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PERSPECTIVE

Skill Formation and the Economics of Investing in Disadvantaged Children

James J. Heckman

This paper summarizes evidence on the effects of early environments on child, adolescent, and adult achievement. Life cycle skill formation is a dynamic process in which early inputs strongly affect the productivity of later inputs.

Four core concepts important to devising sound social policy toward early childhood have emerged from decades of independent research in economics, neuroscience, and developmental psychology (*1*). First, the architecture of the brain and the process of skill formation are influenced by an interaction between genetics and individual experience. Second, the mastery of skills that are essential for economic success and the development of their underlying neural pathways follow hierarchical rules. Later attainments build on foundations that are laid down earlier. Third, cognitive, linguistic, social, and emotional competencies are interdependent; all are shaped powerfully by the experiences of the developing child; and all contribute to success in the society at large. Fourth, although adaptation continues throughout life, human abilities are formed in a predictable sequence of sensitive periods, during which the development of specific neural circuits and the behaviors they mediate are most plastic and therefore optimally receptive to environmental influences.

A landmark study concluded that "virtually every aspect of early human development, from the brain's evolving circuitry to the child's capacity for empathy, is affected by the environments and experiences that are encountered in a cumulative fashion, beginning in the prenatal period and extending throughout the early childhood years" (*2*). This principle stems from two characteristics that are intrinsic to the nature of learning: (i) early learning confers value on acquired skills, which leads to self-reinforcing motivation to learn more, and (ii) early mastery of a range of cognitive, social, and emotional competencies makes learning at later ages more efficient and therefore easier and more likely to continue.

Early family environments are major predictors of cognitive and noncognitive abilities. Research has documented the early (by ages 4 to 6) emergence and persistence of gaps in cognitive and noncognitive skills (*3*, *4*). Environments that do not stimulate the young and fail to cultivate these skills at early ages place children at an early disadvantage. Disadvantage arises more from lack of cognitive and noncognitive stimulation given to young children than simply from the lack of financial resources.

This is a source of concern because family environments have deteriorated. More U.S. children are born to teenage mothers or are living in single parent homes compared with 40 years ago (*5*). Disadvantage is associated with poor parenting practices and lack of positive cognitive and noncognitive stimulation. A child who falls behind may never catch up. The track records for criminal rehabilitation, adult literacy, and public job training programs for disadvantaged young adults are remarkably poor (*3*). Disadvantaged early en-

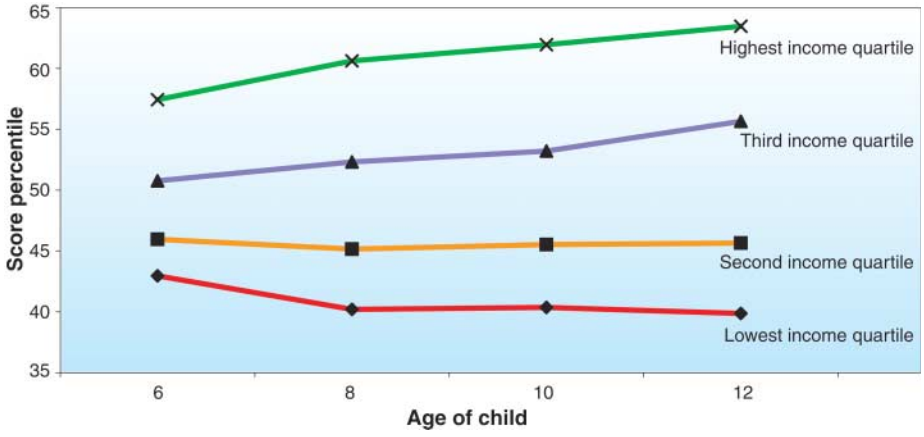

Fig. 1. Average percentile rank on Peabody Individual Achievement Test–Math score by age and income quartile. Income quartiles are computed from average family income between the ages of 6 and 10. Adapted from (*3*) with permission from MIT Press.

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vironments are powerful predictors of adult failure on a number of social and economic measures.

Many major economic and social problems can be traced to low levels of skill and ability in the population. The U.S. will add many fewer college graduates to its workforce in the next 20 years than it did in the past 20 years (*6*, *7*). The high school dropout rate, properly measured with inclusion of individuals who have received general educational development (GED) degrees, is increasing at a time when the economic return of schooling has increased (*8*). It is not solely a phenomenon of unskilled immigrants. Over 20% of the U.S. workforce is functionally illiterate, compared with about 10% in Germany and Sweden (*9*). Violent crime and property crime levels remain high, despite large declines in recent years. It is estimated that the net cost of crime in American society is $1.3 trillion per year, with a per capita cost of $4818 per year (*10*). Recent research documents the importance of deficits in cognitive and noncognitive skills in explaining these and other social pathologies (*11*).

