89.6 per 1,000, peaked at 101.2 per 1,000, and fell to 90.1 per 1,000 in 1998.[26]

The same trend holds for the percentage of births to unmarried mothers within each race.[27] In 1969, 5.5% of white children were born to unmarried mothers. The corresponding percentage for blacks was 34.9%. By 1999, these numbers were 26.7% and 68.8%, respectively. The percentage for Hispanics in 1999 was 42.1% *versus* 36.7% in 1990. Until recently, unmarried births have been increasing overall, although the percentage due to minority mothers has stabilized.[28]

Single parenthood is much more prevalent for high school dropouts (see figure 6b and the discussion in Ellwood and Jencks, 2002). Although the media has focused on celebrities who choose single parenthood, the bulk of the single mothers have high school education or less and the majority of this group consists of high school dropouts (see figure 6c). The incidence of divorce is greater for this group as well.[29] The percentage of children born to unmarried teenagers has trended up dramatically over the past fifty years. Close to 10% of all children were born to unmarried teenage mothers in 2000 (see figure 6d).

Many pathologies are associated with less educated mothers and teenage mothers. They

are less likely to marry when they have children and they are more likely to divorce. Their abilities, (see Armor, 2003), family incomes, and the emotional and intellectual support accorded children are low. Figures 7a-b show that younger mothers provide less emotional and cognitive stimulation for their children, as do mothers with less schooling (figures 7c-d). While the debate is not settled as to which features of adverse family environments are most harmful to the success of children, there is uniform agreement that poor environments adversely affect child outcomes.

Other studies show the same pattern. Mayer analyzed child outcomes classified by a long run measure of parental income.[30] Low family income is associated with single parenthood, divorce, reduced education, and low parental ability. Child test scores are greater for children from higher income families. Teenage pregnancy and high school dropout rates are strongly negatively correlated with family income. Young adult education, earnings, wage rates and participation in social pathologies are much greater for children from poor families. Mayer does not isolate which factors in the constellation of poverty are the main causes of poor child outcomes; but the constellation has a clear association with adverse child outcomes.

McLanahan and Sandefur focus on another aspect of childhood disadvantage: one-parent vs. two-parent families. For a variety of data sets, and controlling for parental education, and family size, they show that: 1) attrition from high school is higher[31] , while test scores and school expectations are lower for children from one parent families[32] ; 2) college enrollment is lower[33] ; 3) labor force and school withdrawal is greater for disadvantaged children[34] ; and 4) teenage pregnancy is greater.[35] Ginther and Pollak extend their analysis to note that the real dichotomy is that between children living with both biological parents vs. other family structures. Being raised in an intact, two-parent family benefits child outcomes, relative to other family statuses.

Armor presents evidence on a variety of home environmental factors and uses test scores of children as the outcomes for his analysis. Test scores, taken at early ages, predict schooling

and many other outcomes (see Cameron and Heckman, 2001). Armor shows the gap in ability and knowledge of math between children of teenage mothers and children of older mothers.[36] The gaps are 20 points when he does not control for maternal ability and are smaller but still important when he controls for parental ability (6 points higher ability leads a person to complete two more years of school). His book demonstrates the importance of parental ability as well as the additional negative effect of teenage pregnancy on child outcomes.

Armor studies the effects of cognitive stimulation on child ability and math scores.[37] He goes part way toward isolating the factors characterizing adverse environments. Armor studies the effects of various environmental factors on the ability and math achievement of children.[38] Mothers' ability plays an important role but even controlling for that effect, family environmental factors play a substantial role in raising child test scores. Controlling for maternal ability, never-wed mothers who provide above average cognitive stimulation to their children can largely offset the circumstance of single parenthood in terms of their child's cognitive outcomes. This evidence is consistent with a large body of research reported in the National Research Council Report *Neurons to Neighborhoods* (Shonkoff and Phillips; Carneiro, Heckman, and Masterov; and Cunha, et al.).

The growth of adverse childhood environments explains a substantial part of the problems of schools, skills and crime in American society. It is especially problematic that poor environments are more common in the minority populations on which America must depend for the growth in its labor force (recall the data in table 1). Unless these environments are improved, one cannot rely on a growth in the skills of these groups to propel growth in workforce quality at the rate we have experienced in the past.

The Importance of Cognitive and Noncognitive Ability in Economic Life

A large literature has established the importance of both cognitive and noncognitive ability in social and economic life. Basic intelligence, acquired skills, social skills, self-control, and persistence matter for success in life (see Heckman et al., 2006, for recent evidence). The full implications of this body of evidence have not yet made their way into the design of economic and social policy.

Cameron and Heckman (1999, 2001) document that substantial gaps in the college-going rates of different racial and ethnic groups, which are nominally due to gaps in parental family income in the college-going years, are actually due to ability differences—that is, child college readiness. Adjusting for ability, family income and tuition play only minor roles in accounting for disparity in college attendance rates. This evidence explains why so many poor or disadvantaged children fail to utilize the programs that subsidize the college tuitions of the disadvantaged.

In the next section, we show that the ability gaps that explain college attendance gaps open up early, before schooling begins. A school-based policy for eliminating these gaps is less effective. Ability formed in the early years is also important in explaining crime, teenage pregnancy and a variety of social pathologies. Figure 8a shows that women with low cognitive ability are more likely to bear children when they are young. Figure 8b shows that low cognitive ability is associated with a higher probability of incarceration. Ability also affects the economic return to each year of schooling. Figures 8c-d show that mothers with low cognitive ability provide less cognitive and emotional stimulation for their children. Finally, in their research, Carneiro and Heckman (2003) show that the economic returns to one year of college for people of different ability differ greatly.[39] Those at the bottom 5% of the ability distribution get half of the return to education of those at the top 5% of the ability distribution. Ability also affects wages independently of schooling, as shown in Carneiro, Heckman, and Masterov.

Heckman, Stixrud, and Urzua analyze the changes in the probability of various outcomes

that are brought about by altering cognitive or noncognitive ability, holding the other constant. Figure 9a, taken from their study, clearly shows that higher levels of both cognitive and noncognitive skills are associated with lower rates of attrition from high school. For many outcome measures in their study, increasing noncognitive ability by the same percentile has a higher effect on outcomes than cognitive ability.

Increasing noncognitive ability to the highest level reduces the probability of being a high school dropout to virtually zero for females with average cognitive ability.[40] The same argument holds for other behavioral outcomes. Both types of ability have the same effect on reducing the likelihood of spending time in jail by age 30 (see figure 9b). Figure 9c shows the same effect for smoking. Figure 9d show this for teenage pregnancy. For this outcome, noncognitive ability is as important as cognitive ability. [41]

Human Ability and Its Determinants

The recent synthesis of neuroscience and social science has produced a much deeper understanding of the processes by which skills are formed over the life cycle, although much remains to be known (see Shonkoff and Phillips; Knudsen et al.; and Cunha and Heckman, 2007). The social science literature establishes that both cognitive and noncognitive abilities affect schooling attainment, participation in welfare, teenage pregnancy and crime (see Heckman et al., 2006, for a comprehensive analysis). More able and engaged parents produce more able children.

The recent literature distinguishes between IQ and achievement tests. IQ approximates intellectual capacity. Achievement tests capture knowledge in specific areas. IQ spurs achievement. At the same time, persons more motivated to learn and more persistent, and those who plan ahead—important aspects of noncognitive skills—also score higher on achievement tests at the same level of IQ. Families produce both cognitive and noncognitive skills, and both

matter for the social and economic success of the child. Gaps among income and race groups open up early and persist.

Figure 10a presents the average percentile ranks on a math test administered at ages 6, 8, 10 and 12 for children from different income groups. The test measures a composite of raw IQ and achievement.[42] Gaps in ranks by family income are substantial overall. Figure 10b shows that these differentials are greatly reduced when the scores are adjusted by mother's IQ, education, and intact family status. Similar adjustments appear when the mother's status is controlled for, and when other test scores are used. Enriched environments produce higher ability children.[43]

Figures 11a-b present parallel analyses for noncognitive skills. A high value of an antisocial score stands for a range of behavioral problems. High scores are associated with low-income environments; low scores with high-income environments. Again, gaps open up early among income groups, and again, gaps can largely be eliminated by accounting for the quality of the early environments facing the child.[44] A large body of literature, surveyed in Carneiro and Heckman (2003) and Cunha, et al., demonstrates that skill gaps open up early, before schooling begins, and that these gaps are major determinants of social and economic success. The strong association between family characteristics and child performance measured by cognitive and noncognitive skills also demonstrates the value of a strategy targeted toward disadvantaged families.

Implications of the Evidence on Ability for Skill Formation Policy

The policy implications of the emerging body of evidence on the technology of human skill formation are substantial. Conventional school-based policies start too late to effectively remedy early deficits, although they can do some good. The best way to improve the schools is to

improve the early environments of the children sent to them.

At current levels of funding, incremental expenditures on schooling quality are unlikely to be effective. Table 6 is based on estimates of the effect of schooling on earnings from a paper by Card and Krueger that greatly influenced recent California efforts to reduce class size. It shows the discounted economic returns (*i.e.*, effects on discounted lifetime income) to decreasing pupil-teacher ratios by 5, but keeping the quality of students the same. Reducing pupil-teacher ratios is frequently advocated to raise the performance of schools. Taking the most favorable estimates reported by these advocates of schooling programs produces a net *negative* return, even if the social cost of taxation used to fund schooling is ignored and optimistic estimates of aggregate productivity growth are used. The cost of reducing class size would be better spent on giving children a savings account. These calculations are too optimistic because they understate the full costs of the policy, which would entail substantial increases in teacher salaries to hire the new teachers, or lower the quality of teachers hired into the school system.[45]

The celebrated Tennessee Star experiment produced, at best, marginal gains to participants that did not survive a rigorous cost benefit analysis (see the discussions in Hanushek; and Krueger). The widely discussed policy of improving schools by reducing pupil-teacher ratios is unlikely to have substantial benefits unless the quality of the input going to school is improved (see Carneiro and Heckman, 2003). The importance of family to the success in schools has been known since the Coleman Report, but this wisdom has not yet found its way into policy.

Tuition and family income support for families of children in the college-going years are often proposed. The basis for this policy recommendation is the empirical regularity that child college-going rates are inversely related to family income in the college-going years. This empirical association is treated as a causal relationship which should guide policy. Politicians around the world campaign on this issue. The recent literature, surveyed in Carneiro and

Heckman (2002, 2003), documents that at most 8% of American children are cash-constrained in the college-going years. While a policy targeted to the cash-constrained has a high economic return, it will not go far in promoting college attendance or reducing schooling among racial and ethnic groups.

As Carneiro and Heckman (2003), Cunha, et al. and Cunha and Heckman (2007) document, the real credit constraint facing children is *not* the lack of access to funds for tuition and room and board in the college-going years. Rather, it is the inability of children to borrow against future income to buy a parental environment that will allow them to fulfill their potential. It is the accident of birth.

The empirical regularity that drives policy discussions has been misinterpreted. The widely discussed correlation between parental income in the child's college-going years and child college participation arises only because it is *lifetime resources* that affect college readiness and college-going, and family lifetime resources are strongly positively related to family resources available to the adolescent in the college-going years.

Government job training programs and GED programs are second chance efforts designed to remedy the deficits caused by early childhood and schooling neglect. The GED program does not confer benefits to very many of its participants (Heckman and LaFontaine, 2007). Job training programs targeted at the disadvantaged do not produce high rates of return and fail to lift participants out of poverty (See the evidence in Heckman, LaLonde and Smith; and in Martin and Grubb, 2001). At current levels of funding, these programs are largely ineffective and cannot remedy the skill deficits accumulated over a lifetime of neglect.

Cunha and Heckman (2007), and Cunha, Heckman, and Schennach formalize the technology of skill formation by families and estimate empirical models of dynamic skill formation. They show that investments in children are complementary and that early investments

improve the return on later investments. The self productivity of early investment warrants more investment in the young.

Their analysis shows that the young receive highest returns to a dollar of investment. Early skills breed later skills because early learning begets later learning. Both on theoretical and empirical grounds, at current levels of funding, investment in the young is warranted. Returns are highest for investments made at younger ages and remedial investments are often prohibitively costly. Figure 12 summarizes their model and the findings of an entire literature. Returns for disadvantaged children are highest for investments made at young ages. The optimal investment profile declines with age. This pattern is true for all children. But more advantaged children receive massive early investments from their parents that disadvantaged children do not receive. Figure 12 shows the returns for human capital programs for the disadvantaged at current levels of investment.

This literature *does not* suggest that no investments should be made in schooling or post-school on-the-job training. They are major sources of skill formation. Indeed, the complementarity or synergism between investments at early and later ages suggests that early investment has to be complemented by later investment to be successful. Currie and Thomas suggest that the effects of early investment will dissipate unless it is followed by later investment. If early investments are made, the returns to later investments will rise. Investment in the preschool years raises the productivity of schooling and post-school job training. Cunha and Heckman (2006) show that adolescent remediation for the effects of adverse early environments is very costly and Cunha and Heckman (2007) present an analytical synthesis of the literature.

However, the self-productivity of investment suggests that an optimal investment strategy should focus investments in the early years compared to the later years. Carneiro and Heckman (2003) argue as an empirical proposition in the U.S. that there is currently under-investment in

the young, especially in disadvantaged populations.[46]

Two matters of concern arise in using this evidence to guide policy. First, it is associational or correlational. It establishes empirical relationships that may or may not be causal. Second, while family factors matter, it is far from obvious how to improve families. We cannot easily raise the education of parents, nor can we improve their IQs.

The evidence presented in Armor, in figures 10-11, and in the other studies reviewed here suggests that early investment is productive. But traditionally, the early years of a child's life are the exclusive province of the family. The tough question is how to enrich the family and at the same time preserve the benefits of parents? An accumulating body of evidence on voluntary interventions points the way. We now turn to a review of the evidence on the benefits of these voluntary interventions.

In the past 40 years, many voluntary interventions have been devised to improve the early years of children by supplementing the resources of disadvantaged families. These family supplements do not actively intrude on family life, yet they enrich the early years of the child.

Some of these interventions have been implemented using random assignment. Packages of enriched environments are randomly assigned to children in disadvantaged environments, while children in comparable families are randomly denied access to the enriched treatment. When successfully implemented, randomization allows analysts to be more confident that the empirical associations produced by the interventions are causal. The findings from this experimental literature bolster the evidence from the associational literature that we have just discussed.

Evidence from Enriched Preschool Programs

Currie and Blau and Currie present comprehensive surveys of numerous preschool

programs and their measured effects.[47] The programs they analyze vary, both in terms of age of enrollment and age of exit. The effects, however, are generally consistent, although in some cases only weak effects are found. Generally, performance of children in school is improved in terms of less grade repetition, more graduation and higher test scores. Unfortunately, many of these programs are not evaluated by following children into late adolescence or adulthood and looking at their outcomes.

Three programs have long-term follow-ups, and we focus on them here. They all target high-risk children from disadvantaged families. The Chicago Child-Parent Centers (CPC), is a half-day program on a large scale in the Chicago public schools. It is evaluated by a non-experimental method (matching) and has a sample of about 1,500 children. The second program is the Abecedarian program, a full-day, year-round educational child care program in Chapel Hill, NC. It was evaluated by randomization and has 111 participants. Students are followed to age 21. Finally, the High/Scope Perry Preschool is a small-scale half-day program in the Ypsilanti, MI public schools. It was evaluated by experimental methods. Sample size is 123, and follow-up is to age 27. CPC and Perry had a parental involvement component — Abecedarian did not.

The programs differ by duration and child age of entry. Abecedarian started with young children in the first months of life. Perry and the CPC program start with older children, 3 or 4-5 years old. The programs differ in intensity.[48] It is also important to point out that the comparison made in all of the studies is between children with enriched preschool environments and children with ordinary early environments, some of whom may attend preschool and kindergarten, albeit of a less intense variety.[49]

Program Descriptions

Perry Preschool Experiment

The Perry preschool experiment was an intensive preschool program administered to randomly selected black children enrolled in the program over five different waves between 1962 and 1967. All the children came from Ypsilanti, MI. A control group provides researchers with an appropriate benchmark to evaluate the effects of the preschool program.

The assignment to the experimental group was performed in the following way. Candidate families were identified from a census of the families of the students attending the Perry school at the date of operation of the program, neighborhood group referrals and door-to-door canvassing. Poor children who scored between 75 and 85 on the Stanford-Binet IQ test were randomly divided into two undesignated groups.[50] The children were then transferred across groups to equalize the socioeconomic status, cognitive ability (as measured by the IQ test) and gender composition of the samples. Finally, a coin was tossed to determine which group received the treatment and which did not. Initially the treatment and control groups included 64 children each, but the actual treatment and control groups contained 58 and 65 children, respectively.[51]

Children entered the Perry School in five waves, starting with wave zero (of four-year-olds) and wave one (of three-year-olds) in 1962, and then waves two, three and four (of three-year-olds) entered in each subsequent year through 1965. The average age at entry was 42.3 months. With the exception of wave zero, treatment children spent two years attending the program. In the final year of the program, 11 three-year-olds who were not included in the data attended the program with the 12 4-year-olds who were. About half of the children were living with two parents. The average mother was 29 years old and completed 9.4 years of school.

The treatment consisted of a daily 2 1/2 hour classroom session on weekday mornings and a weekly ninety-minute home visit by the teacher on weekday afternoons to involve the mother in the educational process. The length of each preschool year was 30 weeks, beginning in mid-October and ending in May. Ten female teachers filled the four teaching positions over the course

of the study, resulting in the average child-teacher ratio of 5.7 for the duration of the program.[52] All teachers were certified to teach in elementary, early childhood or special education.[53] If it were administered today, the Perry preschool program would cost approximately $9,785 per participant per year in 2004 dollars.

Abecedarian Project

The Abecedarian Project recruited 111 children born between 1972 and 1977 whose 109 families scored high on the High Risk Index.[54] It enrolls and intervenes in the lives of children beginning a few months after birth. Enrollment is based on the characteristics of the families more than on those of the children, as in the Perry program. Virtually all of the children were Black, and their parents had low levels of education, income, cognitive ability and high levels of pathological behavior. The children were screened for mental retardation. 76% of the children lived in a single parent or multigenerational household. The average mother in this group was less than 20 years old, completed 10 years of schooling and had an IQ of 85. There were four cohorts of about 28 students each. By the time they were 6 weeks old, the children were assigned randomly to either a preschool intervention or a control group. The mean age of entry was 4.4 months. At age 5—just as they were about to enter kindergarten—all of the children were reassigned to either a school age intervention through age 8 or to a control group. This produced 4 distinct groups: children who experienced no intervention at all, those who experienced an intervention when they were young, those who experienced an intervention when they were older; and finally, those who enjoyed a high-quality intervention throughout their whole childhood. The children were followed up until age 21.

The Abecedarian program was more intensive than the Perry program. Its preschool program was a year-round, full-day intervention. The initial infant-to-teacher ratio was 3:1,

though it grew to a child-to-teacher ratio of 6:1 as the kids progressed through the program. Infants in the control group received an iron-fortified formula for 15 months and diapers as needed to create an incentive for participation. Many of the control children were enrolled in preschool and/or kindergarten.

During the first three primary school years, a home-school teacher would meet with the parents and help them provide supplemental educational activities at home. The teacher provided a curriculum tailored specifically for each child. The target set for the parents was at least 15 minutes per day of supplementary activities. This home-school teacher would also serve as a liaison between the teachers and the family, and she would interact with the parents and the teachers about every two weeks. She would also help the family deal other issues that might improve their ability to care for the child, such as finding employment, navigating the bureaucracy of social services agencies, and transporting children to appointments. Data were collected regularly up to age 21. In terms of 2004 dollars, it cost roughly $15,000 per year.

Chicago Child-Parent Center and Expansion Program

The Chicago Child-Parent Center was not evaluated by the method of random assignment but by matching treated children to comparable nontreated children on the basis of age, eligibility for intervention, and family socioeconomic status. It was started in 1967, in 11 public schools serving impoverished neighborhoods of Chicago. Using federal funds, the center provided half-day preschool program for 3- and 4-year-olds during the 9 months that they were in school. The program provided an array of services, including health and social services, and free meals. It also sought to include the parents, including helping the parents complete school, home visits and field trips.

In 1978, state funding became available, and the program was extended through third

grade and included full-day kindergarten. Eventually, 24 centers provided preschool and after-school activities, up to second or third grade. This is the period during which the sample analyzed by Reynolds, et al. was enrolled in the program. The preschool program ran 3 hours per day during the week for the nine months that school was in session, and usually included a six-week summer program.

During the kindergarten years, more services were provided at the affiliated school. Teacher-child ratios were 17:2 for the preschool component and 25:2 for kindergarten. Participation during the primary years was open to any child in the school. Program participants experienced reduced class sizes of 25 rather than 35 or more. Teachers' aides, extra instructional materials, and enrichment activities were also available. Some children continued to participate in CPC through age 9, for a maximum of 6 years.[55] 93% of the children were black and 7% were Hispanic. Costs were considerably less, but intensity was correspondingly lower. (See Cunha et al.)

Lessons from Early Interventions

These and other studies of interventions for children from low-income families find that participants experienced higher achievement test scores, decreased grade retention, reduced time in special education, less crime and delinquency and increased high school graduation. The gains vary with quality and age at which the program is started, and there are important differences by the sex of the child.

Programs differ in the measures they use to evaluate the outcomes. As a result, it is hard to compare the programs using a standard basket of benefits. The CPC program had significant effects on high school graduation rates, reductions in special (remedial) education, grade repetition and juvenile arrest (figure 13).

The Perry Preschool Program is the flagship intervention. Children are followed through age 40, with data collected annually from ages 3-11, and again at ages 14, 15, 19, 27 and 40.[56] The boost in IQ faded by the time the children were in second grade (see figure 14a), but the program had substantial effects on educational achievement. Test scores for the treatment group were consistently and significantly higher through age 14, and as were literacy scores at 19 and 27. Participants had higher grades and were more likely to graduate from high school. Substantially less time was spent in special education or in repeating grades, and high school graduation rates of participants improved (figure 14b).

Participants were more likely to be employed, to earn more (figure 14c), and they were less dependent on welfare.[57] There was substantially less crime among participants (figure 14d)—both in terms of incidence and severity, a recurrent finding of early intervention programs (recall the evidence summarized in table 5). However, there was no significant difference in grade retention by age 27 between the two groups. Teenage pregnancy was lower, and marriage rates were higher by age 27 for program participants.

The Abecedarian program appears to have had an effect on IQ, but it is concentrated primarily among girls.[58] Figure 15a shows the overall IQ gap between treatments and controls. It is persistent over ages. The Abecedarian program intervenes in the very early years, and it is known that IQ is malleable when children are very young (see *e.g.*, Armor; and the references in Cunha and Heckman, 2007). This message is reinforced by the fact that the IQ boost was not found among children who only experienced the later intervention. Comparable effects are found for reading (figure 15b) and math achievement scores (figure 15c). The test score effects persist through age 21, which is the last age analyzed.

Figure 15d shows that there were substantial academic benefits. Treatment group members participated less in remedial special education at age 15 and repeated fewer grades at all

ages. High school graduation and four-year college participation rates were high. Participants were less likely to smoke and had better jobs (see figure 15e).

Table 7 presents estimated costs and benefits of the Perry and Chicago programs with benefits discounted at a 3% rate. All figures are in 2004 dollars. The benefits vary among programs.[59] Perry produced some gain to parents in terms of reduced child care costs, and earnings gains for participants were substantial. The K-12 benefit arises from the increment in student quality and is a reduction in special education costs. This benefit is substantial across all programs. The college/adult category represents the extra tuition paid by students who go to college. Crime represents the reduction in direct costs (incarceration and criminal justice system) as well as damage done to victims. This excludes transfers. Welfare effects are modest. Future Generation (FG) Earnings represents the improvement in the earnings of the children of the program participants. Smoking and health benefits were not measured in the Perry and Chicago data. For Abecedarian, there were substantial effects, including major differences in smoking rates. CPC documents a decline in child abuse and the costs of treating abused children. The costs of Perry are substantial but per year are about the average cost of expenditure on public school students. CPC per year costs about $6,796 for the preschool and $3,428 for the school-age component (in 2004 dollars). The reported benefit-cost ratios are substantial: 9 to 1 for Perry; 8 to 1 for Chicago CPC. Rolnick and Grunewald claim that the annual rate of return for Perry is 4% for participants and 12% for society at large, for a total of 16%.

