Investing in our Young People: Lessons from Economics and Psychology[*]

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Economists have come to appreciate the role of personality and cognitive ability in shaping life outcomes. We have learned that more than cognition is at work in explaining differences in human achievement. There is also a substantial role for chance (50% at age 18) in predicting lifetime outcomes (Cunha and Heckman, 2007a). This knowledge is helpful in devising strategies to promote human development.

Economists and psychologists address many of the same questions and both consider the factors that promote human development. It is useful to integrate the research in the two fields to enrich each other. In this lecture, I show how psychology informs the economist's understanding of human development. I discuss some open questions and how psychology and economics can enrich each other.

1   Lessons for Economics from Psychology

Economics and psychology were once closely united. A central development in the economics of first half of the 20th century was the weaning of economics from psychology, culminating in revealed preference analyses that replaced measurable-cardinal-utility with ordinal utility. In the past 60 years, there has been a gradual reattachment of the two fields. Since the

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middle of the last century, economists have returned to certain versions of cardinal utility to understand choices in risky situations. The emerging field of behavioral economics has drawn extensively on the psychology of preferences and has introduced a variety of new preference specifications into economics to explain behavior.

New concepts of risk aversion and time discounting, as well as notions of loss aversion, ambiguity aversion and social preferences have been introduced to explain a diverse array of behaviors that standard theory cannot explain or can explain only through very contorted mechanisms. More recently, economists have worked with psychologists and measured "happiness," quantifying a version of Jeremy Bentham's social utility (van Praag and Ferrer-i Carbonell, 2004). Even more recently, economists have drawn on and contributed to personality psychology (Borghans, Duckworth, Heckman, and ter Weel, 2008).

Economists have long noted that the psychological construct IQ is a principle determinant of earnings, the basic economic constraint that affects the choice behavior of most people. Economists have also studied personality as a determinant of earnings, as well as of information and preferences. More generally, personality defines a set of constraints. Both personality and cognitive constraints affect the options people can select.

Recent research also investigates the origin of preferences, personality and cognition, and how families and other social institutions generate them. This works examines the origins of inequality and helps in devising policies to reduce it (Cunha and Heckman, 2009).

Psychology teaches economists to recognize heterogeneity in preferences and types and to understand that traits are not "set in stone" but develop (see Borghans, Golsteyn, Heckman, and Meijers, 2009). Traits also have stability across situations. While they change over the life cycle, they do so in a stable way. It is important in designing good policies for investing in young people to recognize the predictive power of personality traits and the evidence on how they develop.

2 Some Evidence on the Importance of Noncognitive Skills

Evidence from the GED program in the United States demonstrates the power of noncognitive skills (Heckman, Humphries, LaFontaine, and Mader, 2009).[1] The GED program is a second chance program in the U.S. and Canada given to secondary school dropouts to certify them as equivalent to ordinary secondary school graduates. Participation in the GED program is growing. Currently 14% of U.S. high school "graduates" are dropouts who exam

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[1]GED is an acronym for General Educational Development.

Figure 1: Density of age adjusted AFQT scores, GED recipients and high school graduates with twelve years of schooling. AFQT is a measure of scholastic achievement. This graph shows that, in terms of cognitive measures, GEDs are the equals of ordinary high school graduates.
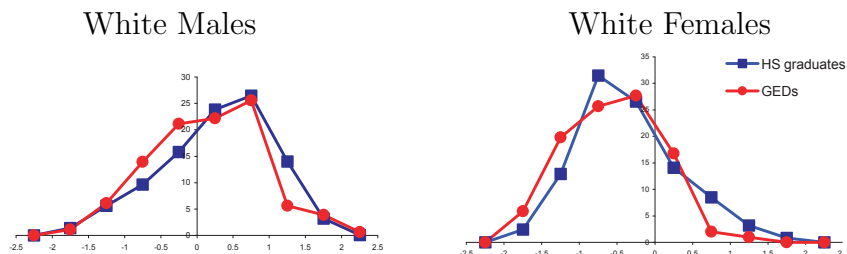
Source: Heckman and Rubinstein (2001).

certify. GEDs are required to pass a test of cognitive capabilities. The test is successful in its own terms. See Figure 1 which plots the distributions of test scores for GEDs and for ordinary high school graduates. The distributions are virtually identical.