Noncognitive Skills and Examples of Successful Early Interventions

Cognitive skills are important, but noncognitive skills such as motivation, perseverance, and tenacity are also important for success in life. Much public policy, such as the No Child Left Behind Act, focuses on cognitive test score outcomes to measure the success of interventions in spite of the evidence on the importance of noncognitive skills in social success. Head Start was deemed a failure in the 1960s because it did not raise the intelligence quotients (IQs) of its participants (*12*). Such judgments are common but miss the larger picture. Consider the Perry Preschool Program (*13*), a 2-year experimental intervention for disadvantaged African-American children initially ages 3 to 4 that involved morning programs at school and afternoon visits by the teacher to the child's home. The Perry intervention group had IQ scores no higher than the control group by age 10. Yet, the Perry treatment children had higher achievement test scores than the control children because they were more motivated to learn. In followups to age 40, the treated group had higher rates of high school graduation, higher salaries, higher percentages of home ownership, lower rates of receipt of welfare assistance as adults, fewer out-of-wedlock births, and fewer arrests than the controls (*13*). The economic benefits of the Perry Program are substantial (Table 1). Rates of return are 15 to 17% (*14*). (The rate of return is the increment in earnings and other outcomes, suitably valued, per year for each dollar invested in the child). The benefit-cost ratio (the ratio of the aggregate program benefits over the life of the child to the input costs) is over eight to one.

Perry intervened relatively late. The Abecedarian program, also targeted toward disadvantaged children, started when participants were 4 months of age. Children in the treatment group received child care for 6 to 8 hours per day, 5 days per week, through kindergarten entry; nutritional supplements, social work services, and medical care were provided to control group families. The program was found to permanently raise the IQ and the noncognitive skills of the treatment group over the control group. However, the Abecedarian program was intensive, and it is not known whether it is the age of intervention or its intensity that contributed to its success in raising IQ (*15*–*17*).

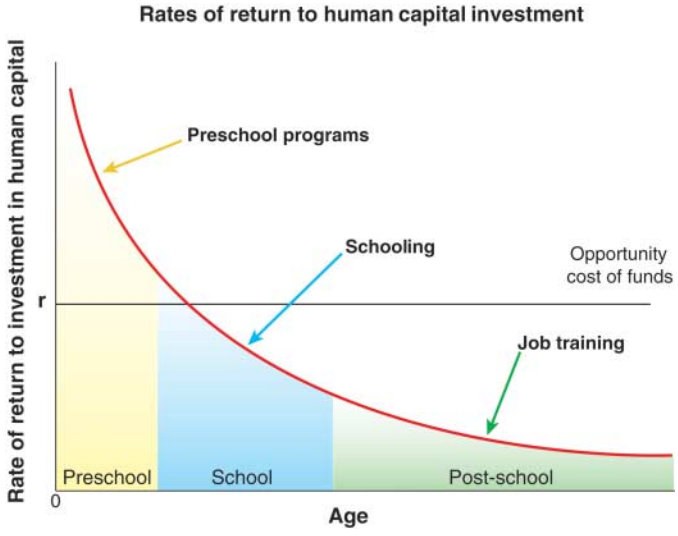

Fig. 2. Rates of return to human capital investment in disadvantaged children. The declining figure plots the payout per year per dollar invested in human capital programs at different stages of the life cycle for the marginal participant at current levels of spending. The opportunity cost of funds (*r*) is the payout per year if the dollar is invested in financial assets (e.g., passbook savings) instead. An optimal investment program from the point of view of economic efficiency equates returns across all stages of the life cycle to the opportunity cost. The figure shows that, at current levels of funding, we overinvest in most schooling and post-schooling programs and underinvest in preschool programs for disadvantaged persons. Adapted from (*3*) with permission from MIT Press.

Reynolds *et al.* present a comprehensive review of early childhood programs directed toward disadvantaged children and their impact (*18*). Similar returns are obtained for other early intervention programs (*19*, *20*), although more speculation is involved in these calculations because the program participants are in the early stages of their life cycles and do not have long earnings histories.