Much more research is needed on Perry, CPC, and a wide variety of other early childhood program results.[60] Results from these programs need to be put on a common footing to understand better the differences in samples, treatments, and effects.[61] A much more careful analysis of the effects of scaling up the model programs to the target population, and its effects on costs, has to be undertaken before these estimates can be considered definitive.

The gain from the pilot programs is a lower bound on the potential benefit of intervening in the early years: although the costs are well established, many of the benefits cannot be precisely monetized. For instance, we do not yet have a full accounting of how the children of the participants will respond to the intervention, and neglecting this likely understates its effect. Extrapolating from old, small, and local programs to large, national ones in the future is precarious business—a fact often neglected in the early childhood literature. The benefits of these interventions appear to be sufficiently large that the actual or potential program may remain cost-effective even after a large reduction in its efficacy.

The Case for Early Intervention

Without claiming to offer a monolithic explanation for the origins of the major social problems discussed in this paper, we nonetheless point out the important role of disadvantaged families in producing less educated and less motivated persons and in producing persons more prone to participate in crime. A large literature establishes that children from disadvantaged homes are less educated and more likely to participate in social pathologies, including crime. In the past forty years or so, the American family has come under stress. Relatively more American children are being raised in the adverse environments that produce less educated and less skilled individuals and persons more likely to commit crime and participate in socially deviant behavior.

American society has traditionally appealed to the schools to remedy what failed families produce. Current policies such as the *No Child Left Behind Act* are premised on using schools to remedy the consequences of disadvantaged families. Schools can only work with what families give them. Successful schools are those that teach children from functioning families.

In addition, the current emphasis in American schools is on test scores, and tests ignore crucial noncognitive components of motivation, persistence and self-control that successful

families foster in their children. Both cognitive and noncognitive skills are important for success in school and in life.[62] The enriched early childhood interventions have had their greatest impacts on creating motivation and successful attitudes among participants — traits usually ignored in discussions of educational policy.

A large body of empirical work at the interface of neuroscience and social science has established that fundamental cognitive and noncognitive skills are produced in the early years of childhood, long before children start kindergarten. The technology of skill formation developed by economists shows that learning and motivation are dynamic, cumulative processes. [63] Schooling comes too late in the life cycle of the child to be the main locus of remediation for the disadvantaged. Public schools focus only on tested academic knowledge and not the noncognitive behavioral components that are needed for success in life. Schools cannot be expected to duplicate what a successfully functioning family gives its children. Parental environments play a crucial part in shaping the lives of children.

Later remediation of early deficits is costly, and often prohibitively so.[64] Remedial schooling, public sector job training programs, and second chance GED programs are largely ineffective at current levels of funding. While these programs can be improved, and do help a few, they are not cost-effective when compared with alternative policies.

Families matter. But most Americans are justifiably reluctant to intervene in the early years and prefer to respect the sanctity of the family. In the past forty years, American society has experimented with voluntary enriched family supplementation programs, which offer children from disadvantaged environments some of the cognitive and emotional stimulation and enrichment given by more advantaged families.

Children who received these enriched environments were followed into adulthood. Comparing their social and economic outcomes to those of similar children denied access to these

environments by randomization, one finds that the treated children perform better at school, are less likely to drop out of school, and are more likely to graduate high school and to attend college. The treated children are less likely to be teenage mothers and foster a new generation of deprived children. They are less likely to be on welfare and less likely to smoke or use drugs. Treated students have higher test scores. A principal benefit of early childhood intervention is in shaping the noncognitive skills - behavior, motivation and self control - that are not considered an important outcome of the schooling curriculum in current policy discussions.

The estimated rate of return to the Perry preschool program is about 16%. This includes benefits from reduced remediation and reduced crime, as well as the increased earnings of the participant. All of the children targeted for intervention are of low ability. While much work remains to be done to bolster the case for wide-scale application of these programs to disadvantaged families, the current evidence is powerfully suggestive, if not yet definitive, that large-scale programs will be effective. None of this evidence supports universal preschool programs.

It is important to note what we are not saying. We do not claim that all skills and motivations are formed in the early years, nor that schools and firms do not matter in producing effective people. We are also not offering any claims that the early years are the sole determinants of later success, or that persons who are raised in disadvantaged families should be absolved of any guilt when they participate in crime. We are simply arguing that early environments play a large role in shaping later outcomes and that their importance is neglected in current policy. The recent evidence on the technology of human skill formation establishes that enriched early environments need to be followed up by good schooling and workplace learning environments. Complementarity of investments at different ages is an intrinsic feature of the human skill formation process. Enriching the early years will promote the productivity of schools

by giving teachers better-quality students. Improving the schools will in turn, improve the quality of the workforce.

The available evidence on the technology of skill formation shows the self-productivity of early investment. Figure 12 summarizes the argument. At current levels of public support, America under-invests in the early years of its disadvantaged children. Redirecting funds toward the early years is a sound investment in the productivity and safety of American society, and also removes a powerful source of inequality.

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Footnotes

[1] Nontraditional families include single-parent families and families where the parents are not married. The evidence summarized below shows that children raised in nontraditional families fare worse in many aspects of social and economic life.

[2] Ventura and Bachrach, who use data from birth certificates, estimate that nonmarital childbearing is considerably higher then the number reported in this paper. In recent years, their estimate is approximately 10 percentage points higher than what we report here. However, their data does not contain much background information on the mothers, so it is less useful for the type of analysis that we want to perform. Hence we will use the more conservative estimate.

[3] See, e.g., Mazumder and the other essays in Bowles, Gintis, and Osborne Groves.

[4] See Trennert on The Phoenix Indian School, and Mayer on the oscillation of American policy between improving the material condition of the poor family and replacing it with surrogate institutions like orphanages and foster care.

[5]See Katz and Autor for a review of the evidence on skill-biased technological change. For international evidence, see Machin and Van Reenen.

[6] See Figures A1 and A2 in our web appendix. Figures and tables that have a prefix "A" in the numbering are from the web appendix, which is available from http://jenni.uchicago.edu/Invest/.

[7]The GED is an exam-certified, alternative high school degree.

[8]The share of labor is 0.7 so $0.7 \times 0.5 = 0.35$ is the contribution of workforce quality to economic growth.

[9]The International Adult Literacy Survey (IALS) was conducted by 13 countries to collect information on adult literacy. In this survey, large samples of adults (ranging from 1,500 to 6,000 per country) were given the same broad test of their literacy skills between 1994 and 1996. Australia, Belgium (Flanders), Canada, Germany, Great Britain, Ireland, Netherlands, Northern Ireland, New Zealand, Poland, Sweden, Switzerland and the United States participated in the IALS. More information on the IALS is available in documents located at http://www.nald.ca/nls/ials/introduc.htm and IALS.

[10]Data on these two scales appear in figures A3a and A3b on the web. Prose literacy is defined as the knowledge and skills required to understand and use information from texts such as newspaper articles and fictional passages. Quantitative literacy (numeracy) is defined as the ability to perform arithmetic operations (either alone or sequentially) to numbers embedded in printed materials, such as calculating savings from an advertisement or the interest earned on an investment.

[11]These cross-country differences are not driven by illiterate immigrants coming to the U.S. While immigrants perform worse on the three tests relative to natives, including immigrants in the analysis only raises the proportion of U.S. females in Level 1

significantly for prose, quantitative and document literacy. The difference is not significant for any other group or level.

[12]These trends are documented at our website. See figures A4a-44c.

[13]See table A1.

[14]The extra year of school is assumed to take place during high school years. The effect of an extra year of kindergarten or college is likely to be rather different.

[15]Lochner and Moretti use estimates of victim costs and property losses taken from Miller, Cohen, and Wiersema, which are based on jury awards in civil suits. Some costs cannot be quantified accurately or are unobservable. These include costs of precautionary behavior, private security expenditures, some law enforcement and judicial costs (*i.e.*, costs that are not related to dealing with particular crimes) and the cost of drug offenses. Some crimes are also omitted from the analysis.

[16]Incarceration cost per crime is equal to the incarceration cost per inmate multiplied by incarceration rate for that crime (approximately $17,000).

[17]It is important to note that this is a steady state calculation. The payoff to pre-K interventions shows up 10-15 years later, whereas the effects of increasing police on crime are more immediately realized. The discounted returns from the two policies are less different, but a 5:1 gap can tolerate a lot of discounting and still be substantial.

[18]Lochner and Moretti actually present a comparison of flow costs ($80,000 per year on a police officer) with a one time stock cost ($600,000 to educate 100 new high

school students at a cost of $6,000 per year assuming that dropouts get 11 years of school). Cameron and Heckman (2001) estimate 10.6 years. Assuming a 40-year working life (including criminal career life) the annual replacement flow cost is $15,000 a year ($6,000×2.5). Even cutting the career life in half produces a flow cost that is less than hiring a policeman. Spending $9,000 per year (to account for the 1.5 year gap between high school dropouts and graduates) still makes education cost effective. The evidence from the Perry Preschool Program suggests that our calculation is conservative. At a cost of $9,000 (2004) per participant, the high school graduation rate was raised by .17 from .60. To get 2.5 more students to graduate requires that we spend only $5300 per pupil. Foregone earnings in high school are small and are offset by the rise.

[19] See Figure A5a.

[20]See Federal Interagency Forum on Child and Family Statistics for more details.

[21]See Figure A5b.

[22]Ginther and Pollak summarize the evidence succinctly and present a more nuanced analysis of family types on adverse outcomes.

[23]See Ventura and Bachrach. See figure A5c.

[24]The corresponding birthrate for married women in these three years was 93.2, 83.8 and 87.3.

[25]See figure A5d.

[26]Birthrates by age within race/ethnic groups show essentially the same patter as the overall rated by race/ethnicity.

[27]See figure A5e.

[28]See Figure A5f.

[29]See Figure A5g.

[30]See Table A2, where we reproduce her results.

[31]See Table A3a.

[32]See Table A3b.

[33]See Table A3c.

[34]See Table A3d.

[35]See Table A3e.

[36]See Table A4a.

[37]See Table A4b.

[38]See Table A4c.

[39]See Table A5.

[40]Figures A6a-c in the web appendix show the same pattern for other levels of educational attainment like high school graduation and college attendance.

[41]Figures A8a-c in the web appendix show the same pattern for other reproductive outcomes.

[42]The test measures age-appropriate math knowledge.

[43]Figures A9a-d repeat this analysis for different race and income groups.

[44]Figures A10a-d repeat this analysis for different race and income groups.

[45]The recent California initiative to reduce pupil-teacher ratios ended in widely acknowledged failure (Stecher and Bohrnstedt).

[46]See Figure A11 for a diagram of the investment profile.

[47]Table A6, from Currie, describes some of the main programs, evaluated by randomized assignment, and their consequences. Table A7 shows the effects of large-scale public early childhood programs which were not evaluated by randomized assignment.

[48]See Table A8.

[49]Arguably the experimental studies understate the value of early childhood interventions against "no intervention" because some of the control group children received treatment. See Heckman, LaLonde, and Smith for an additional discussion of randomization.

[50]Poverty status was determined by a formula that considered rooms per person in the child's household, parental schooling and occupational level. The IQ range was labeled as "borderline educable mentally retarded" by the state of Michigan at the time of the experiment. Only children without an organic mental handicap were included in the study.

[51]Some aspect of the assignment was clearly nonrandom. First, younger children were assigned to the same group as their older siblings. Two treatment children were transferred to the control group because their mothers were not able to participate in any classes or home visits because they were employed far from home. Four treatment children left the program before completing the second year of preschool when their families relocated and one control child died. Thus, the final sample consisted of 123 children came from 100 families. In the control group, 41 families contributed 1 child each, and 12 families contributed 2 children each. In the treatment group, 39 families contributed 1 child apiece, 6 families contributed 2 children apiece, 1 family contributed 3 and another 4 children. Assigning younger siblings to the same group effectively made the family, rather than the individual, the unit of analysis. Still, it is difficult to argue that assigning siblings at random would have been a better strategy. So-called spillovers to the control siblings from home visits would have been one possible source of bias since mothers cannot be expected to treat siblings in accordance with their experimental status. Another potential source of bias is spillover from one sibling to another. In any case, differences in background characteristics between the two experimental groups are virtually nonexistent, with the exception of much higher rates of maternal employment at program entry in the treatment group.

[52]This number is low relative to other early education experiments. For instance, the student-teacher ratio for the Chicago Child-Parent Center and Expansion Program ranged from 8 to 12 (see Fuerst and Fuerst).

[53]Schweinhart, Barnes, and Weikart argue that the certification of the teachers is an important component in the success of the Perry preschool.

[54]The factors that were considered consisted of weighted measures of maternal and paternal education levels, family income, absence of the father from the home, poor social or family support for the mother, indication that older siblings have academic problems, the use of welfare, unskilled employment, low parent IQ, family members who sought counseling or support from various community agencies. Parental income and education were considered most important in calculating the index.

[55] These costs depend on the stage of the program and are presented in detail in the next section.

[56]See Schweinhart, et al. for a summary of results up through age 40.

[57]The difference in employment rates was only significant at age 19.

[58]Heckman notes that the Perry program tends to show stronger effects for girls than boys.

[59] There is a cost benefit study of the Abecedarian program (Barnett and Masse), but it is highly speculative, so that we did not include it here.

[60]Heckman, et al. present a comprehensive reanalysis of the Perry program. Similar reanalyses are being conducted for each major intervention.

[61]This task is being undertaken by a consortium housed at the Harris School, University of Chicago.

[62]See the evidence in Heckman, Stixrud, and Urzua.

[63]See Cunha et al. for a summary of this evidence and Knudsen, et al.

[64]See the evidence in Cunha and Heckman (2006).

Table 1. Characteristics of the labor force aged 25 and over and components of change 1980, 2000, 2020
(Millions of workers)

Age	Labor Force in 1980	Growth 1980 – 2000	Labor Force in 2000	Growth 2000 – 2020	Labor Force in 2020
25 – 54	65.0	35.1	100.1	3.0	103.1
55 - 64	11.8	2.2	14.0	12.5	26.5
65 +	3.0	1.4	4.4	4.0	8.4
Total	*79.8*	*38.7*	*118.5*	*19.4*	*137.9*
Race/Ethnicity/Nativity					
White Non-Hispanic – Native	63.0	21.5	84.5	2.6	87.1
Black Non-Hispanic – Native	7.6	4.6	12.2	2.8	15.0
Hispanic – Native	2.5	2.3	4.8	6.8	11.6
Other Non-Hispanic – Native	0.8	1.0	1.8	1.2	3.0
Hispanic – Foreign Born	1.8	4.5	6.3	2.8	9.1
Non-Hispanic – Foreign Born	4.1	4.8	8.9	3.3	12.2
Total	79.8	38.7	118.5	19.4	137.9
Summary					
Native White Workers 25 - 54	50.8	19.3	70.1	-7.7	62.4
Native White Workers 55 & Over	12.2	2.2	14.4	10.3	24.7
Workers of Color 25 – 54	9.4	7.3	16.7	7.7	24.4
Workers of Color 55 & Over	1.6	0.5	2.1	3.0	5.1
Foreign Born Workers	5.9	9.4	15.3	6.0	21.3
Total	*79.8*	*38.7*	*118.5*	*19.4*	*137.9*

Source: Ellwood (2001)

Table 2. Educational characteristics of the labor force aged 25 and over: 1980, 2000 and 2020

	Labor Force in 1980	Growth 1980 – 2000	Labor Force in 2000	Growth in 2000 – 2020	Labor Force in 2020
Education					
Less than High School	17.3	-5.3	12.0	0.9	12.9
High School Only	31.5	6.3	37.8	3.8	41.6
Some Schooling Beyond High School	13.8	19.1	32.9	6.2	39.1
College Degree or More	17.3	18.5	35.8	7.7	43.5
Total	*79.8*	*38.7*	*118.5*	*18.6*	*137.1*
% with College Degree	21.6%		30.2%		31.7%

Note: Assumes that subsequent cohorts have same education at age 25 as the cohort age 25 in 2000.
Source: Ellwood (2001).

Table 3. Aggregate Burden of Crime

Crime-induced Production ($ billion)	464
Opportunity Costs ($ billion)	152
Risks to Life And Health ($ billion)	672
Transfers ($ billion)	706
Gross Burden ($ billion)	1,995
Net of Transfers ($ billion)	1,289
Per Capita ($)	4,818

Source: Anderson (1999). All figures inflated to 2004 dollars using the CPI.

Table 4. Effects of early intervention programs

Program/Study	Cost*	Program Description	Pre-delinquency Crime
Abecedarian Project** (Ramey, et al., 1988)	N/A	Full-time year round classes for children from infancy through preschool	No effect
Houston PCDC** (Johnson, 1988)	N/A	Home visits for parents for 2 yrs; child nursery care 4 days per week in year two (Mexican Americans)	Rated less aggressive and hostile by mothers (ages 8-11)
Perry Preschool Program** (Schweinhart, Barnes, & Weikart, 1993)	$19,162	Weekly home visits with parents; intensive, high quality preschool services for one to two years	2.3 vs. 4.6 lifetime arrests by age 27; 7% vs. 35% arrested 5 or more times
Syracuse University Family Development (Lally, Mangione and Honig, 1988)	$54,483	Weekly home visits for family; day care year round	6% vs. 22% had probation files; offenses were less severe
Yale Experiment	$33,319	Family support; home visits and day care as needed for thirty months	Rated less aggressive and pre-delinquent by teachers and parents (age 12½)

Note: All comparisons are for program participants versus non-participants. [a]Costs valued in 2004 dollars. [b]Studies used a random assignment experimental design to determine program impacts. Data from Donohue and Siegelman (1998), Schweinhart, Barnes and Weikart (1993), and Seitz (1990) for the impacts reported here. N/A indicates not available.

Source: Heckman, Lochner, Smith and Taber (1997).

Table 5. Estimated social benefits of increasing high school completion rates by 1 percent

	Estimated Change In Crime	Social Benefits
Violent Crimes:		
Murder	-373	$1,457,179,565
Rape	1,559	-$179,450,969
Robbery	918	-$11,116,176
Assault	-37,135	$475,045,373
Property Crimes:		
Burglary	-9,467	$12,052,009
Larceny/Theft	-35,105	$8,958,962
Motor Vehicle Theft	-14,238	$22,869,192
Arson	-469	$23,637,635
Total:	-94,310	$1,809,175,590

Notes: Victim costs and property losses taken from Table 2 of Miller *et al.*(1996). Incarceration costs per crime equal the incarceration cost per inmate, $17,027 (U.S. Department of Justice, 1999), multiplied by the incarceration rate (U.S. Department of Justice, 1994). Total costs are calculated as the sum of victim costs and incarceration costs less 80% of the property loss (already included in victim costs) for all crimes except arson. Total costs for arson are the sum of victim costs and incarceration costs since there is no transfer of property between victim and criminal. Estimated changes in crimes adjust the arrest effect by the number of crimes per arrest. The social benefit is the estimated change in crimes times the total cost per crime. All dollar figures are adjusted to $2004 using the CPI. Source: Lochner and Moretti (2004).

Table 6. Evaluating school quality policies: discounted net returns to decreasing pupil-teacher ratio by 5 pupils per teacher for people with 12 years of schooling in 1990

	Productivity Growth Rate	Includes 50% Social Cost of Funds	Annual Rate of Return to Earnings from School Quality Change: 1%	2%
7% Discount Rate				
	0%	Yes	-9056	-8092
	0%	No	-5716	-4752
	1%	Yes	-8878	-7736
	1%	No	-5538	-4396
5% Discount Rate				
	0%	Yes	-9255	-7537
	0%	No	-5597	-3880
	1%	Yes	-8887	-6802
	1%	No	-5230	-3145
3% Discount Rate				
	0%	Yes	-8840	-5591
	0%	No	-4810	-1562
	1%	Yes	-8036	-3984
	1%	No	-4007	45

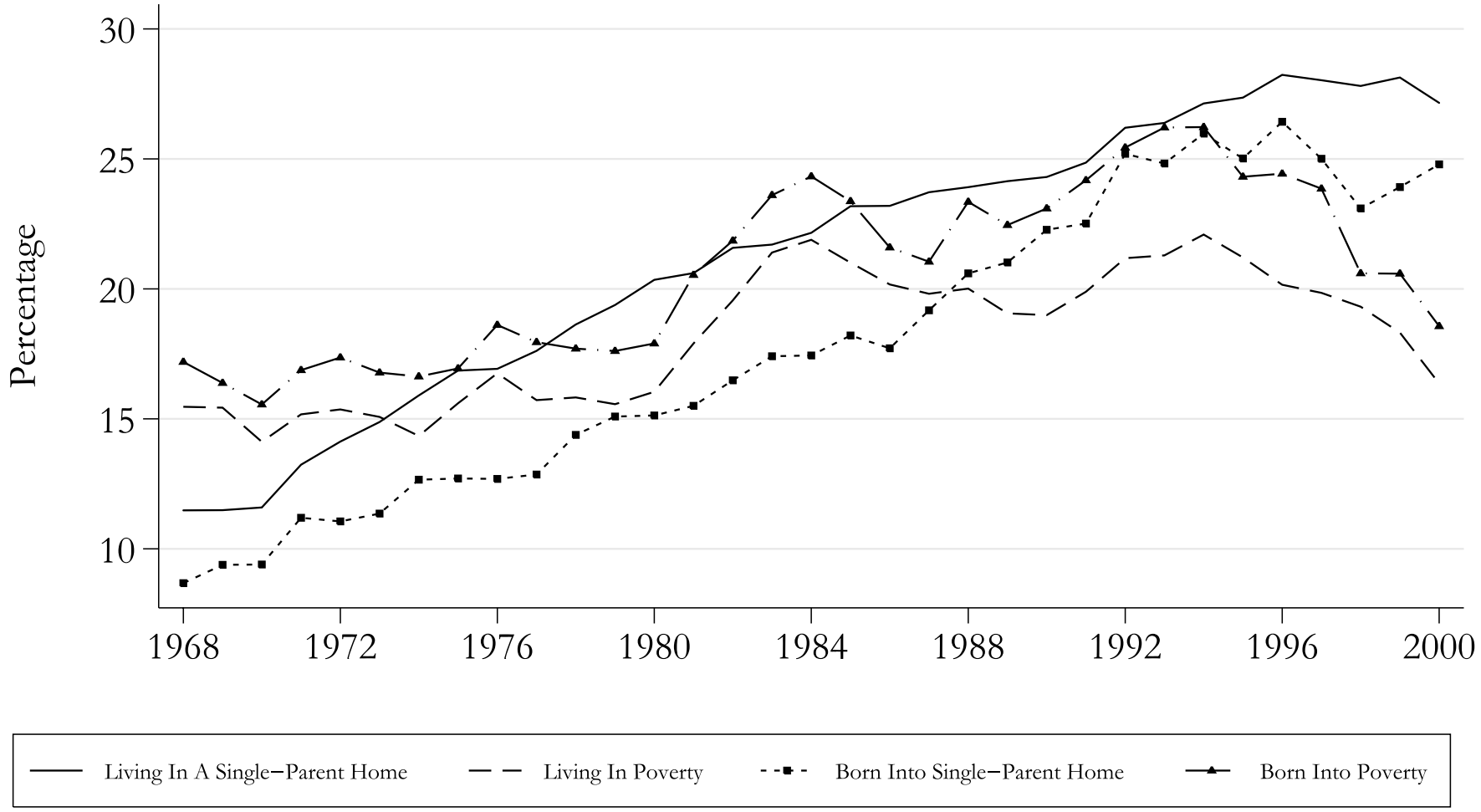
Note: All values, in 1990 dollars, are given as net present values at age 8 of an individual; costs of schooling improvements are incurred between ages 6 and 18 and benefits from increased earnings occur between ages 19 and 65. Data for costs are from NCES 1993. Costs of adding new teachers include salaries and capital, administrative, and maintenance expenditures. Estimates of increases in earnings resulting from a decreasing the pupil-teacher ration by 5 pupils per teacher come from Card and Krueger (1992, table 3) which produces a range of estimated earnings increase from about 1 to 4 percent, whereas most of the estimates are in the 1 to 2 percent range, which we use in this paper. To capture the benefits of smaller class sizes, students must attend twelve years of higher-quality schooling. We calculate the costs for one year of improvements and then calculate the present value of the costs over the twelve years of school attendance.