Yet GEDs earn at the rate of high school dropouts. GEDs are as smart as ordinary high school graduates. Yet they lack noncognitive skills. The GEDs are the wise guys who can't finish anything. The failure of a test of cognition to predict success in the labor market is revealing. It suggests that noncognitive skills play a powerful role in shaping life outcomes.

3 Capabilities and Outcomes

3.1 Incorporating Personality Enriches Economics

A core low-dimensional set of capabilities explains a variety of diverse socioeconomic outcomes. Cognitive and noncognitive capabilities can be measured precisely and both are important causal determinants of many social and economic outcomes. (See Heckman, Stixrud, and Urzua, 2006.) They are not solely genetically determined, and they can be enhanced by investments made by families and society. There are sensitive periods for their development: earlier in life for cognitive capabilities, and later in life for noncognitive capabilities. This evidence has major implications for the design of economic policy. (See Cunha and Heckman, 2009.)

A major finding of microeconomics and psychology is heterogeneity and diversity among people in preferences, traits and constraints. This produces comparative advantage in many aspects of economic and social life and leads to sorting of people into different occupations in life.

4   Understanding the Multiplicity and Power of Capabilities: Ability matters and abilities are multiple in nature

Cognitive capabilities are divided into two categories: crystallized and fluid intelligence. (See, e.g., McArdle, Ferrer-Caja, Hamagami, and Woodcock, 2002.) There are different age profiles for their development.

Noncognitive capabilities include perseverance, motivation, time preference, risk aversion, self-esteem, self-control, preference for leisure, conscientiousness, and forward-looking behavior. (See Borghans, Duckworth, Heckman, and ter Weel, 2008.) There is substantial evidence that cognitive and noncognitive traits are *not* solely situational specific. Each trait evolves over the life cycle, and is affected by family and social environments. Over the life cycle, levels of each trait are positively (but not perfectly) correlated. Both cognitive and noncognitive capabilities have direct causal effects on wages (controlling for schooling), schooling, health, performance on achievement tests, crime, teenage pregnancy, compliance with health protocols, smoking and many other aspects of social and economic life.

Consider some of the empirical evidence on the predictive power of cognitive and noncognitive traits. Figure 2 shows that both cognitive and noncognitive traits are important in predicting a variety of outcomes.