Schools and Skill Gaps

Many societies look to the schools to reduce skills gaps across socioeconomic groups. Because of the dynamics of human skill formation, the abilities and motivations that children bring to school play a far greater role in promoting their performance in school than do the traditional inputs that receive so much attention in public policy debates. The Coleman Report (*21*) as well as recent work (*22*, *23*) show that families and not schools are the major sources of inequality in student performance. By the third grade, gaps in test scores across socioeconomic groups are stable by age, suggesting that later schooling and variations in schooling quality have little effect in reducing or widening the gaps that appear before students enter school (*4*, *24*). Figure 1 plots gaps in math test scores by age across family income levels. The majority of the gap at age 12 appears at the age of school enrollment. Carneiro and Heckman performed a cost-benefit analysis of classroom size reduction on adult earnings (*3*). Although smaller classes raise the adult earnings of students, the earnings gains received by students do not offset the costs of hiring additional teachers. The student-teacher achievement ratio (STAR) randomized trial of classroom size in Tennessee shows some effect of reduced classroom size on test scores and adult performance, but most of the effect occurs in the earliest grades (*25*, *26*). Schools and school quality at current levels of funding contribute little to the emergence of test score gaps among children or to the development of the gaps.

Second Chance Programs

America is a second chance society. Our educational policy is based on a fundamental optimism about the possibility of human change. The dynamics of human skill formation reveal that later compensation for deficient early family environments is very costly (*4*). If society waits too long to compensate, it is economically inefficient to invest in the skills of the disadvantaged. A serious trade-off exists between equity and efficiency for adolescent and young adult skill policies. There is no such trade-off for policies targeted toward disadvantaged young children (*28*).

The findings of a large literature are captured in Fig. 2. This figure plots the rate of return, which is the dollar flow from a unit of investment at each age for a marginal investment in a disadvantaged young child at current levels of expenditure. The economic return from early interventions is high, and the return from later interventions is lower. Remedial programs in the adolescent and young adult years are much more costly in producing the same level of skill attainment in adulthood. Most are economically inefficient. This is reflected in Fig. 2 by the fact that a segment of the curve lies below the opportunity cost of funds (the horizon-

tal line fixed at r). The opportunity cost is the return from funds if they were invested for purposes unrelated to disadvantaged children.

Conclusions

Investing in disadvantaged young children is a rare public policy initiative that promotes fairness and social justice and at the same time promotes productivity in the economy and in society at large. Early interventions targeted toward disadvantaged children have much higher returns than later interventions such as reduced pupil-teacher ratios, public job training, convict rehabilitation programs, tuition subsidies, or expenditure on police. At current levels of resources, society overinvests in remedial skill investments at later ages and underinvests in the early years.

Although investments in older disadvantaged individuals realize relatively less return overall, such investments are still clearly beneficial. Indeed, the advantages gained from effective early interventions are sustained best when they are followed by continued high-quality learning experiences. The technology of skill formation shows that the returns on school investment and postschool investment are higher for persons with higher ability, where ability is formed in the early years. Stated simply, early investments must be followed by later investments if maximum value is to be realized.

Table 1. Economic benefits and costs of the Perry Preschool Program (*27*). All values are discounted at 3% and are in 2004 dollars. Earnings, Welfare, and Crime refer to monetized value of adult outcomes (higher earnings, savings in welfare, and reduced costs of crime). K–12 refers to the savings in remedial schooling. College/adult refers to tuition costs.

	Perry Preschool
Child care	$986
Earnings	$40,537
K–12	$9184
College/adult	$–782
Crime	$94,065
Welfare	$355
Abuse/neglect	$0
Total benefits	$144,345
Total costs	$16,514
Net present value	$127,831
Benefits-to-costs ratio	8.74

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PERSPECTIVE

Studying Adolescence

Linda M. Richter

Young people in their teens constitute the largest age group in the world, in a special stage recognized across the globe as the link in the life cycle between childhood and adulthood. Longitudinal studies in both developed and developing countries and better measurements of adolescent behavior are producing new insights. The physical and psychosocial changes that occur during puberty make manifest generational and early-childhood risks to development, in the form of individual differences in aspects such as growth, educational attainment, self-esteem, peer influences, and closeness to family. They also anticipate threats to adult health and well-being. Multidisciplinary approaches, especially links between the biological and the social sciences, as well as studies of socioeconomic and cultural diversity and determinants of positive outcomes, are needed to advance knowledge about this stage of development.

Young people aged 10 to 19 currently constitute a demographic bulge. They are the largest age group in the world, making up close to 20% of the 6.5 billion world population estimated in 2005 (*1*), 85% of whom live in developing countries and account for about one-third of those countries' national populations. Adolescence has also been described as "demographically dense": a period in life during which a large percentage of people experience a large percentage of key life-course events (*2*). These include leaving or completing school, bearing a child, and becoming economically productive. They also include experiences, more common in this age group than in others, that are capable of substantially altering life trajectories: nonconsensual sex, alcohol and drug abuse, self-harm and interpersonal violence, and getting into trouble with the law. Diet and activity patterns, friendships, educational achievement, and civic involvement all affect current health,

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