Table 7. Economic benefits and costs

	Perry Preschool	Chicago CPC
Child Care	986	1916
Earnings	40537	32099
K-12	9184	5634
College/Adult	-782	-644
Crime	94065	15329
Welfare	355	546
Future Generation Earnings	6181	4894
Abuse/Neglect	0	344
Total Benefits	150525	60117
Total Costs	16514	7738
Net Present Value	134011	52038
Benefits-to-Costs Ratio	9.11	7.77

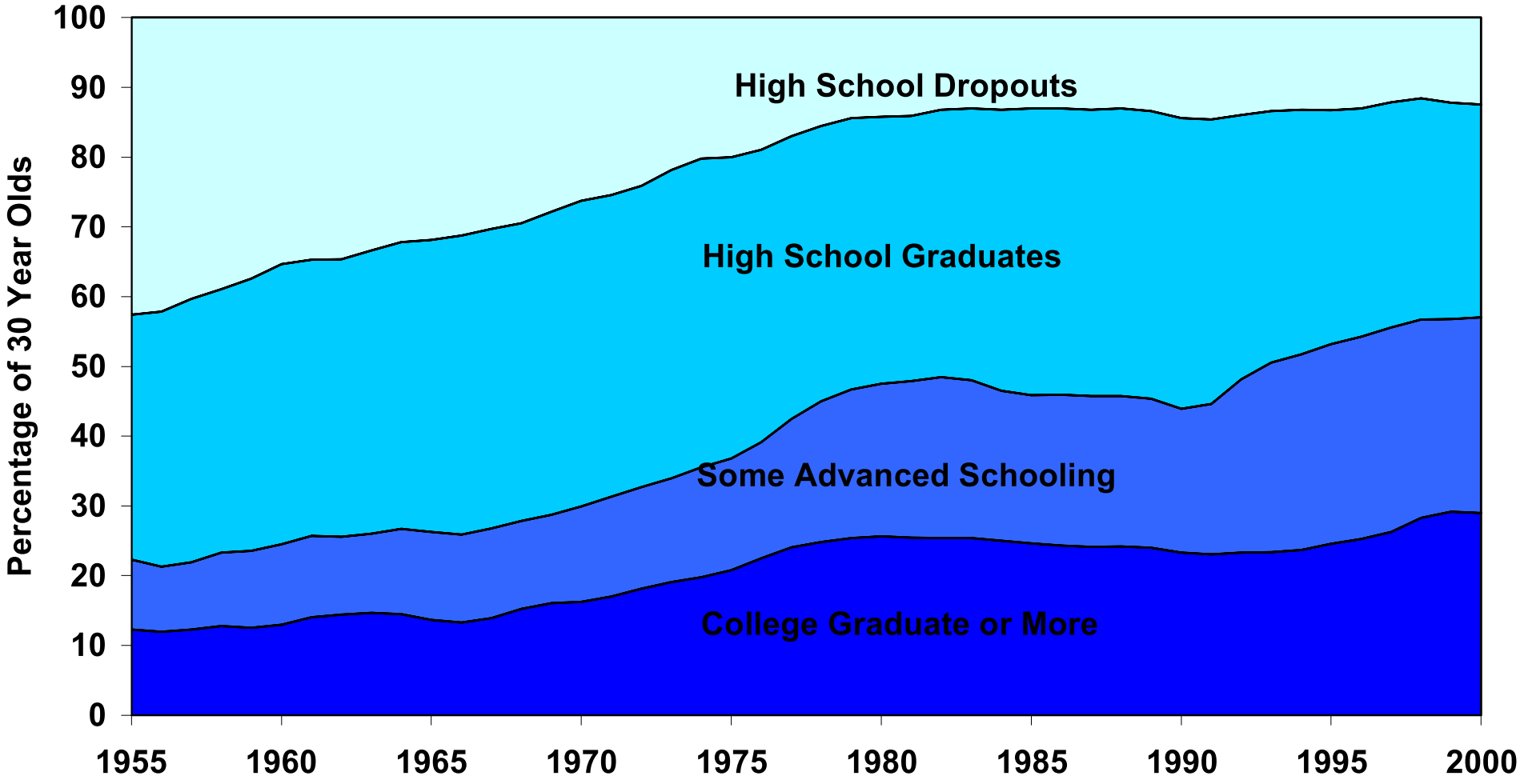
Notes: All values discounted at 3% and are in 2004 dollars. Numbers differ slightly from earlier estimates because Future Generations (FG) Earnings for Perry and CPC were estimated using the ratio of FG Earnings Effect to Earnings Effect (about 15%) that was found in Abecedarian.
Source: Barnett (2004).

Figure 1. Percentage of all children born or living in adverse environments in each year, 1968–2000



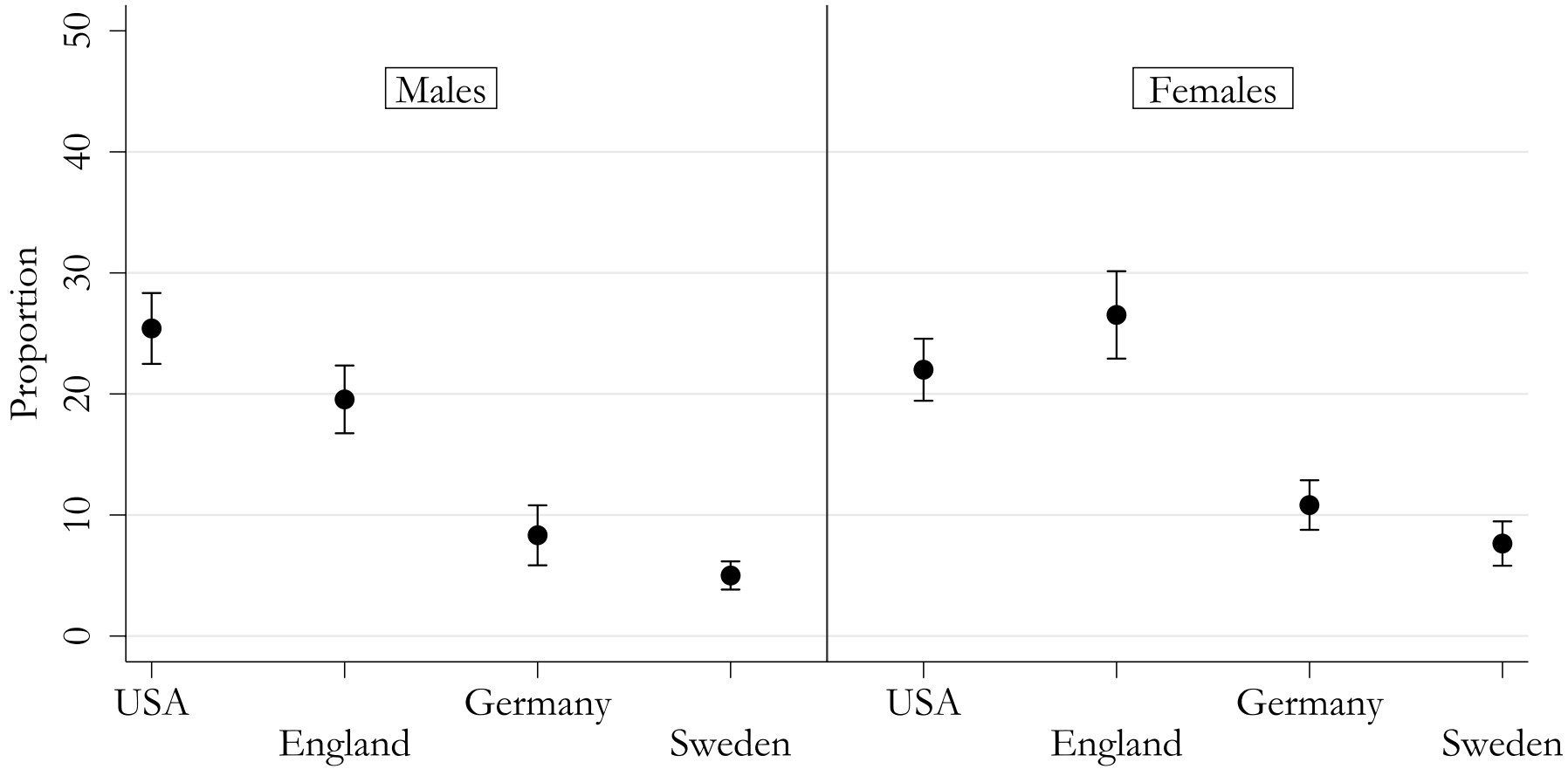
Source: Current Population Survey Annual March Supplement, 1968–2000. Poverty is defined as living in a household with income below the federal poverty line, which is adjusted for age and number of family members. Single–parent homes include cohabiting partners.

Figure 2. Percent distribution of education among 30 year olds by year



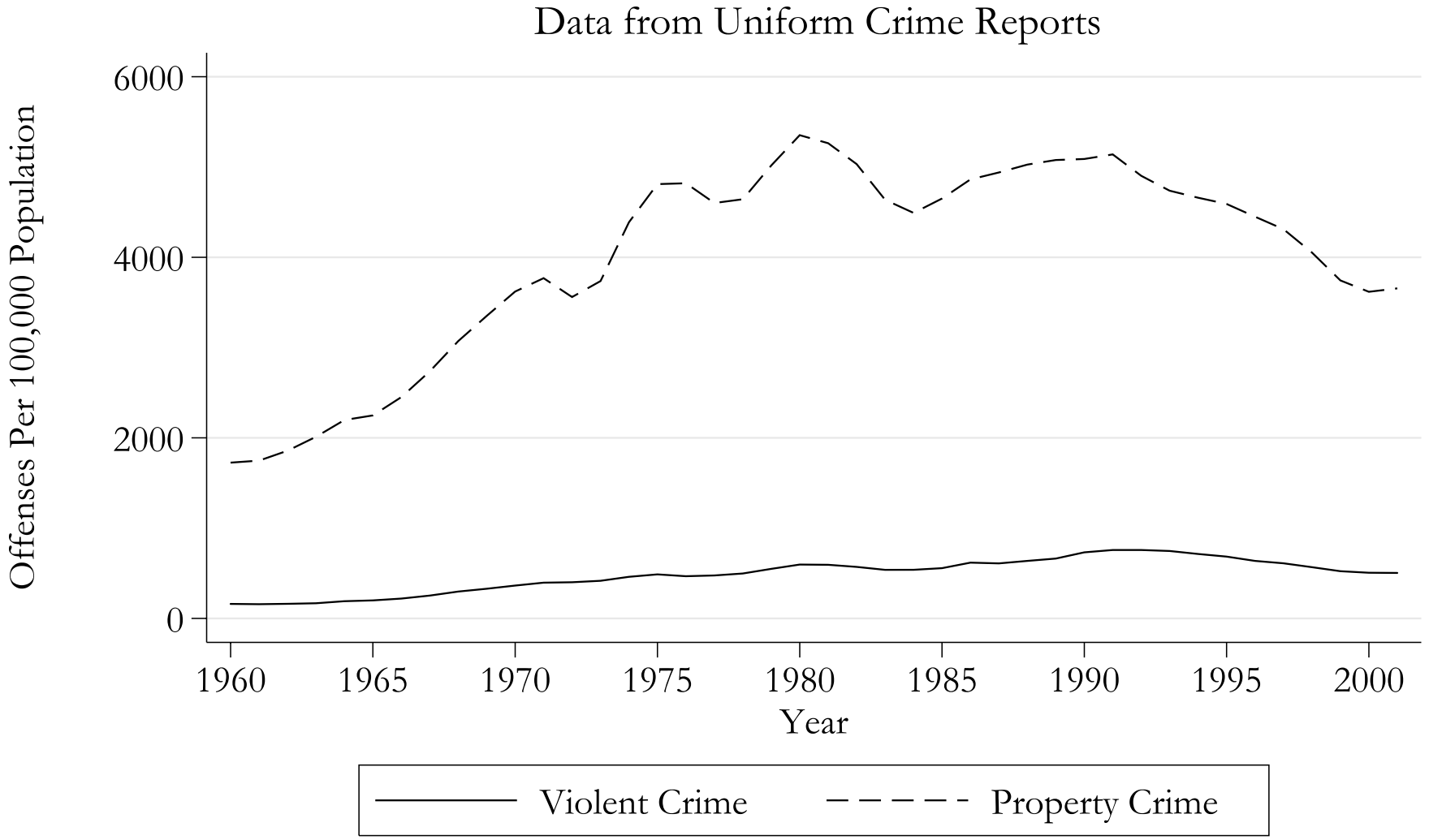
Source: Annual March CPS Data. Three Year Centered Moving Averages (Ellwood, 2001)

Figure 3. Percentage of each gender who perform at level 1 on the IALS document literacy scale



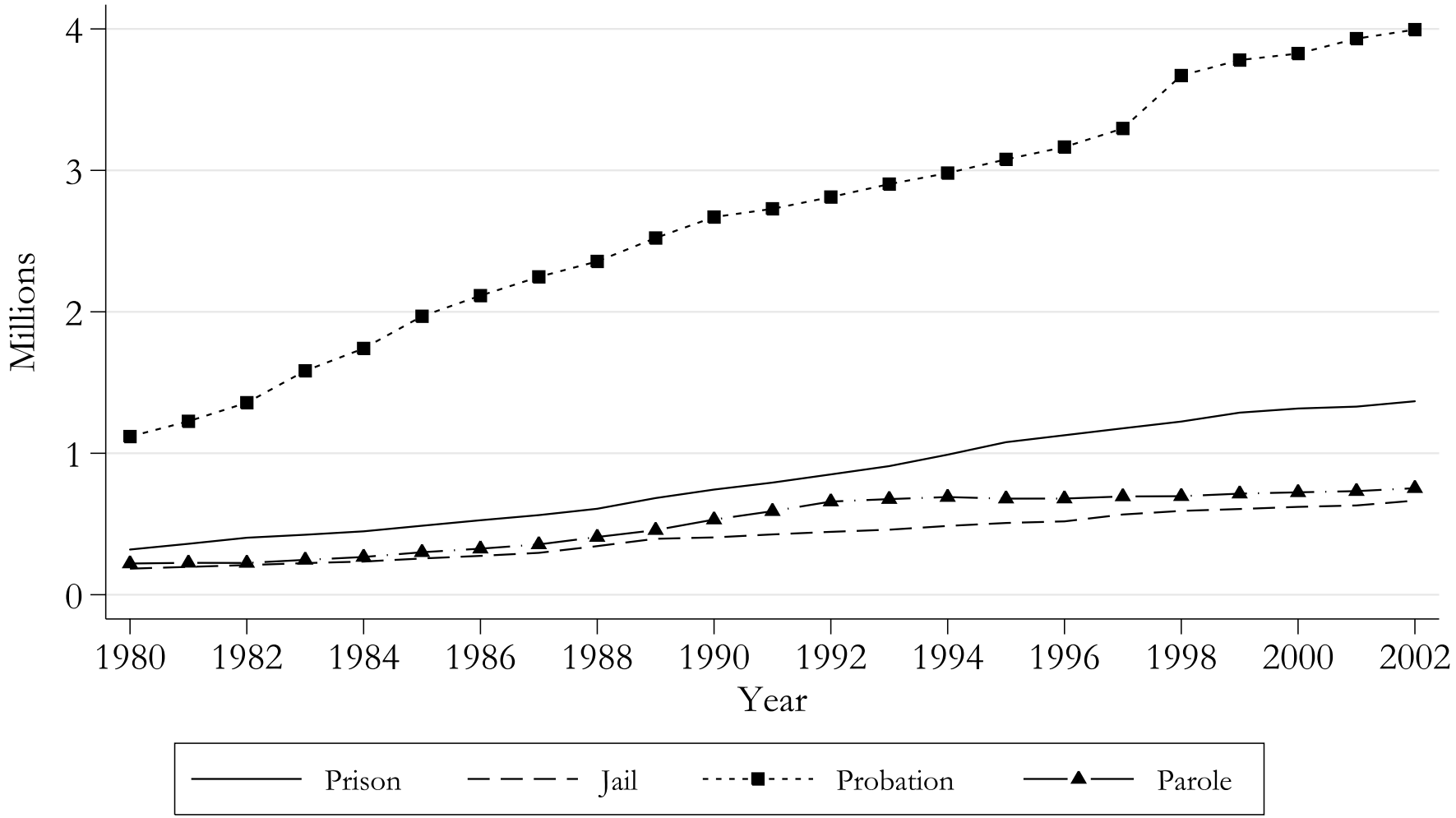
Note: The scale scores were grouped into five levels of increasing difficulty, with Level 1 representing functional illiteracy. Levels 4 and 5 were combined. The sample is restricted to adults who are between 16−65 years of age at the time of the survey (1994 for the US and Germany, 1996 for the UK, and 1994−1995 for Sweden). Standard errors are calculated using the methodology described in IALS (2002).

Figure 4a. Reported violent and property rates, 1991-2001



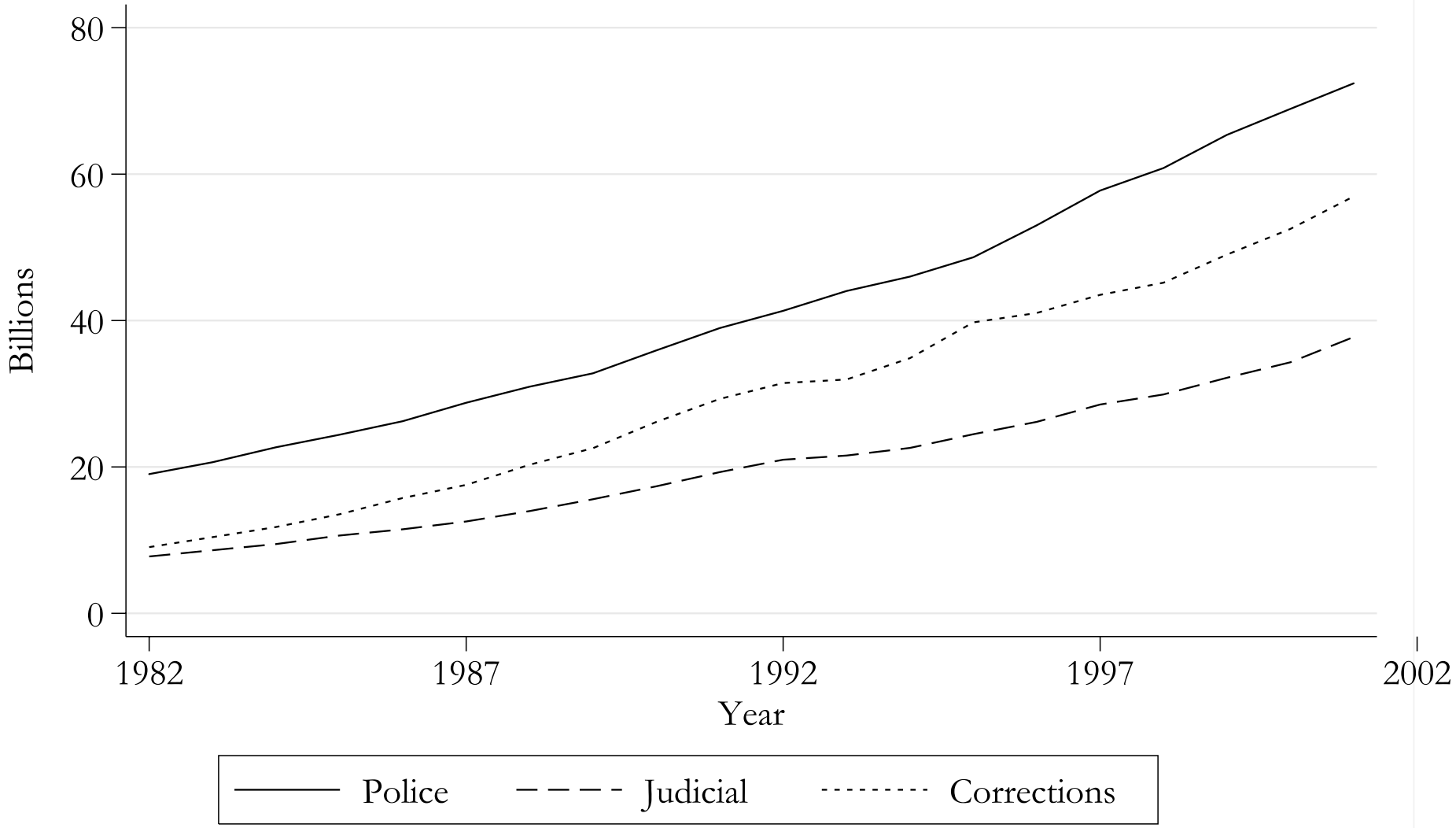
Note: The murder and nonnegligent homicides that occurred as a result of the events of September 11, 2001 are not included.

Figure 4b. Adult correctional population, 1980-2002



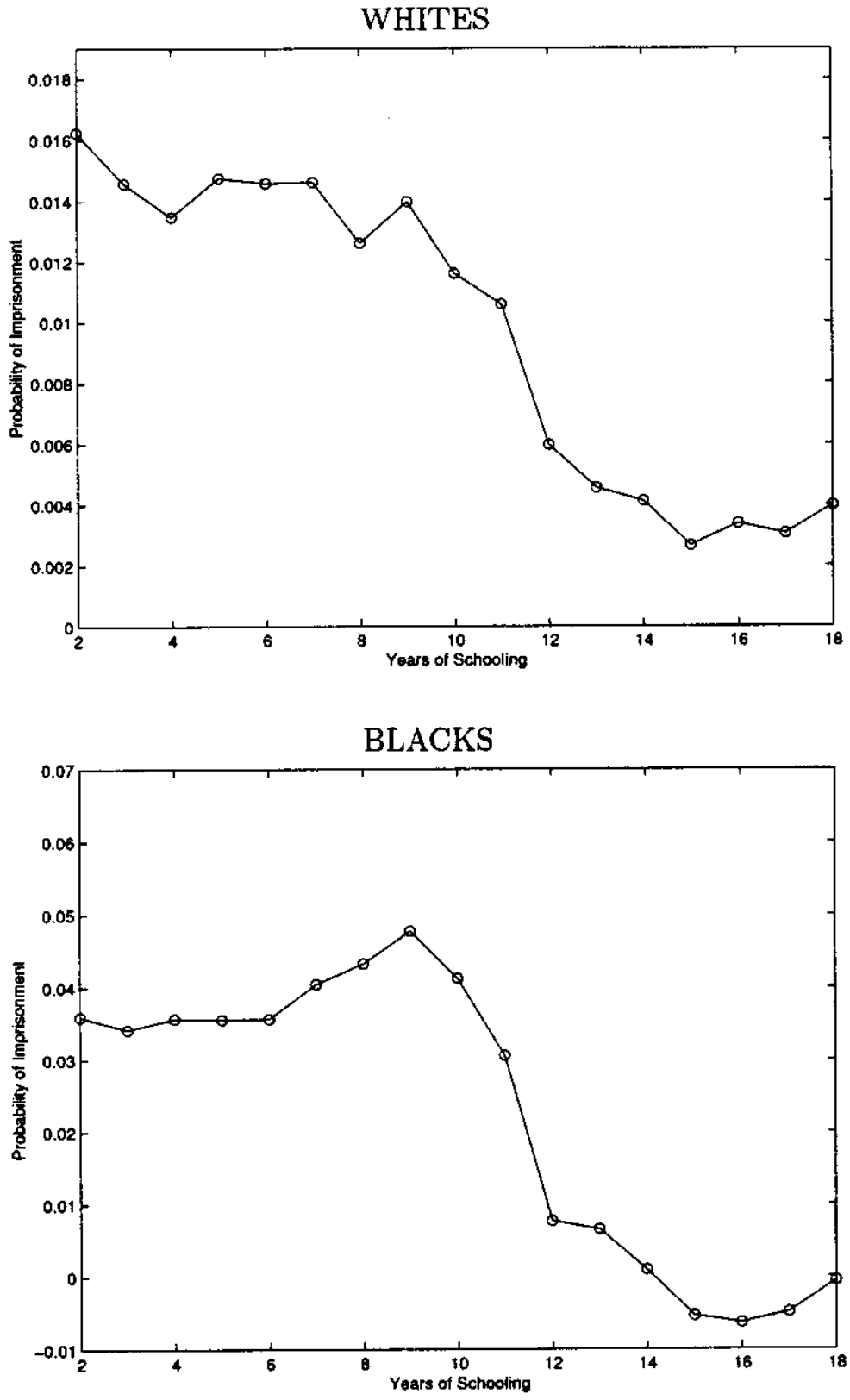
Note: Probation is court ordered community supervision. Prison consists of confinement in a state or federal correctional facility for more than 1 year or longer. Jail is confinement in a local facility while pending trial, awaiting sentencing, serving a sentence less than 1 year, or awaiting transfer to another facility after conviction. Parole is community supervision after a period of incarceration. Data from BJS Justice Expenditure and Employment Extracts.