Figure 2: Predictive Validities, IQ, and Big Five Dimensions
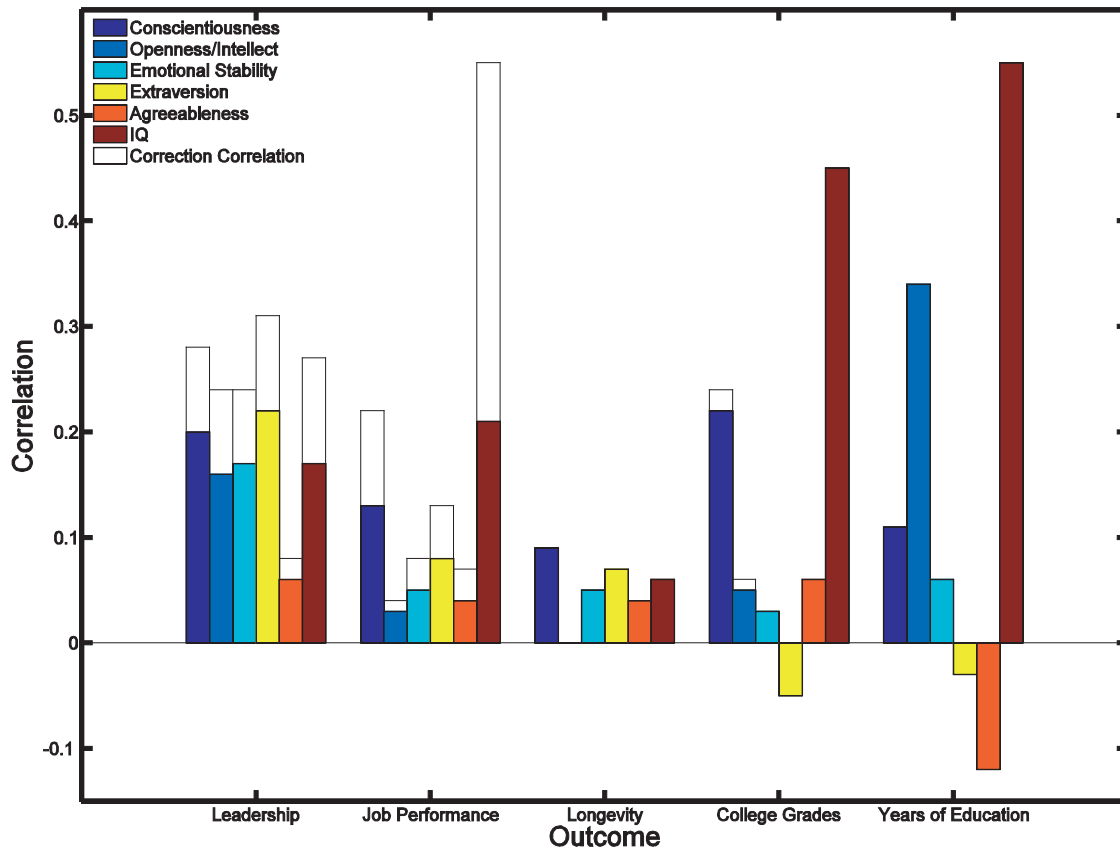
In terms of predicting a variety of outcomes, cognitive and noncognitive traits have roughly equal strength in the sense that a move from the bottom percentile to the top has roughly equal effects on the probability of being in jail by age 30 over most of the range of abilities and arguably stronger effects at low levels of endowments. (See Figure 3.)

The same is true of teenage pregnancy (Figure 4) and wages (Figure 5).

Figure 3: Ever been in jail by age 30, by ability (males)
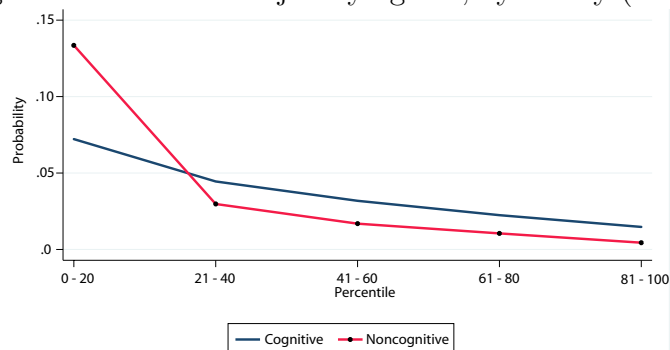
Note: This figure plots the probability of a given behavior associated with moving up in one ability distribution for someone after integrating out the other distribution. For example, the lines with markers show the effect of increasing noncognitive ability after integrating the cognitive ability. Source: Heckman, Stixrud, and Urzua (2006).