Figure 4c. Total direct expenditures by criminal justice function, 1982-2001



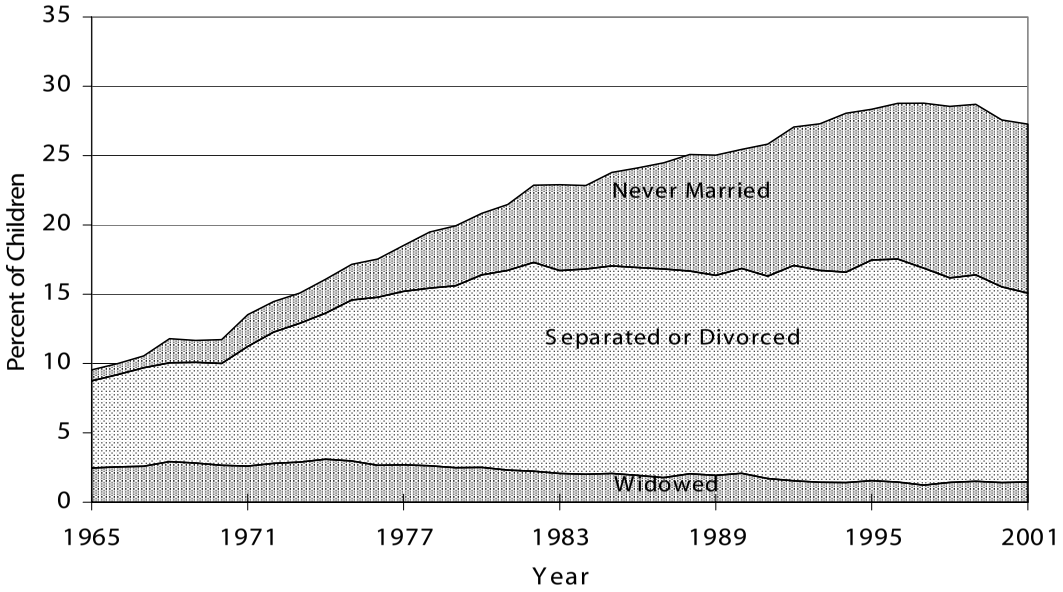
Source: Justice Expenditure and Employment Extracts.

Figure 5. Regression-adjusted probability of incarceration, by years of schooling



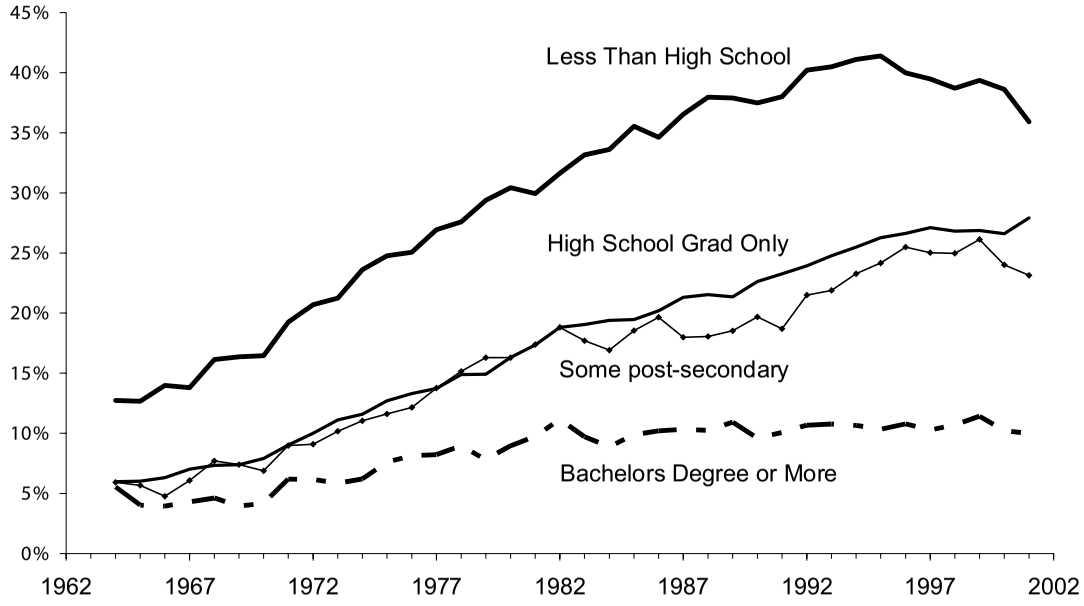
Source: Lochner and Moretti (2004)

Figure 6a. Percent of all children living with one parent by marital status of single parent



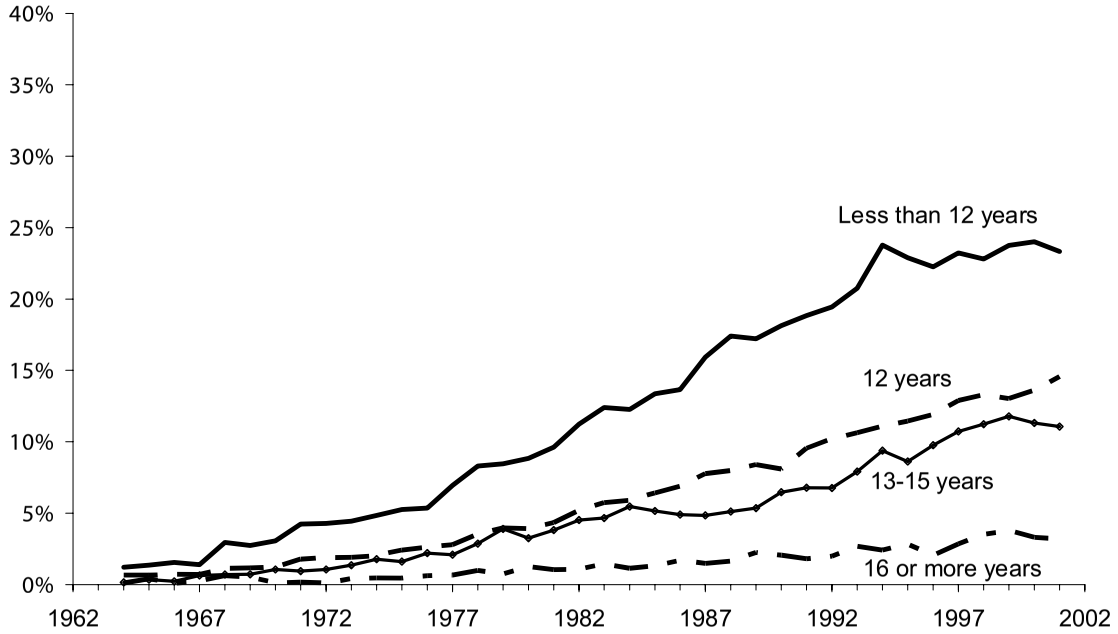
Source: Jencks and Ellwood (2004), using March Current Population Survey.

Figure 6b. Percent of children in single mother homes by education of the mother



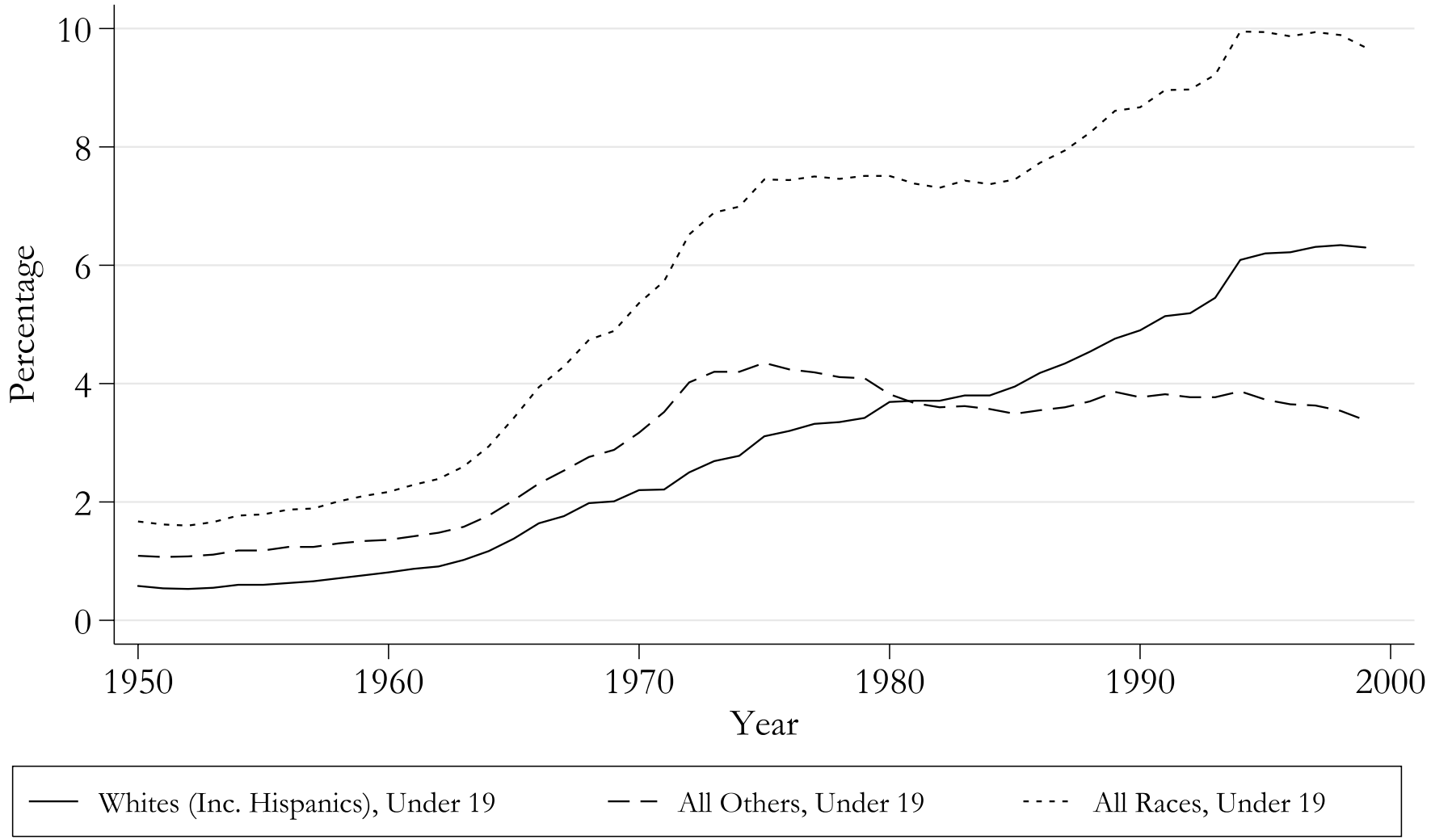
Source: Jencks and Ellwood (2004), using March Current Population Survey.

Figure 6c. Percent of women with children who had never been married by education of mother



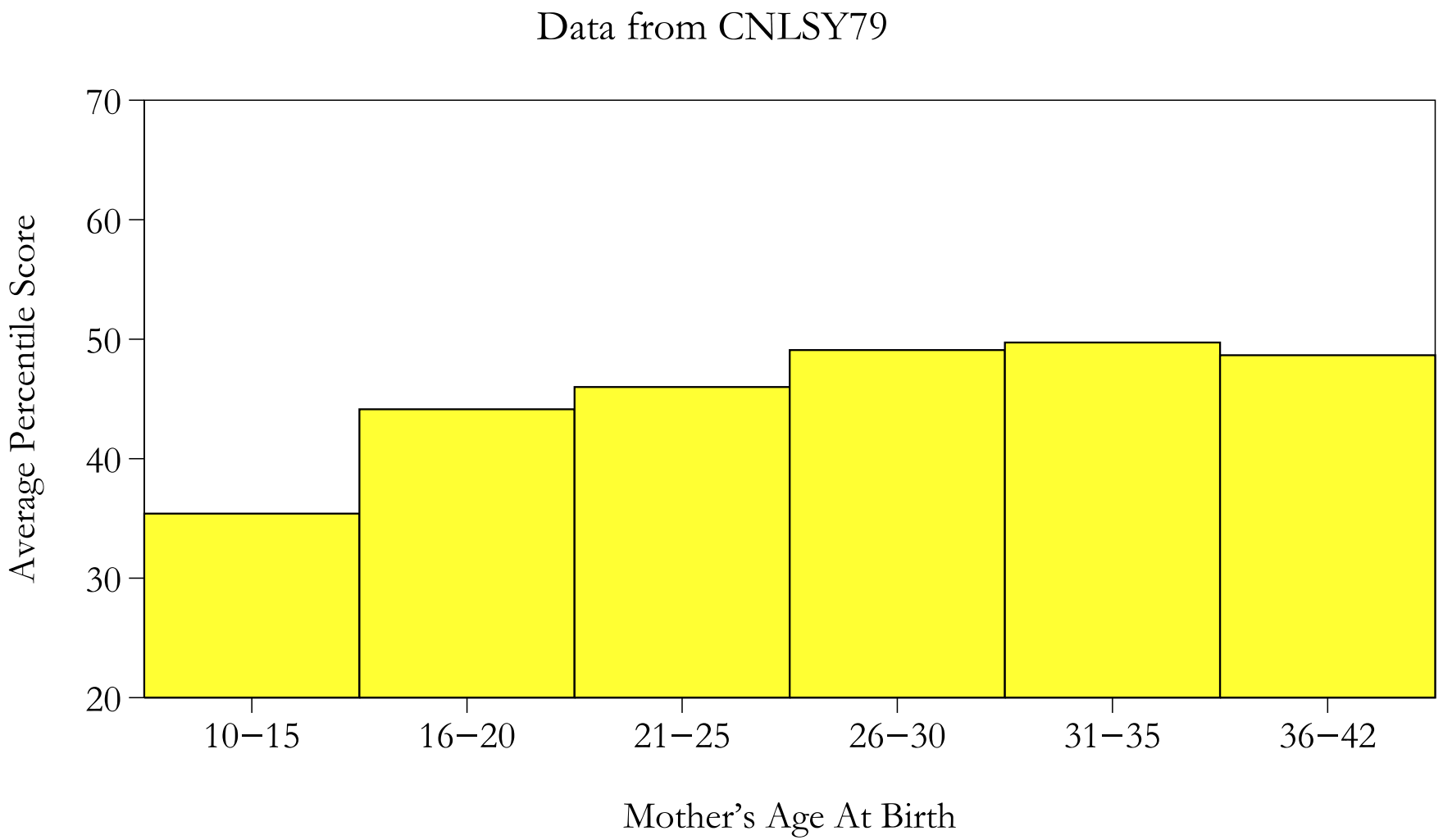
Source: Jencks and Ellwood (2004), using March Current Population Survey.

Figure 6d. Births to unmarried woment under age 19 as a percentage of total births in a given year by race



Note: Data from Ventura and Bachrach (2000). Child's race is used to define race until 1980, and mother's race thereafter.

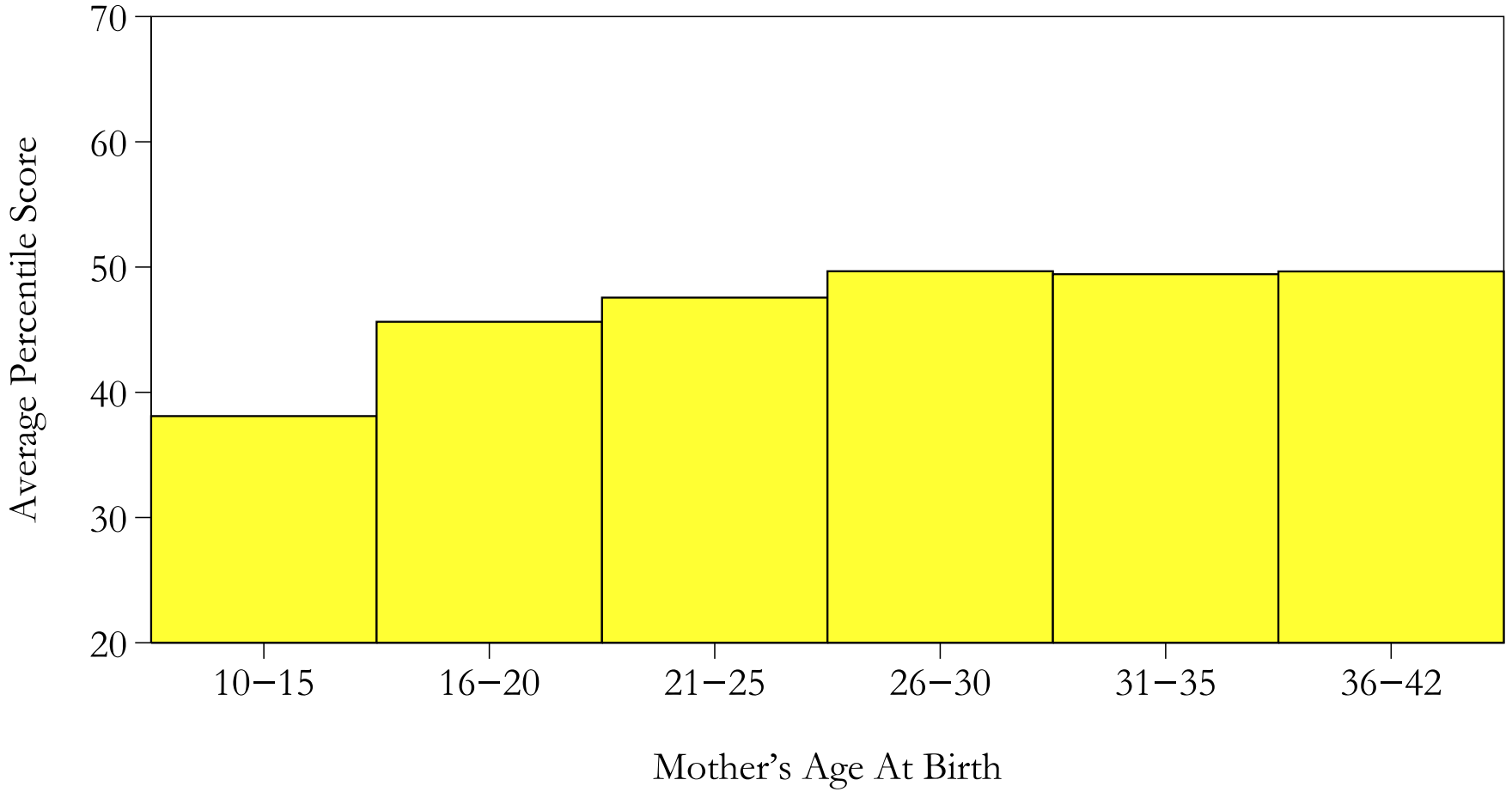
Figure 7a. Average cognitive simulation score by mother's age at birth



Note: Overall stimulation is a measure of the quality of the child's home environment. It comprises emotional and cognitive stimulation subscores. It is based on measures of resources, such as books, and on interactions with parents. The score is measured in percentiles.

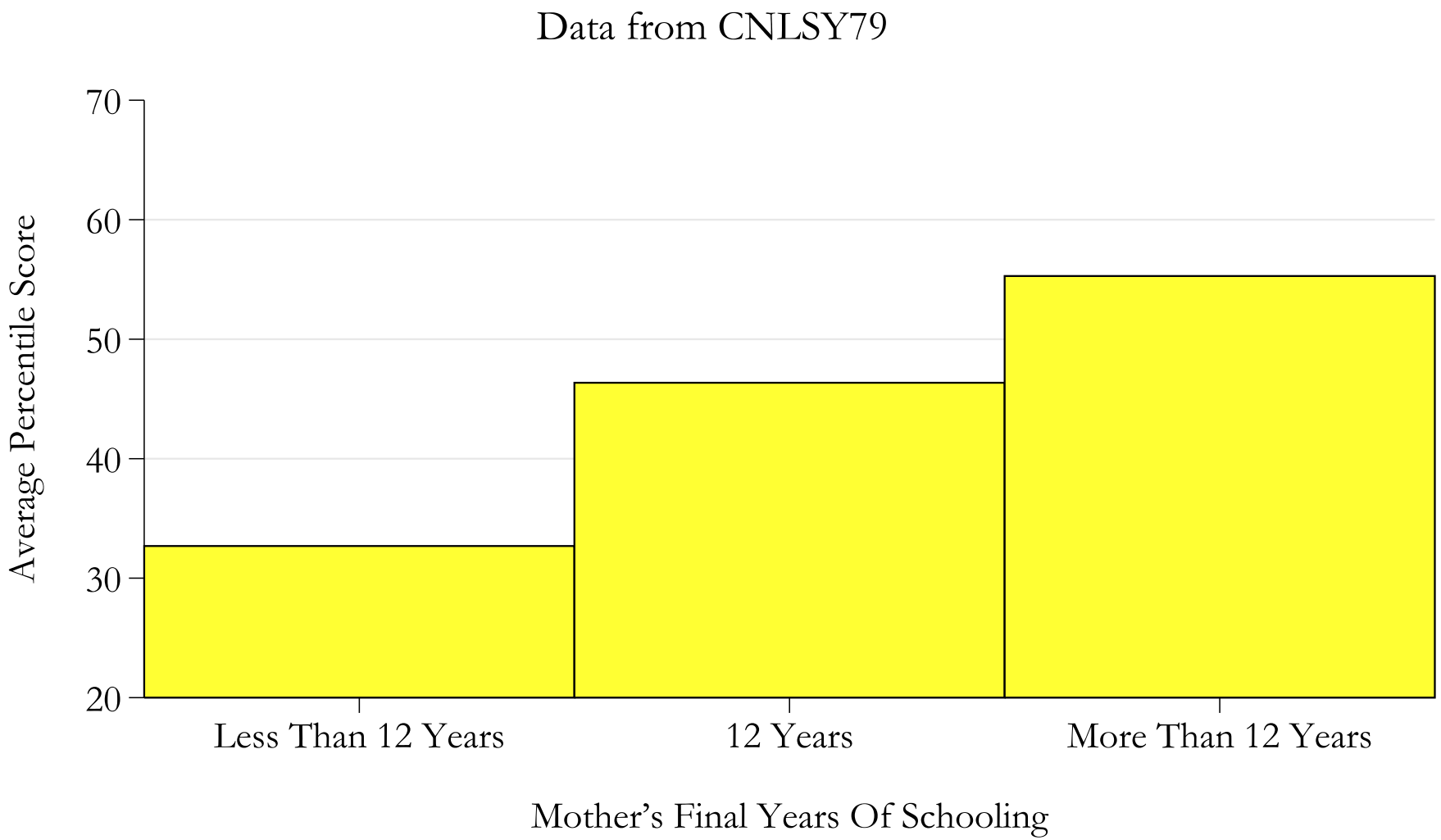
Figure 7b. Average emotional stimulation score by mothers' age at birth

Data from CNLSY79



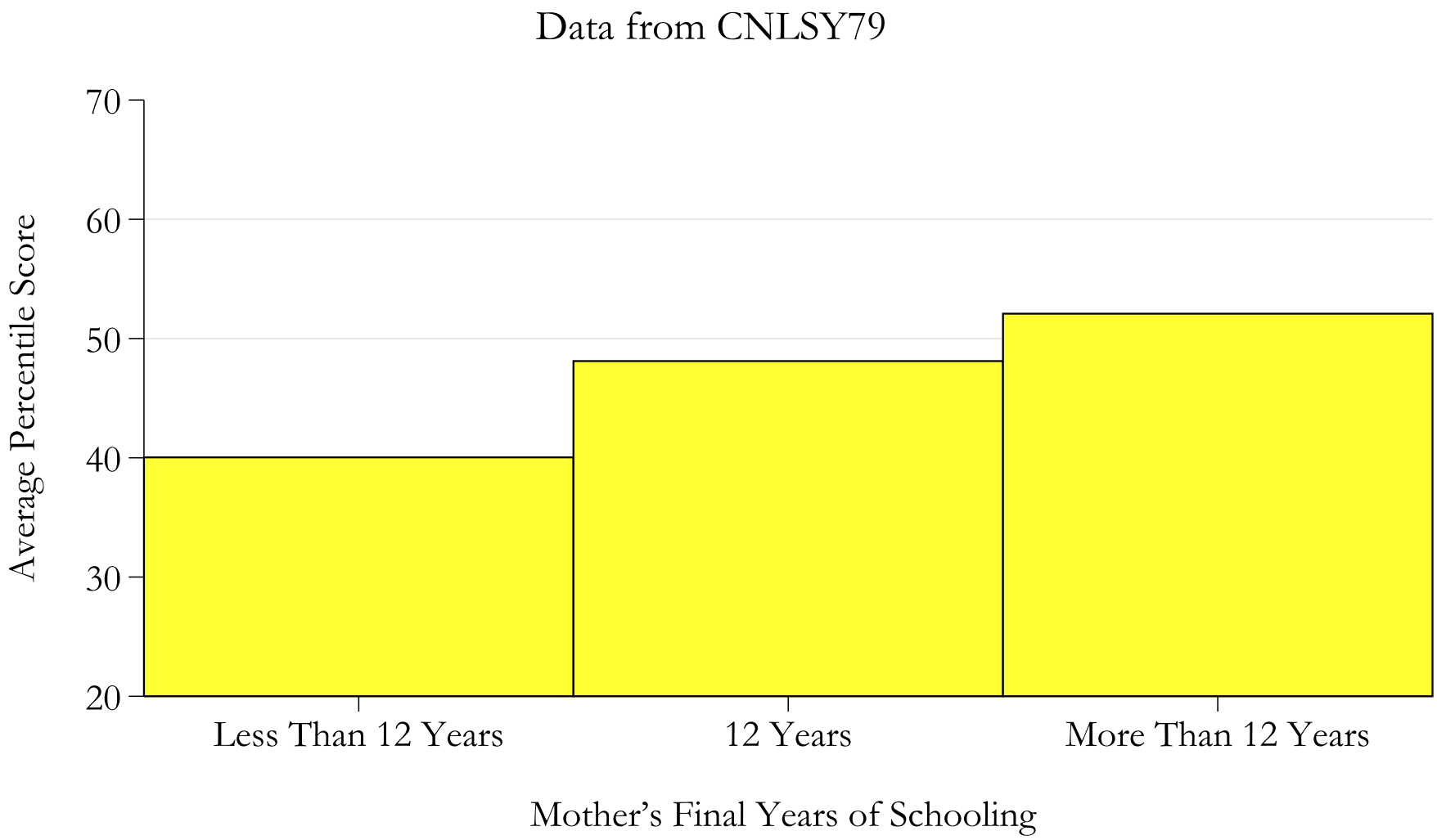
Note: Overall stimulation is a measure of the quality of the child's home environment. It comprises emotional and cognitive stimulation subscores. It is based on measures of resources, such as books, and on interactions with parents. The score is measured in percentiles.