Figure 4: Probability of teenager being single with children (females)
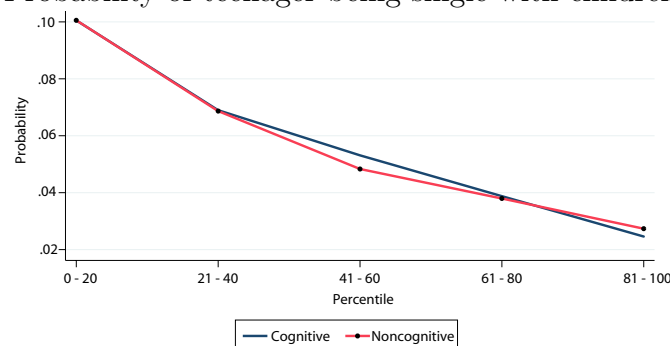
Note: This figure plots the probability of a given behavior associated with moving up in one ability distribution for someone after integrating out the other distribution. For example, the lines with markers show the effect of increasing noncognitive ability after integrating the cognitive ability. Source: Heckman, Stixrud, and Urzua (2006).

Figure 5: Mean log wages by age 30 (males)
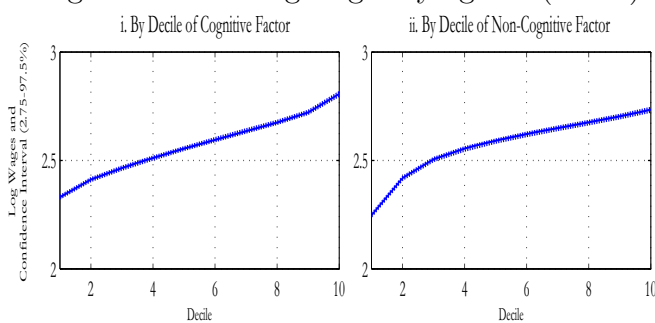
Note: The data simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (50 draws). Source: Heckman, Stixrud, and Urzua (2006).

5 Economic preference parameters are explained in part by cognition and personality.

Two parallel systems of preference parameters have been developed and measured in psychology and economics. Research is now very active that relates economic preferences to psychological measurements. Economic preference parameters include time preference, risk aversion, ambiguity aversion, leisure preference and social preferences (altruism, reciprocity, and inequality aversion). There is a lot of new work that relates conventional economic preference parameters to psychological measurements. This research produces a deeper understanding of the conventional preference parameters used in economics. See Borghans, Duckworth, Heckman, and ter Weel (2008) for further discussion.

6 For both cognitive and noncognitive traits, ability gaps among individuals and across socioeconomic groups open up at early ages and persist.

Figure 6 displays gaps in cognitive test scores by age between advantaged children and disadvantaged children. Schooling after the second grade plays only a minor role in creating or reducing gaps. There is a similar pattern for noncognitive skills. Controlling for early family environments substantially narrows the gaps. We cannot count on schools to narrow these gaps, nor should we blame schools for them. (See Cunha and Heckman, 2009.)

Such evidence leaves open the question of which aspects of families are responsible for producing these gaps. Is it due to genes? Family environments? Family investment decisions? The evidence from intervention studies suggests an important role for investments and family environments in determining adult capabilities.

7 Families vary greatly in the investments they make in children.

Investment in children varies substantially by family type. Differences are persistent over the life cycle of children.[2] Family environments for many children are worsening around the world. A divide is opening up in many other countries between the advantaged and the disadvantaged in the quality of early family environments. Those born into disadvantaged

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[2]See Moon (2009).

Figure 6: Trend in mean cognitive score by maternal education
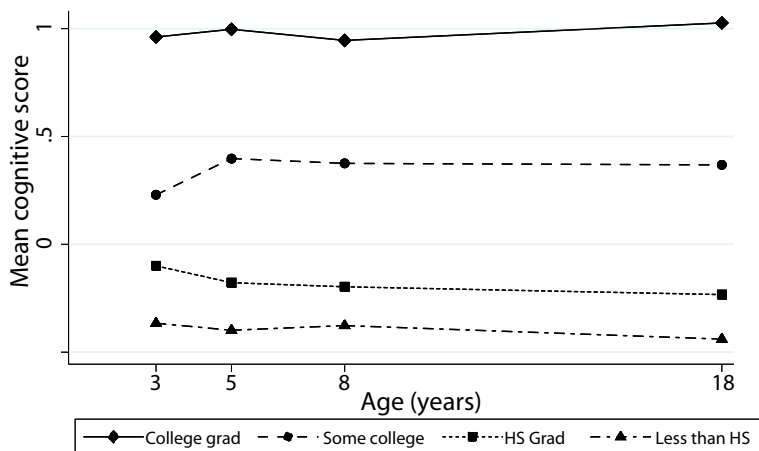
environments are receiving relatively less stimulation and child development resources than those from advantaged families. This phenomenon creates inequality within and across generations.