Figure 7c. Average cognitive stimulation score by mother's final years of schooling



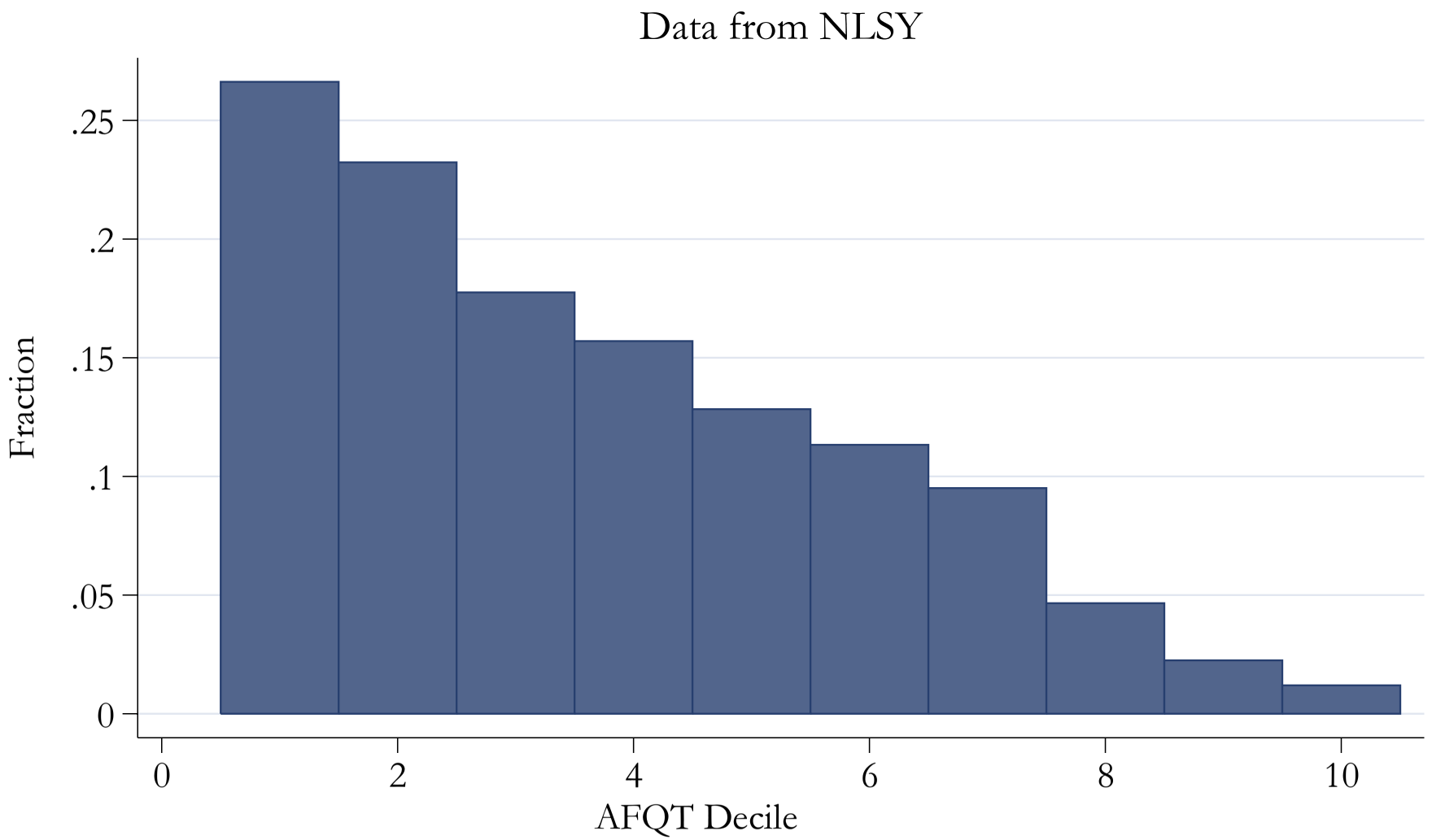
Note: Overall stimulation is a measure of the quality of the child's home environment. It comprises emotional and cognitive stimulation subscores. It is based on measures of resources, such as books, and on interactions with parents. The score is measured in percentiles.

Figure 7d. Average emotional stimulation score by mother's final years of schooling



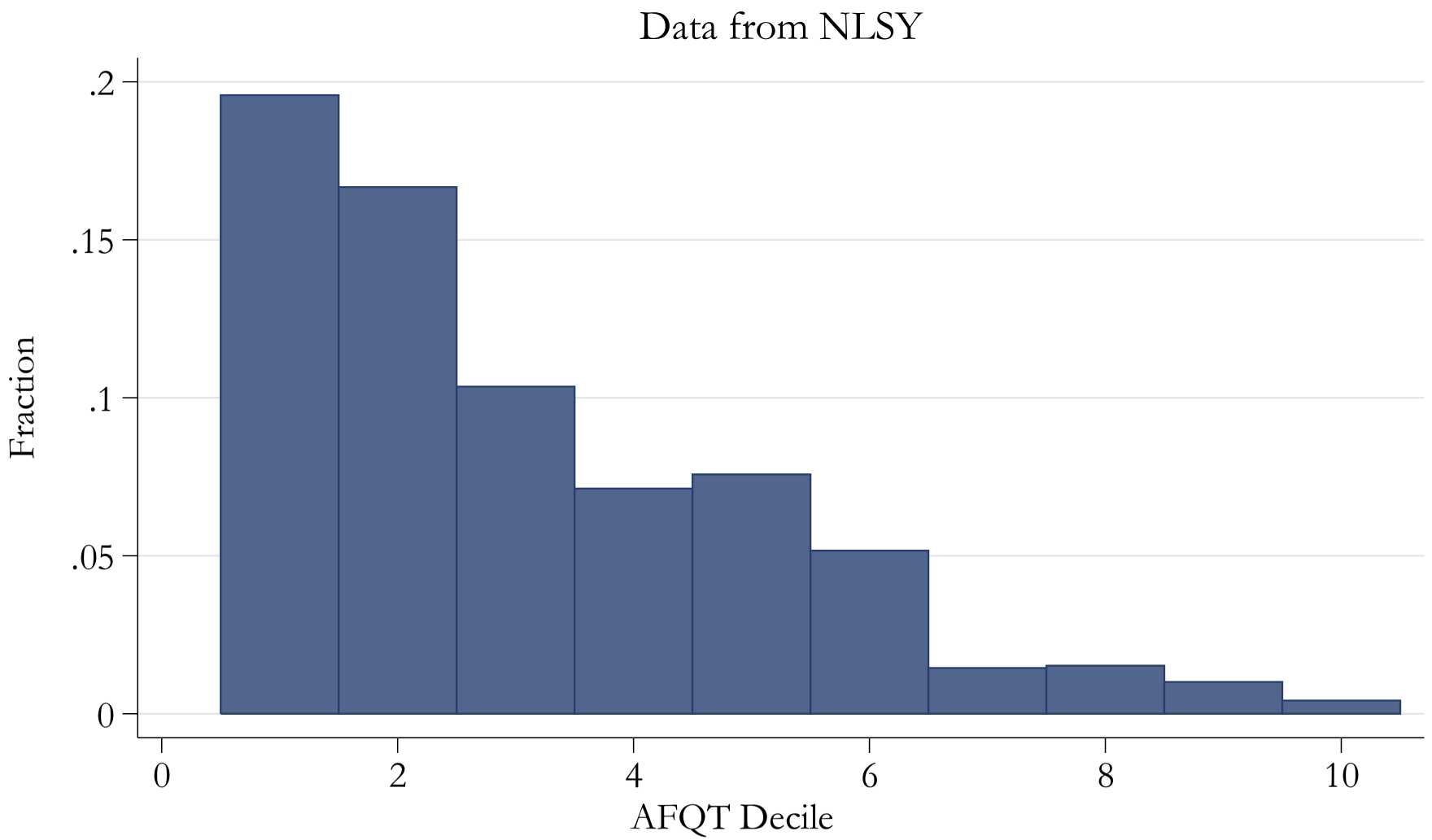
Note: Overall stimulation is a measure of the quality of the child's home environment. It comprises emotional and cognitive stimulation subscores. It is based on measures of resources, such as books, and on interactions with parents. The score is measured in percentiles.

Figure 8a. Fraction of women who gave birth by 18th birthday



Note: Uses the AFQT calculation procedure as defined by the Department of Defense in 1989. Data used 1979−2000

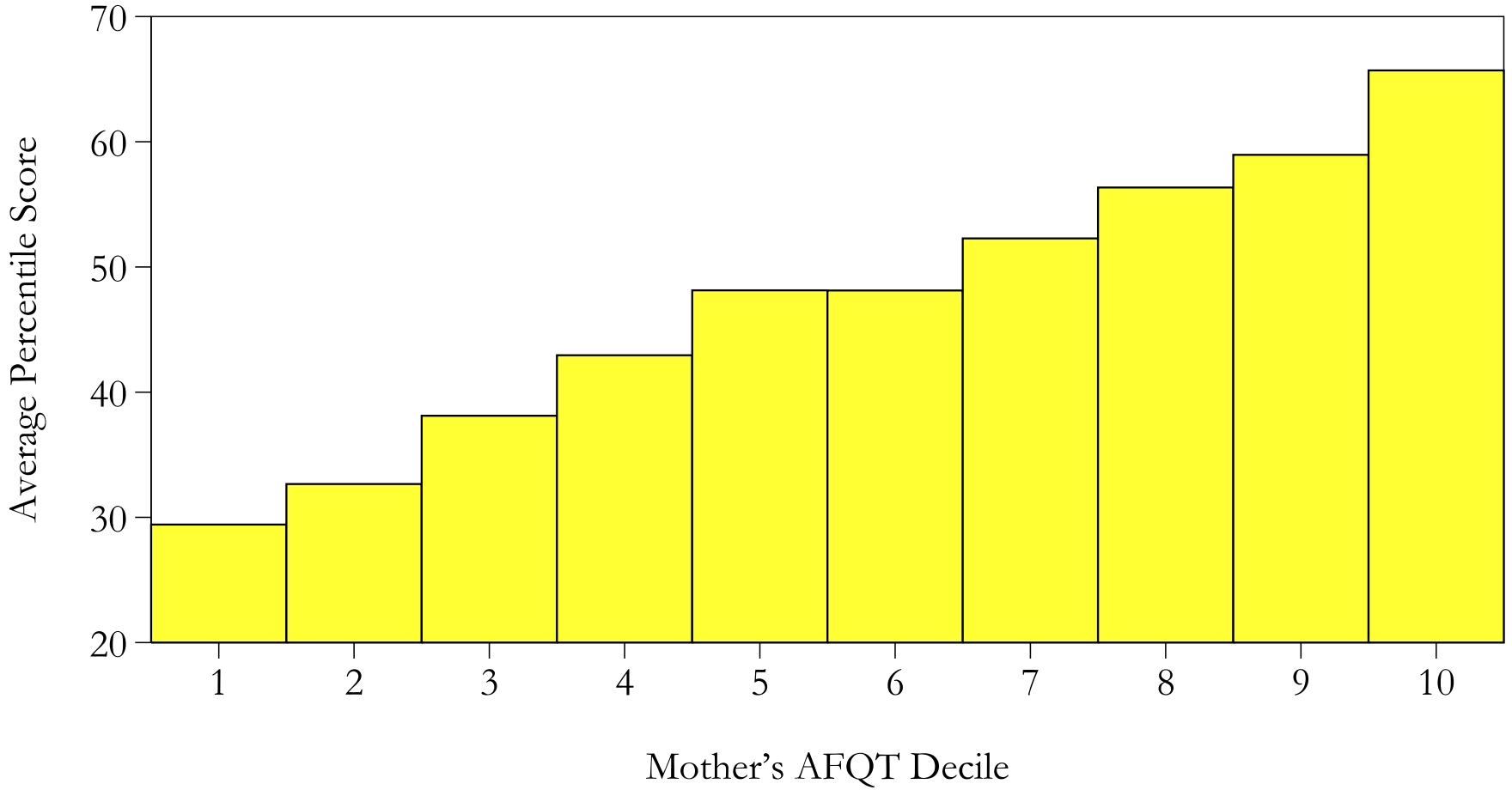
Figure 8b. Fraction of male respondents in jail at age 30 or below



Note: Uses the AFQT calculation procedure as defined by the Department of Defense in 1989. Data used 1979–2000

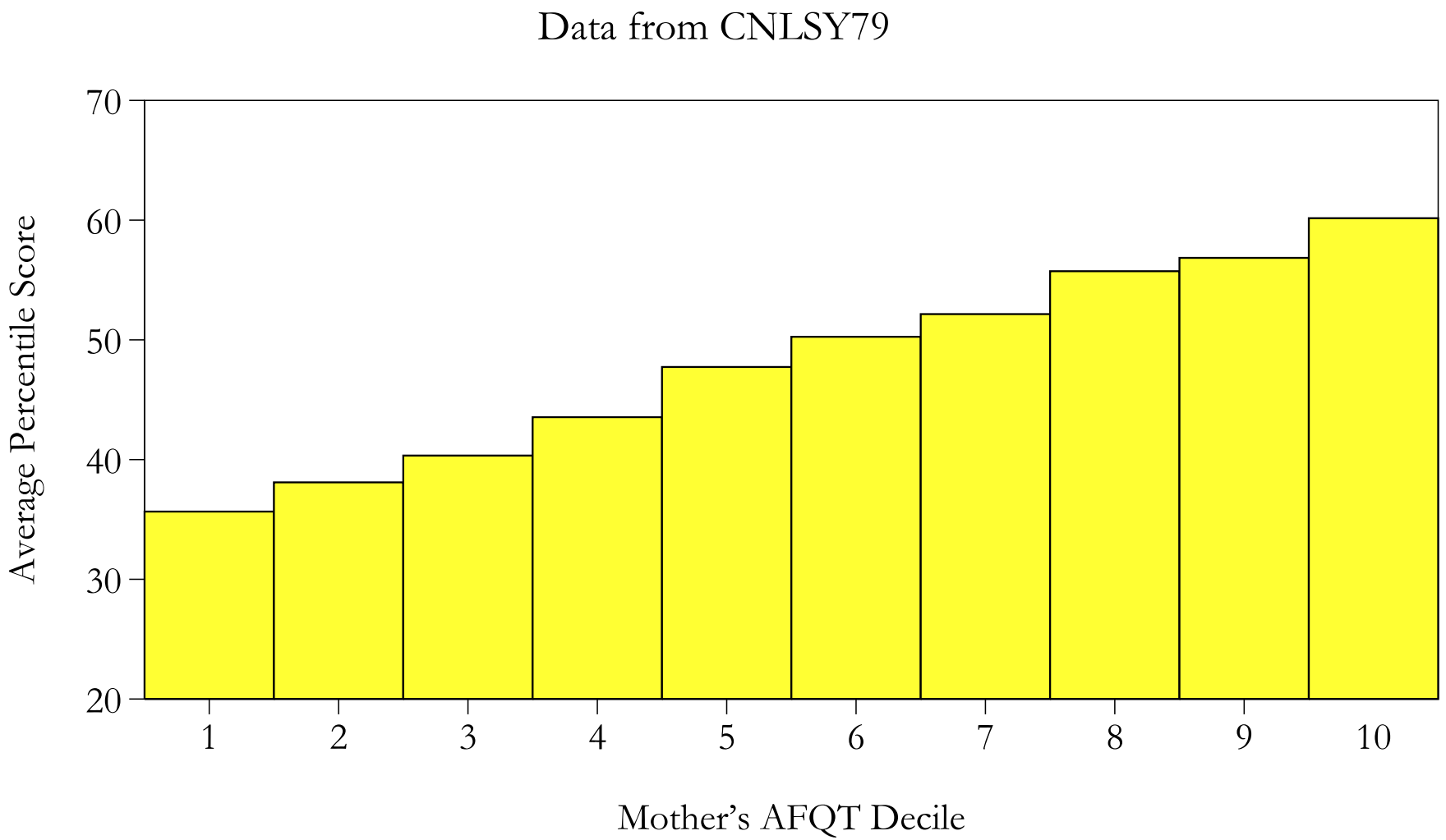
Figure 8c. Average cognitive stimulation score by mother's AFQT decile

Data from CNLSY79



Note: Overall stimulation is a measure of the quality of the child's home environment. It comprises emotional and cognitive stimulation subscores. It is based on measures of resources, such as books, and on interactions with parents. The score is measured in percentiles.

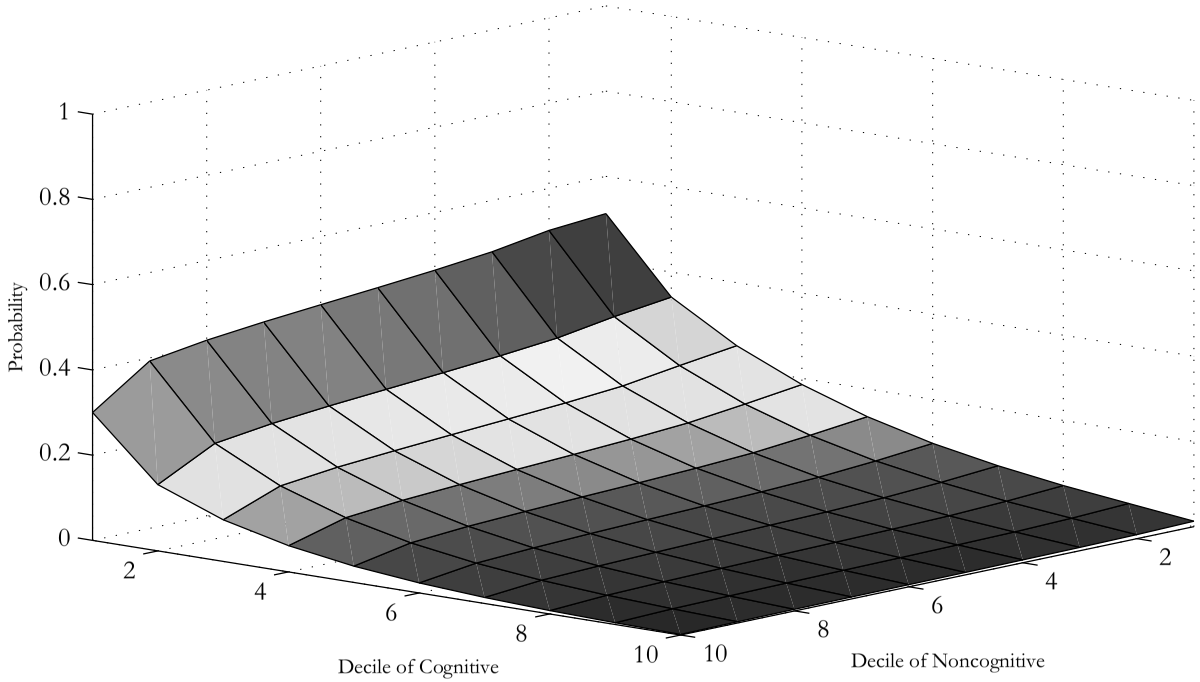
Figure 8d. Average emotional stimulation score by mother's AFQT decile



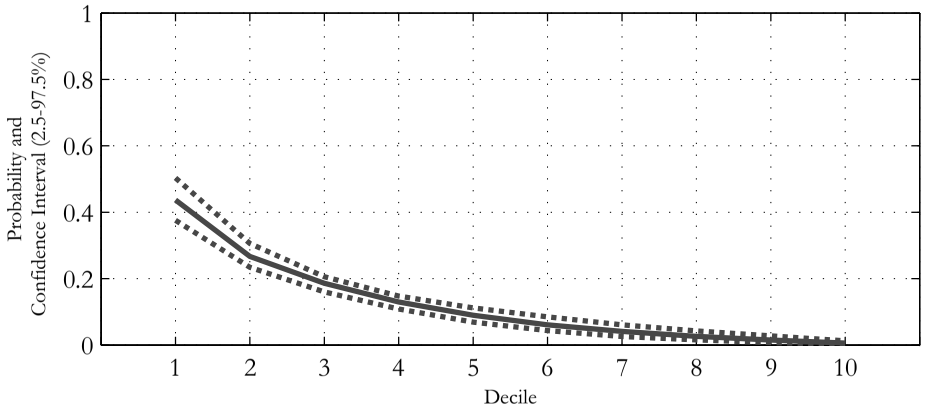
Note: Overall stimulation is a measure of the quality of the child's home environment. It comprises emotional and cognitive stimulation subscores. It is based on measures of resources, such as books, and on interactions with parents. The score is measured in percentiles.

Figure 9a. Probability of Being a High School Dropout by Age 30 - Males

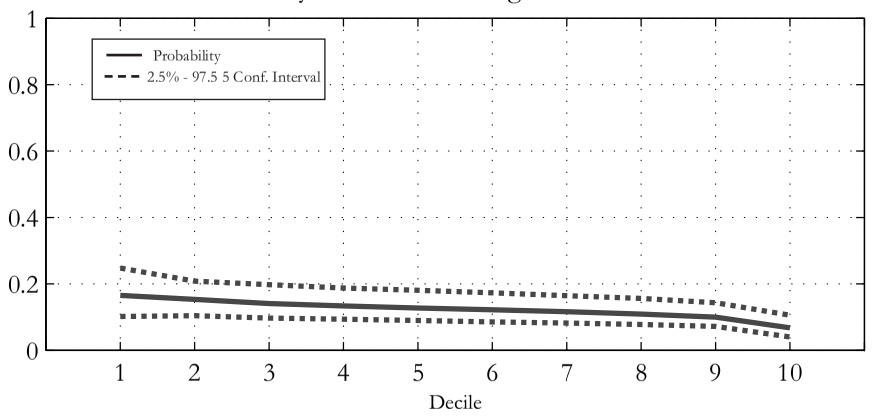
i. By Decile of Cognitive and Noncognitive Factors



ii. By Decile of Cognitive Factor



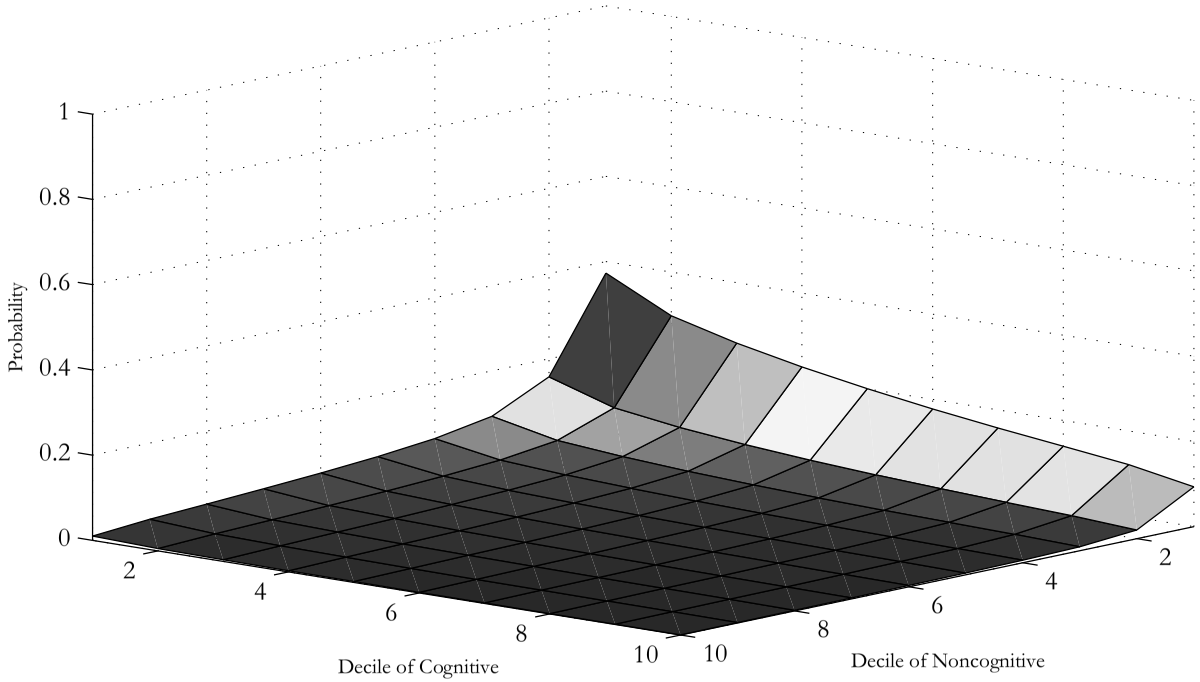
iii. By Decile of Noncognitive Factor



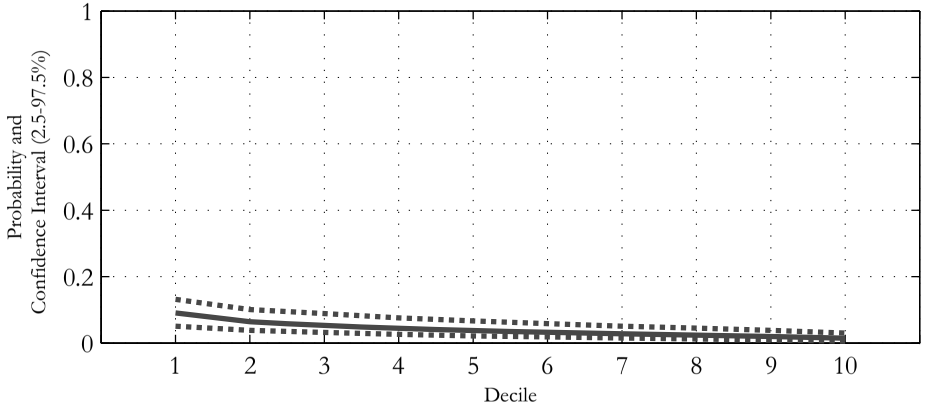
Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws). Source: Heckman, Stixrud and Urzua (2006).

Figure 9b. Probability of Incarceration by Age 30 - Males

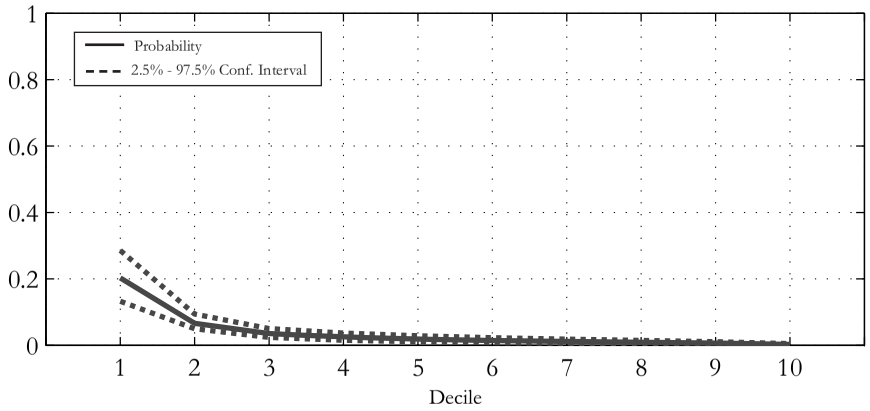
i. By Decile of Cognitive and Noncognitive Factor



ii. By Decile of Cognitive Factor



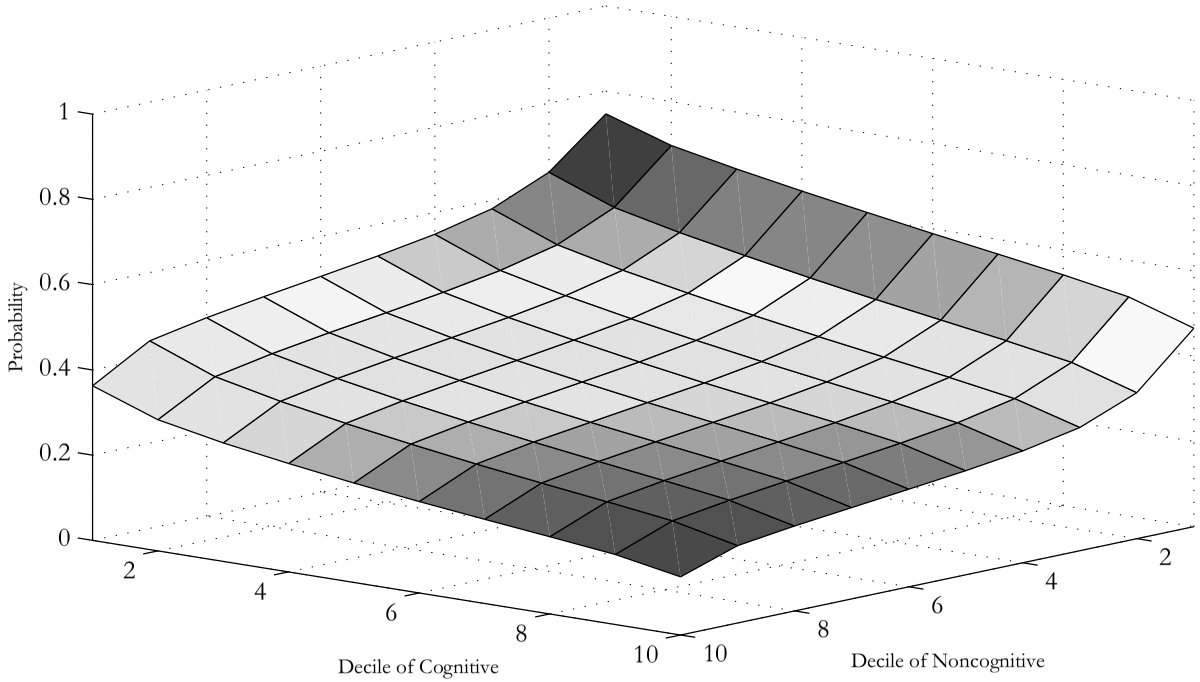
iii. By Decile of Noncognitive Factor



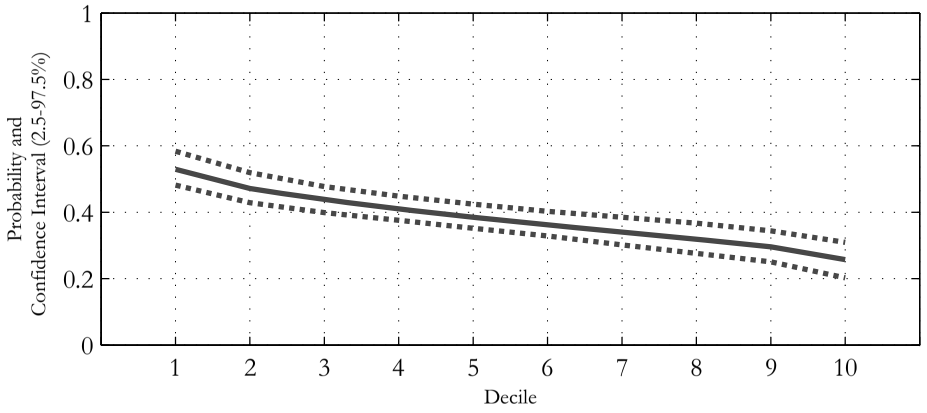
Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws). Source: Heckman, Stixrud and Urzua (2006).

Figure 9c. Probability Of Daily Smoking By Age 18 - Males

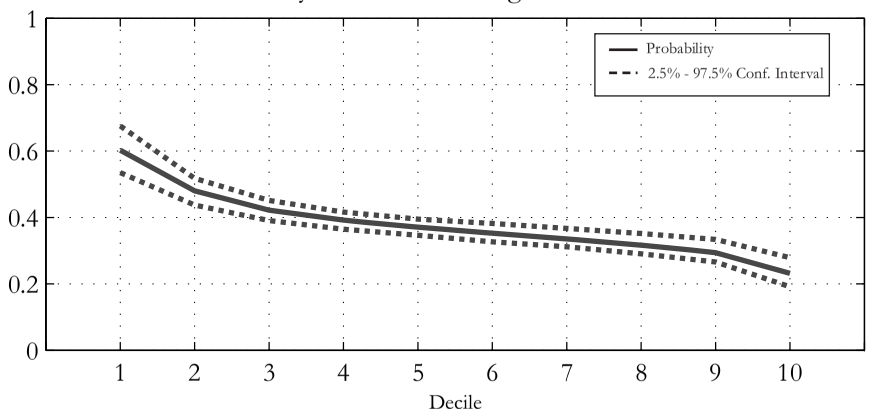
i. By Decile of Cognitive and Noncognitive Factor



ii. By Decile of Cognitive Factor



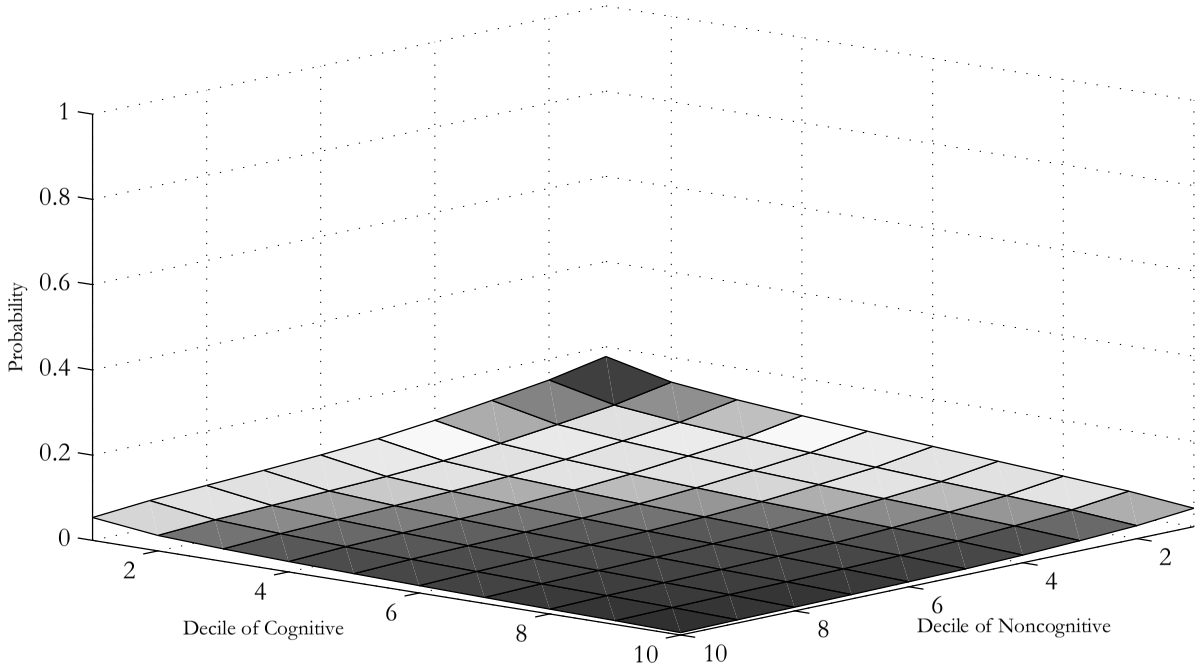
iii. By Decile of Noncognitive Factor



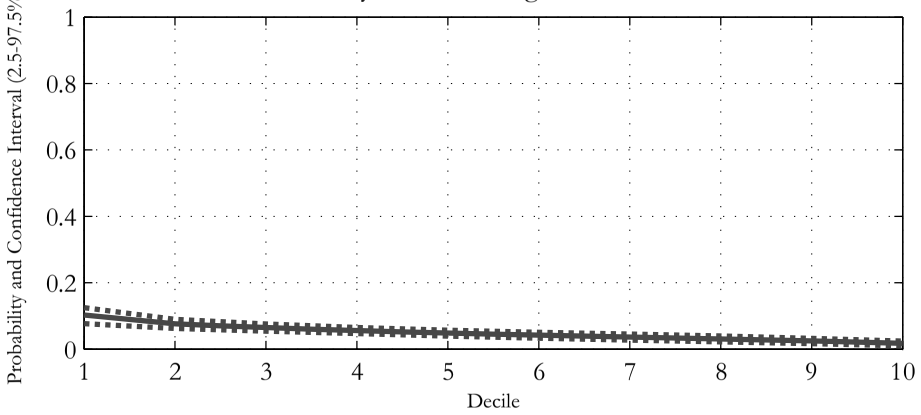
Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws). Source: Heckman, Stixrud and Urzua (2006).

Figure 9d. Probability Of Being Single With Child at Age 18- Females

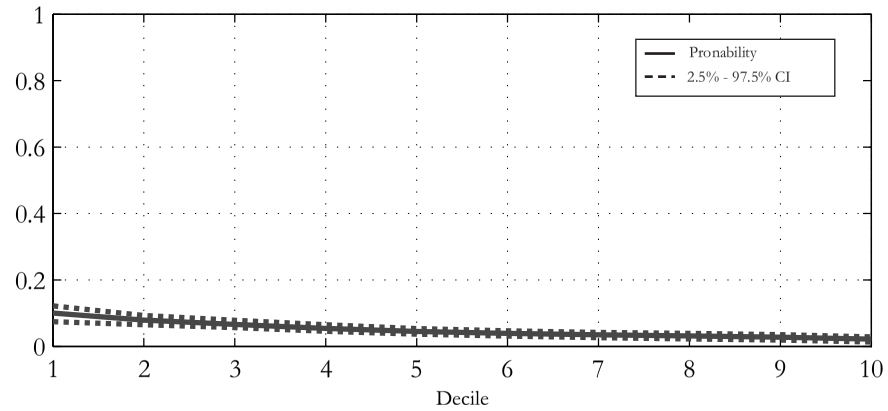
i. By Decile of Cognitive and Noncognitive Factors



ii. By Decile of Cognitive Factor



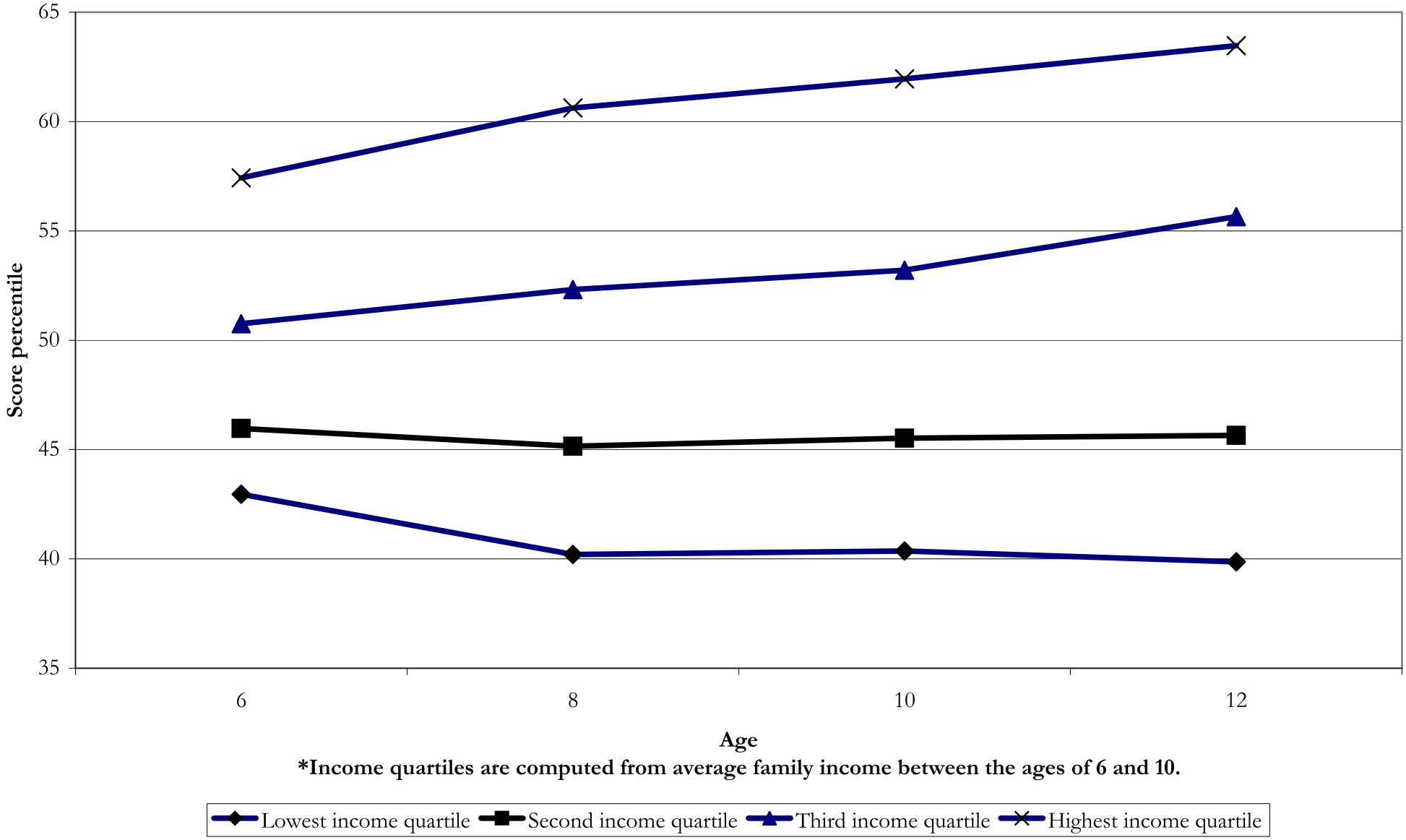
iii. By Decile of Noncognitive Factor



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

Figure 10a. Children of NLSY

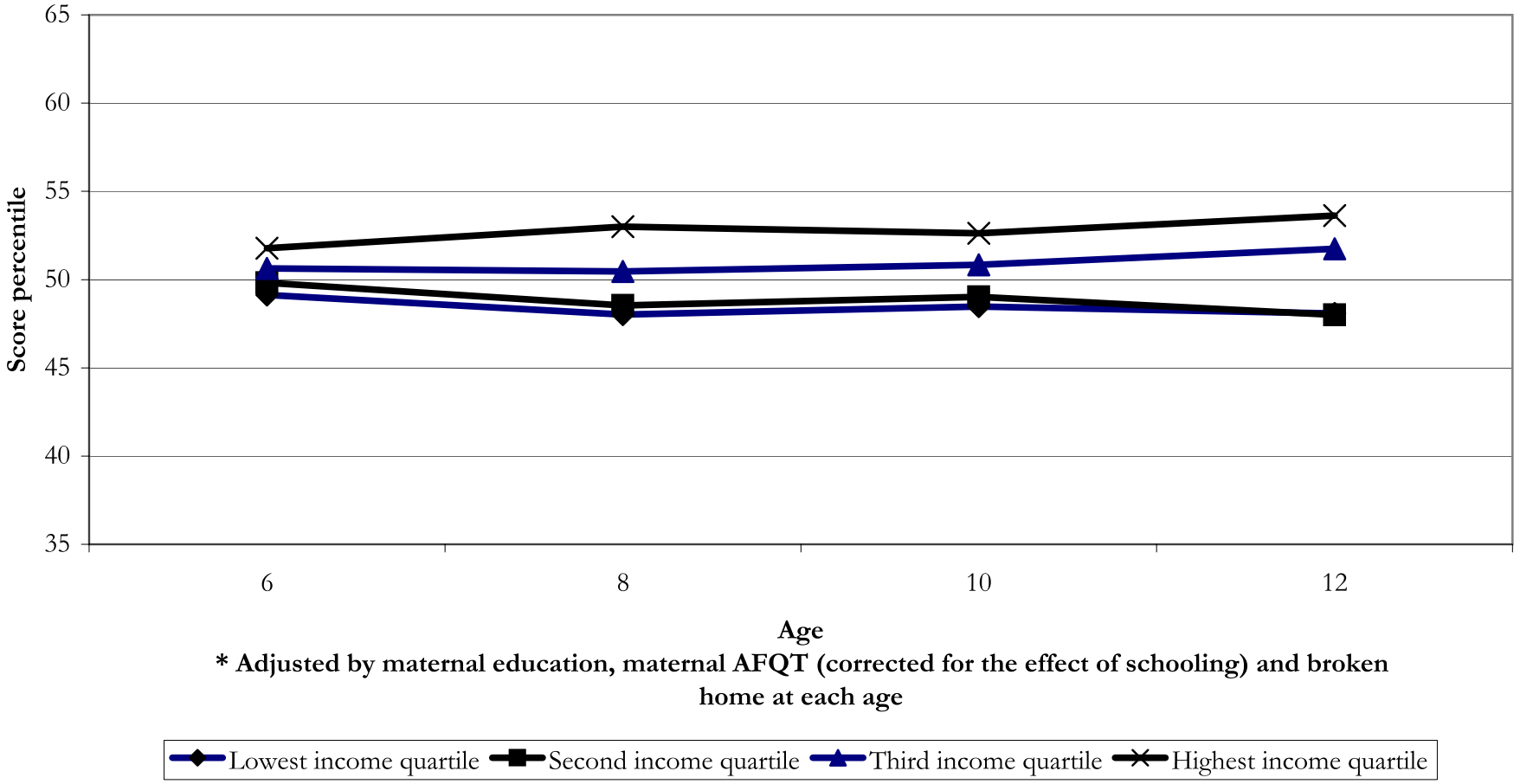
(a) Average percentile rank on PIAT-Math score, by income quartile*



***Income quartiles are computed from average family income between the ages of 6 and 10.**

Figure 10b. Children of NLSY

(a) Adjusted average PIAT-Math score percentiles by income quartile*



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

Figure 11a. Children of NLSY

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

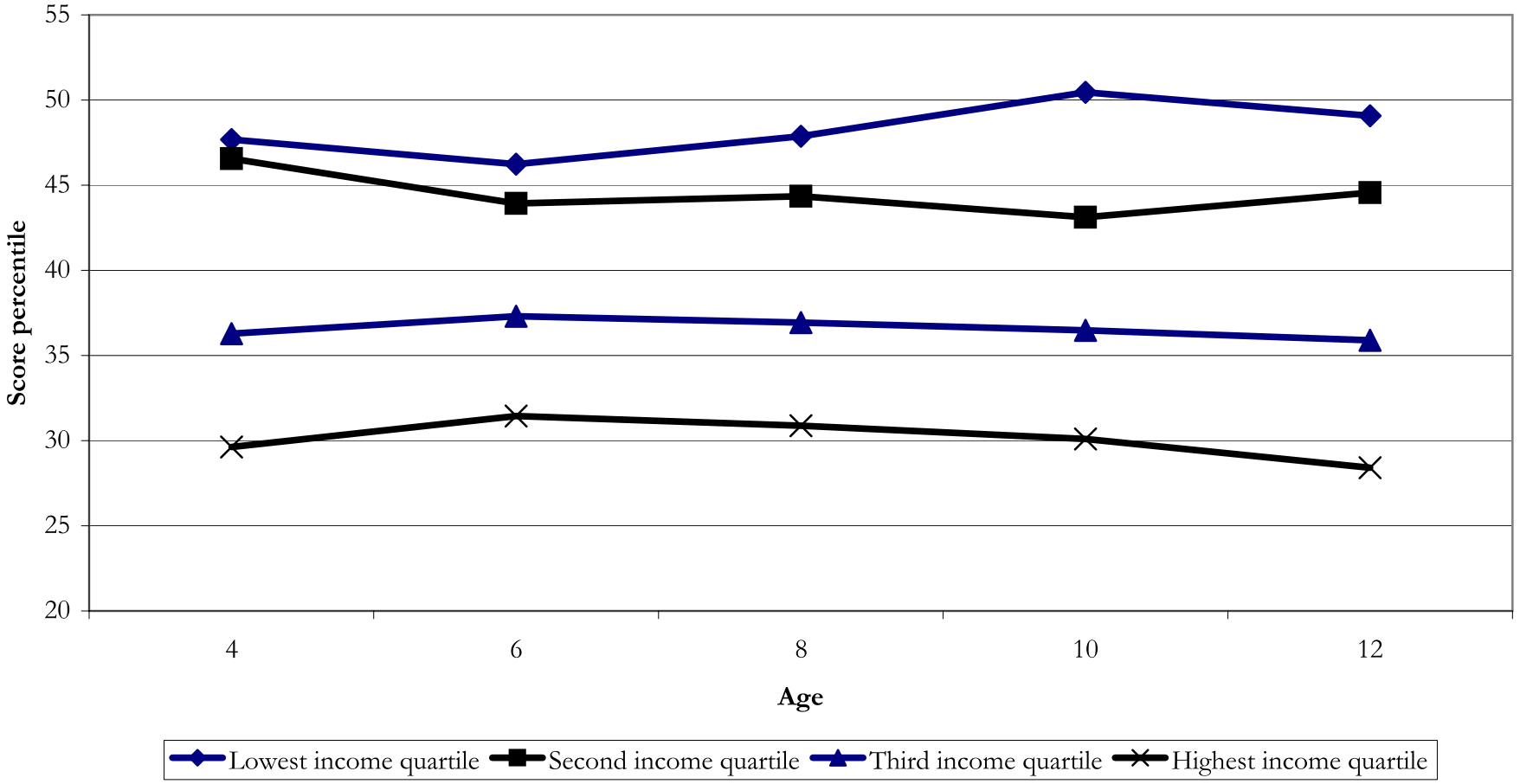
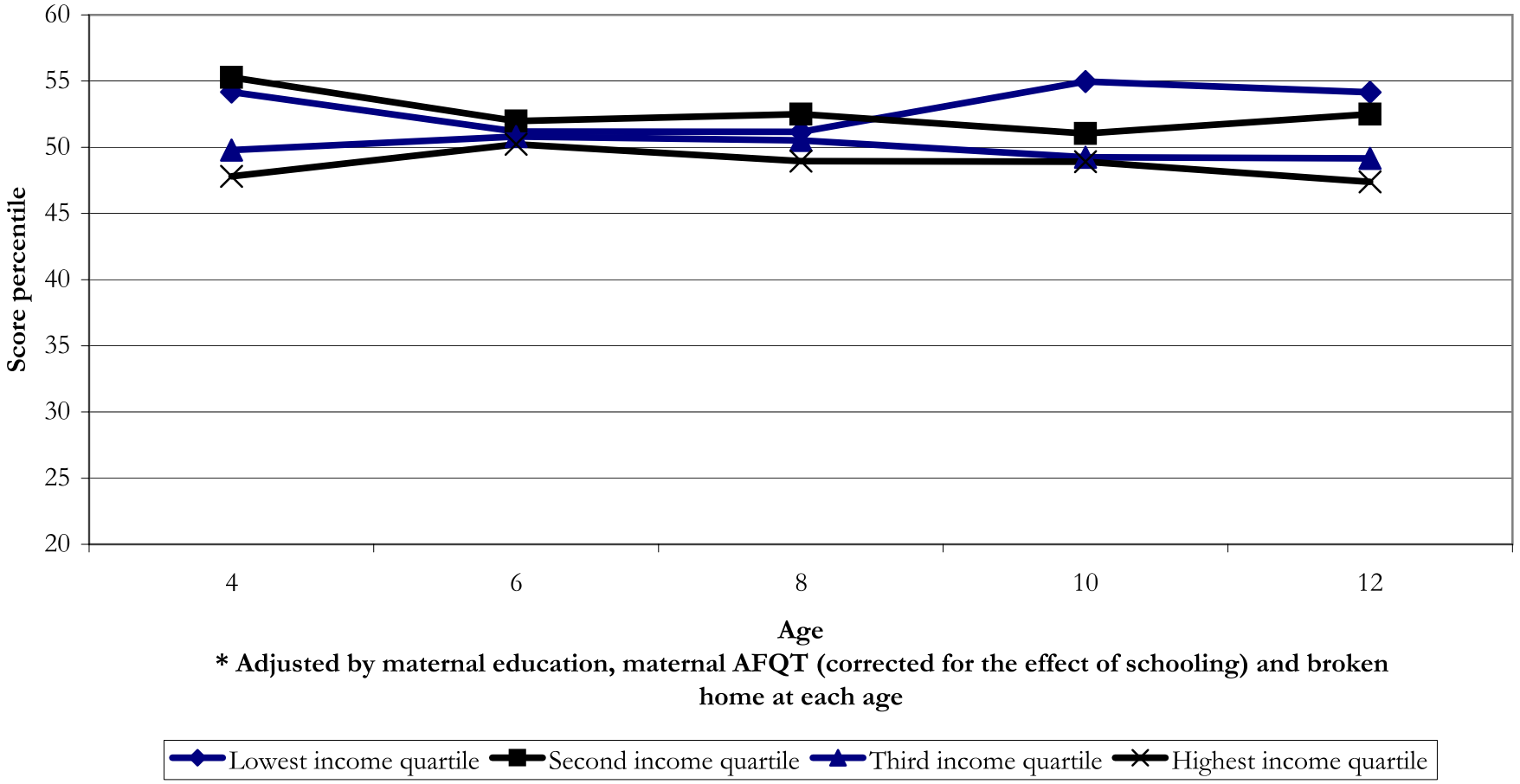


Figure 11b. Children of NLSY

Adjusted average anti-social score percentile by income quartile*



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

Figure 12. Rates of return to human capital investment in disadvantaged children

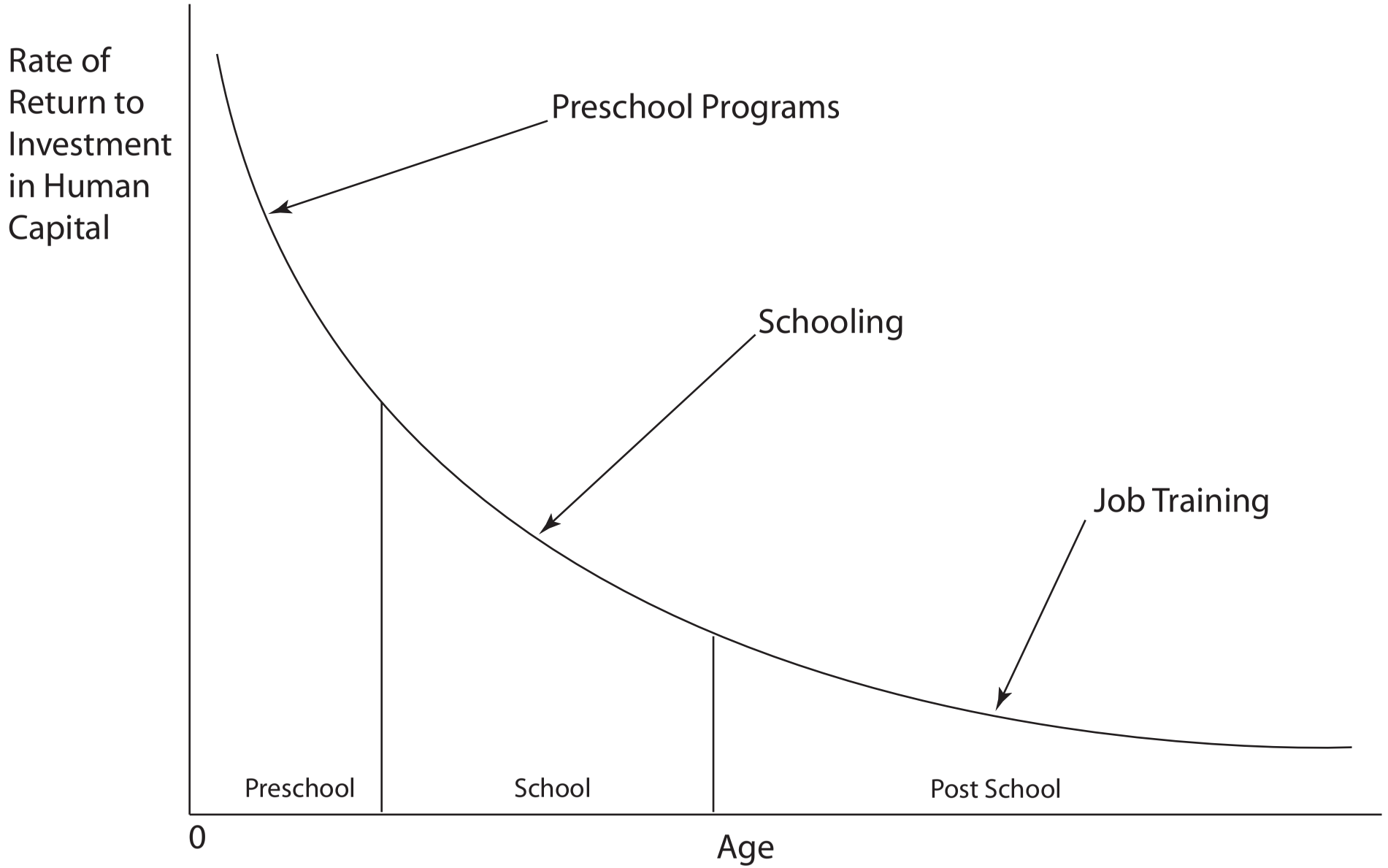
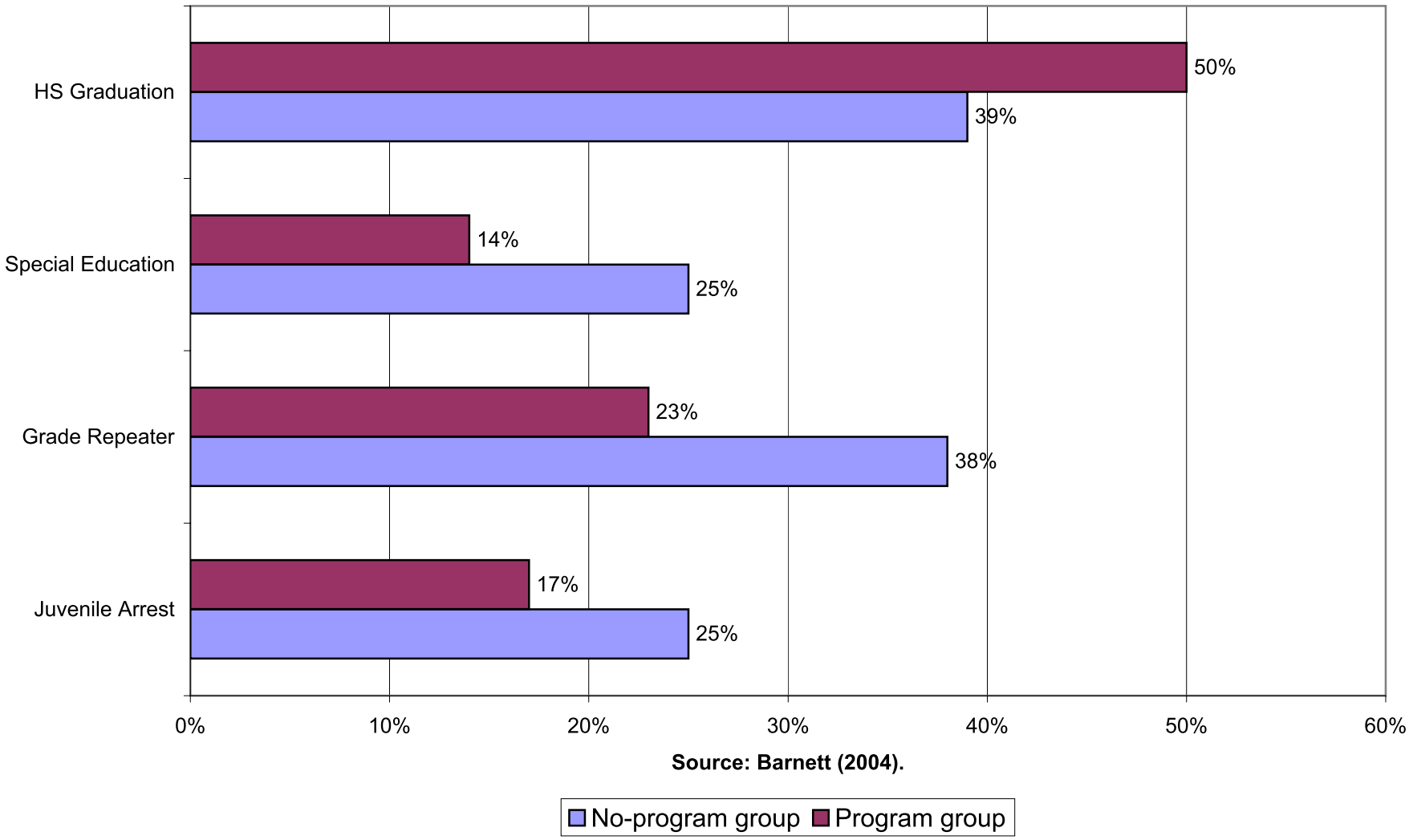


Figure 13. Academic and social benefits at school exit for CPC participants



Source: Barnett (2004).

Figure 14a. Perry Preschool: IQ over time

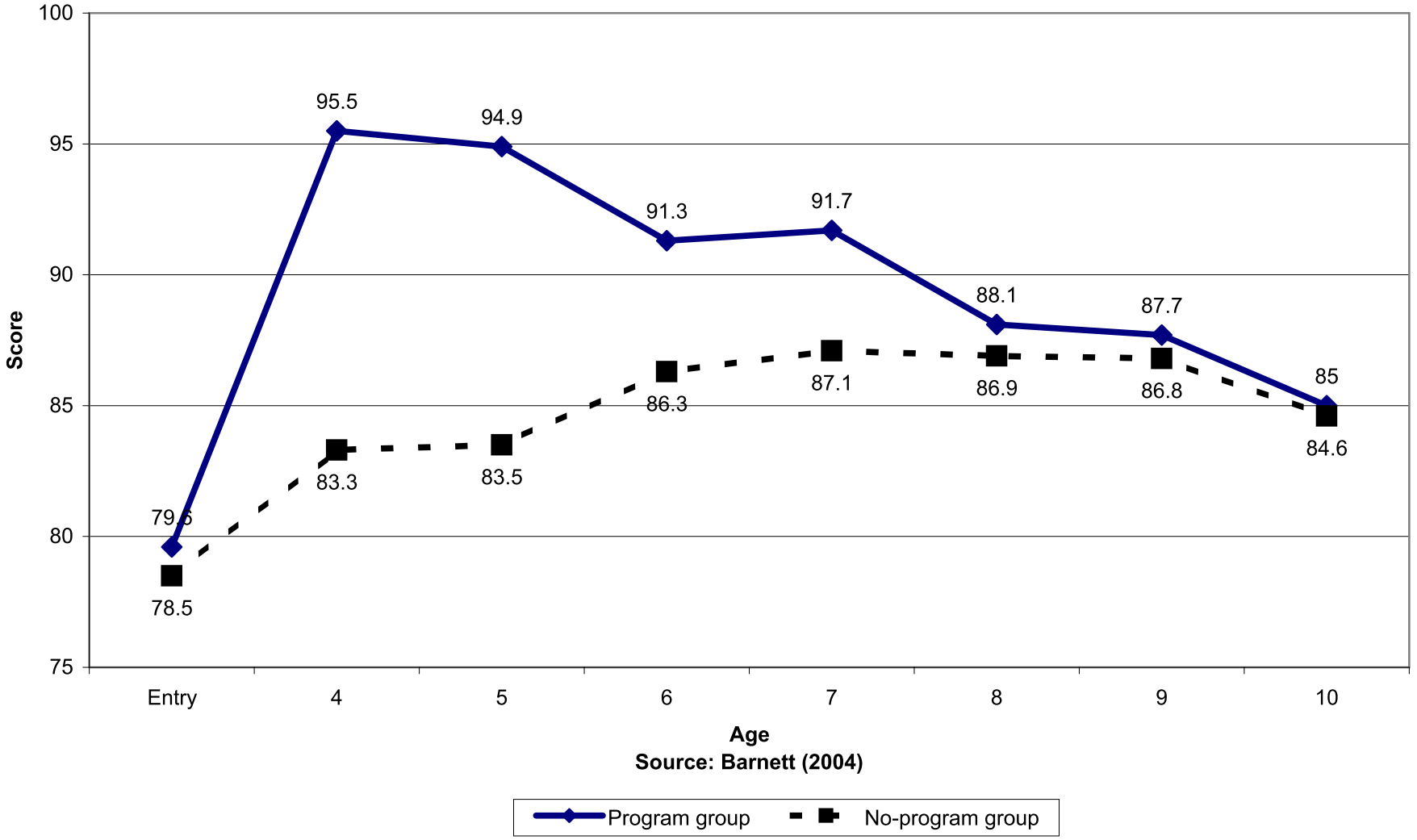
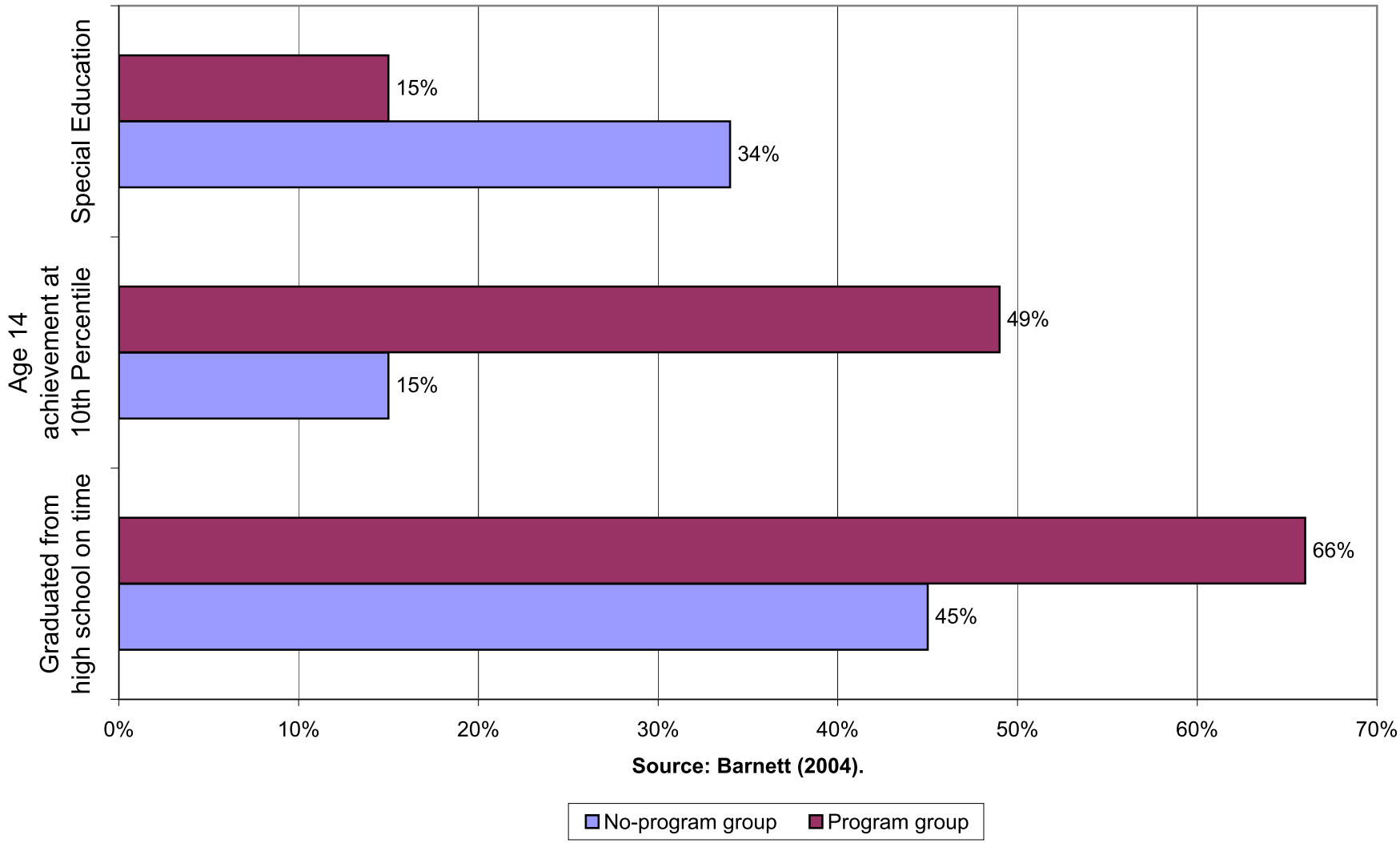


Figure 14b. Perry Preschool: educational effects



Source: Barnett (2004).

Figure 14c. Perry Preschool: economic outcomes

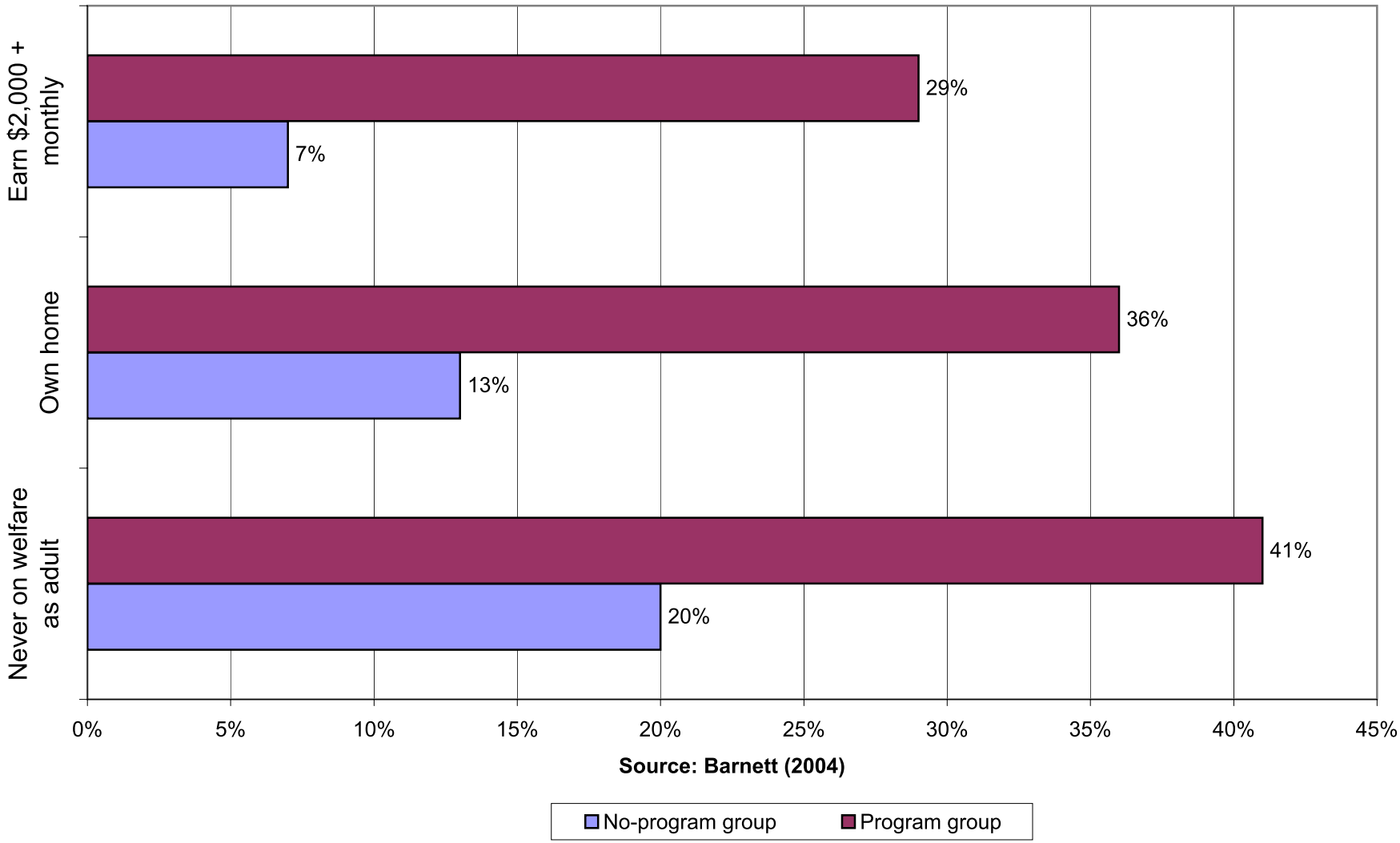
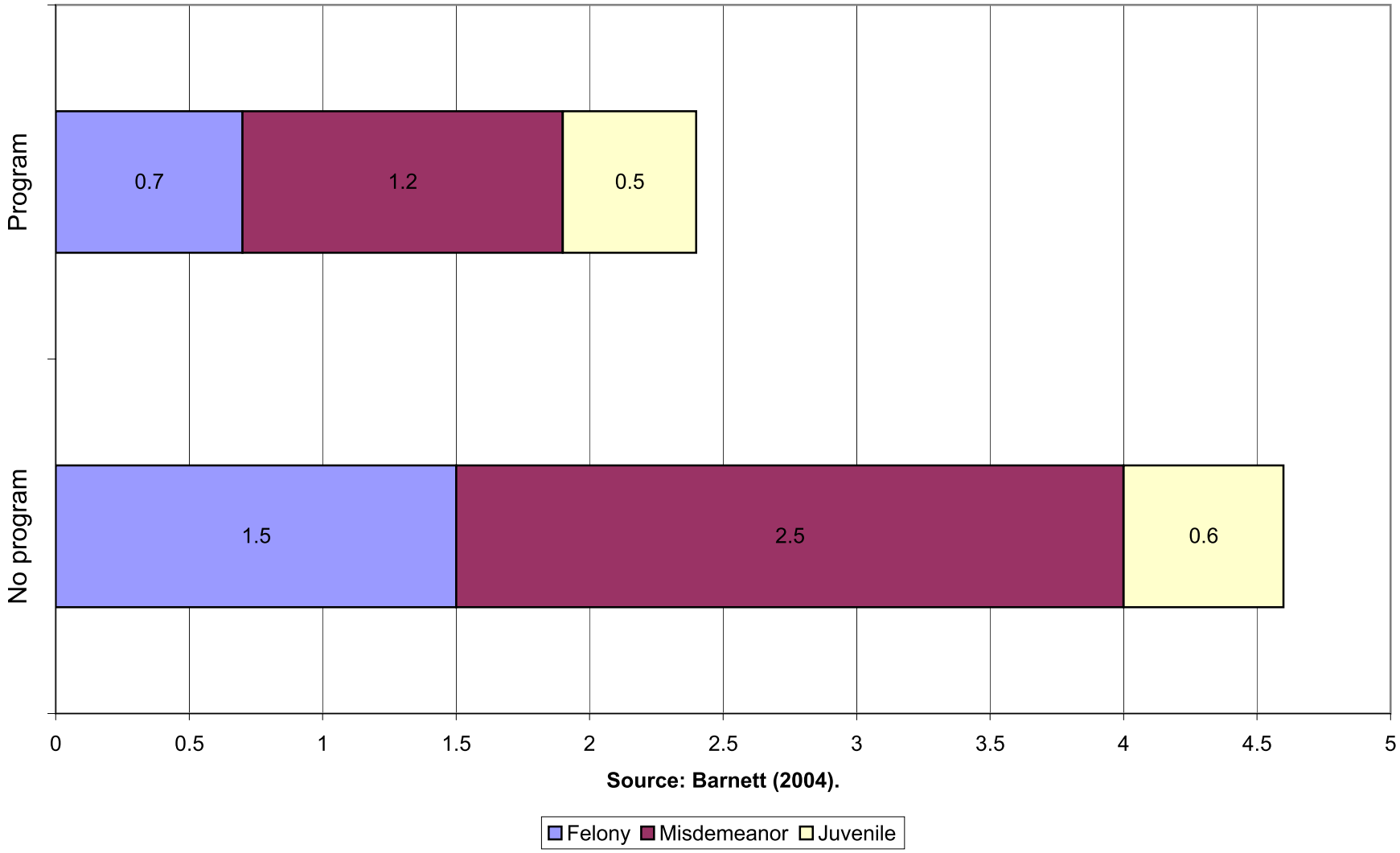
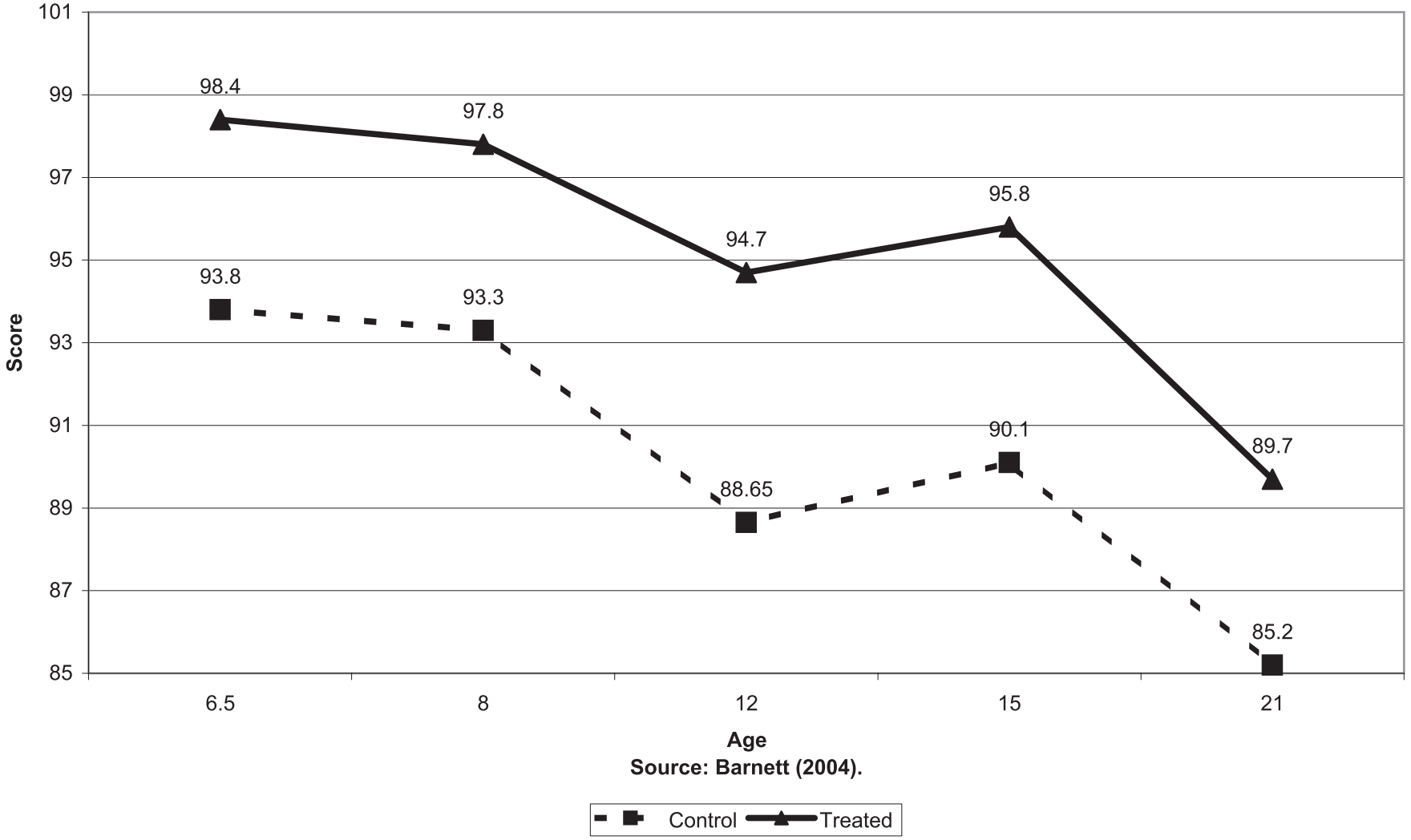


Figure 14d. Perry Preschool: arrests per person by age 27



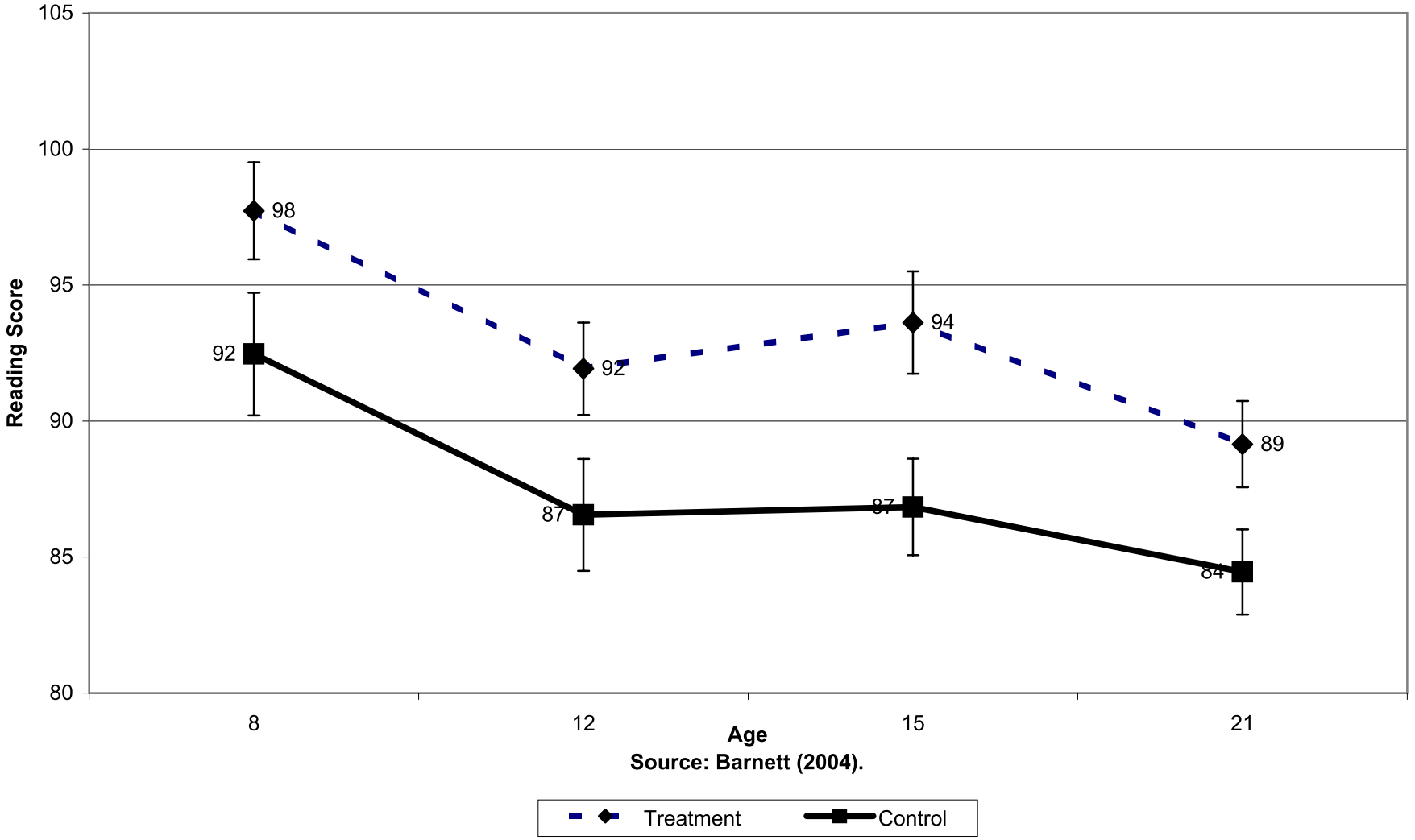
Source: Barnett (2004).

Figure 15a. Abecedarian IQ scores over time



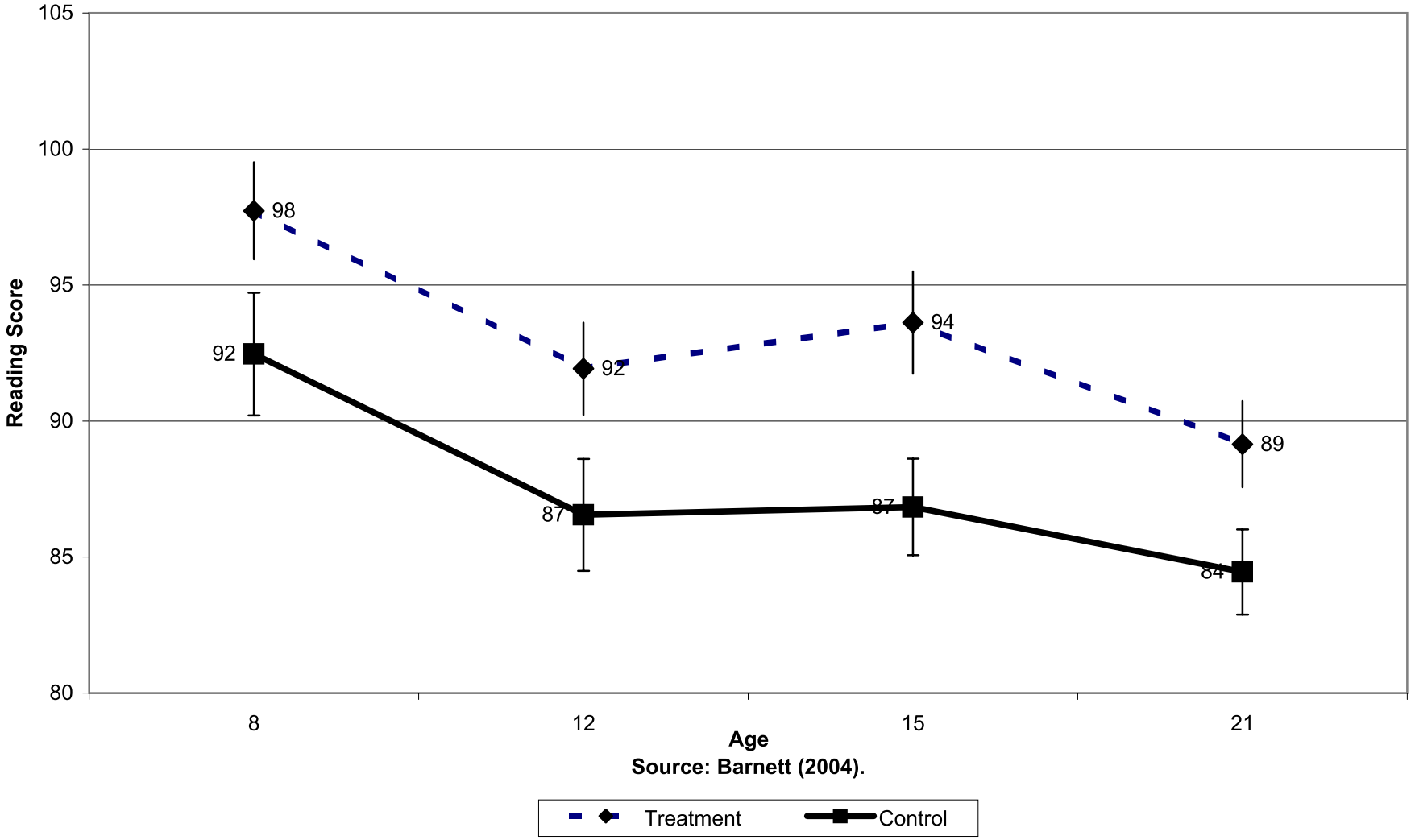
Source: Barnett (2004).

Figure 15b. Abecedarian reading acheivement over time



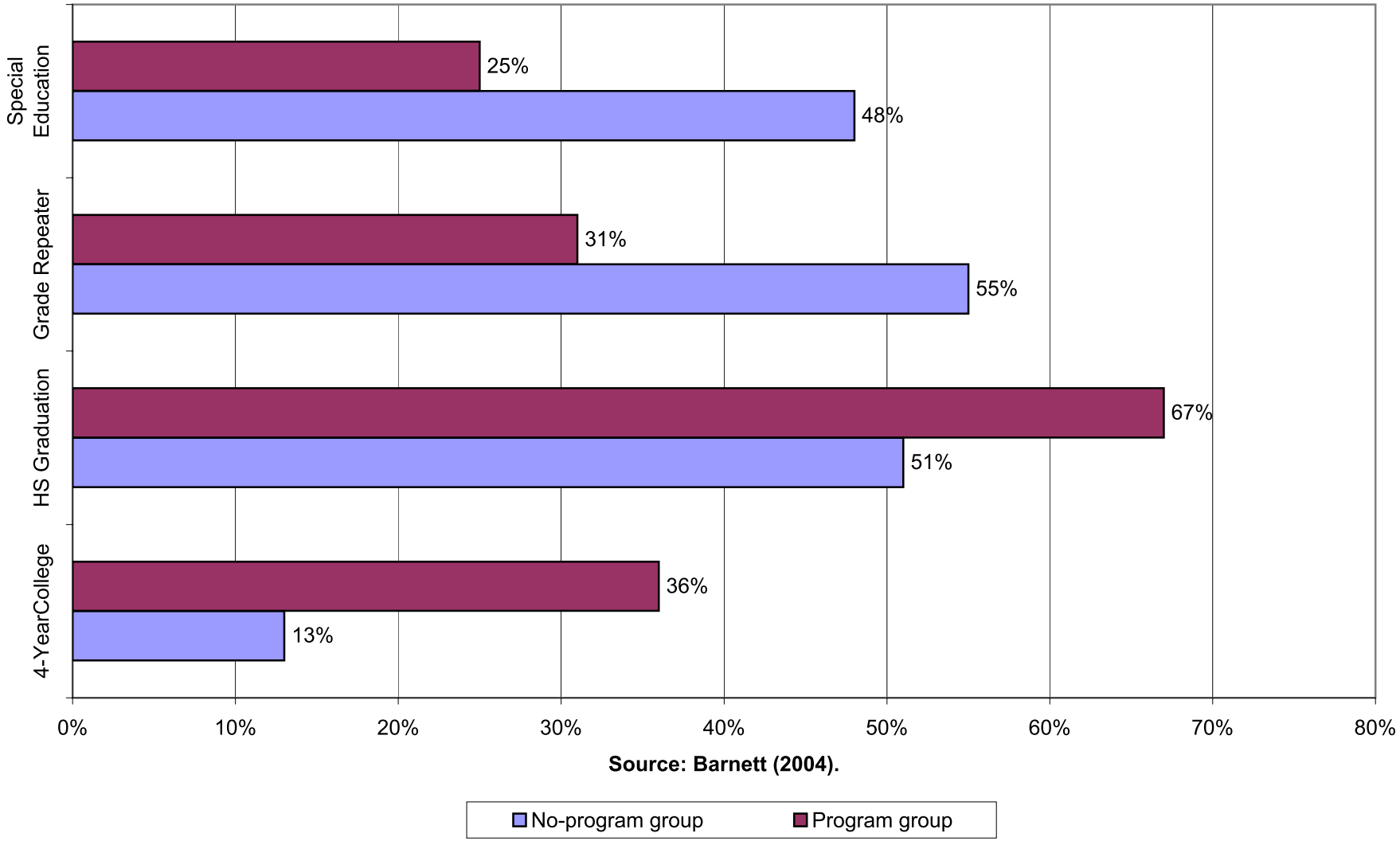
Source: Barnett (2004).

Figure 15c. Abecedarian math acheivement over time



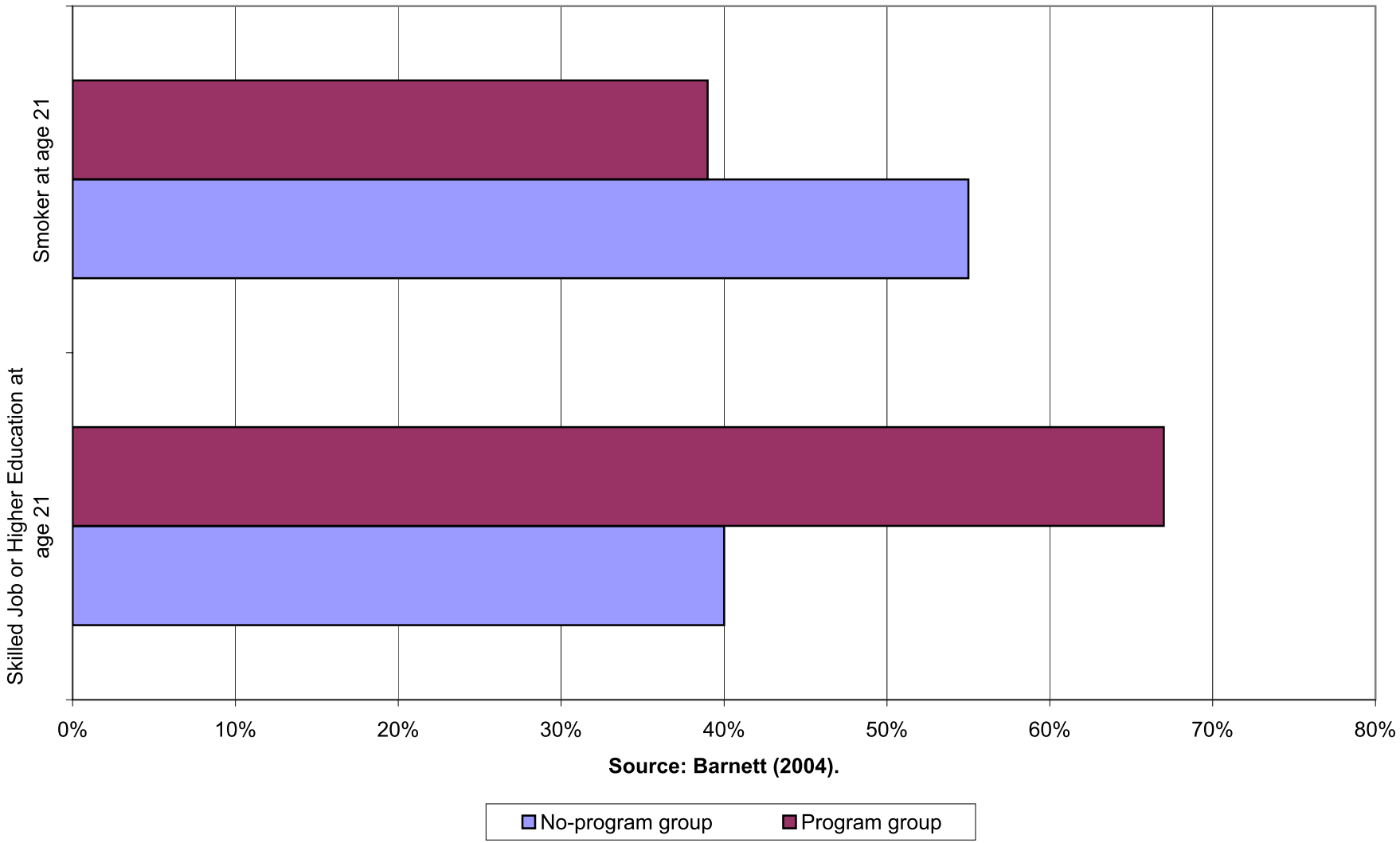
Source: Barnett (2004).

Figure 15d. Abecedarian academic outcomes



Source: Barnett (2004).

Figure 15e. Other benefits of Abecedarian



Source: Barnett (2004).