8 Critical and Sensitive Periods in the Development of Capabilities have been Documented for Humans and Animals

Sensitive and critical periods have been documented extensively for the development of many capabilities: (1) Language acquisition in humans (Newport, 2002). (2) Early vitamin/nutrient deficiencies can have substantial lasting negative effects on human development (e.g., Iron, Vitamin A, Iodine; blindness, impaired IQ, etc.; difficult to remediate at later ages). Knudsen, Heckman, Cameron, and Shonkoff (2006) present evidence on sensitive and critical periods. Cunha and Heckman (2009) and Cunha, Heckman, and Schennach (2009) show that the early years in the life of a child are sensitive periods for the production of cognitive skills, and the adolescent years are sensitive periods for the production of noncognitive skills.

9 Enriching Early Environments can Compensate In Part For the Risks Arising from Disadvantaged Parental Environments

Noncognitive abilities are a main channel through which successful interventions in the lives of disadvantaged children operate.

High/Scope Perry Preschool Program The Perry preschool program enriched the lives of low income African American children with initial IQs below 85 at age 3. It was evaluated by the method of random assignment. Participants were followed for 40 years. The intervention did not lead to sustained gains in IQ. Yet it had a statistically significant rate of return of around 6–10% per annum—for both boys and girls—above the post-World War II stock market returns to equity estimated to be 5.8%. It operated primarily through enhancing noncognitive skills (see Heckman, Malofeeva, Pinto, and Savelyev (2009)).

Table 1: Information about the Perry Preschool study (Schweinhart and Weikart, 1981).

Program Type:	Small sample randomized experiment (123 total children, 58 Treated, 65 Controlled);
Place and Time:	Conducted in Ypsilanti, Michigan, in the early 1960s;
Target Population:	Low IQ, Low SES, disadvantaged African-American Children;
Data:	Multiple measurements at ages 3–15,19,27,40.
Early Age:	Children were ages 3-5 while treated;
Duration:	Program lasted 30 weeks per year: mid-October–May for 2 years;
Curriculum:	Daily classroom sessions were 2.5 hours long;
Home Visits:	Weekly home visits by the teacher lasted 1.5 hours;
Teaching Method:	Perry Program was based on principles of active learning of Jean Piaget (1896–1980) (Schweinhart, Barnes, and Weikart, 1993; Weikart, Bond, and McNeil, 1978, pp. 5–6, 21–23);
Quality:	Teachers were certified in elementary and special education;
Program Cost:	The costs were $9,785 per participant per year (2006 dollars).

Figure 7 shows that by age 10 the effect of the treatment on IQ is zero. If it did not substantially raise IQ, how did it work? How was the 6–10% rate of return generated? What are the main channels of its influence? Like the "dark matter" hypothesis in astrophysics, something not observed by the original analysts of the Perry data is at work.[3] Since the evidence for cognitive impacts is weak, yet strong treatment effects are observed across many domains of social and economic life for both boys and girls, by elimination, Perry raised noncognitive skills (Heckman and Masterov, 2007). Fortunately, recent work in the study of early childhood interventions has moved beyond the dark matter realm. Direct measurements of the effects of the interventions on noncognitive skills have been obtained (Heckman, Malofeeva, Pinto, and Savelyev, 2009).

Figure 7: Perry Preschool Program: IQ, by Age and Treatment Group
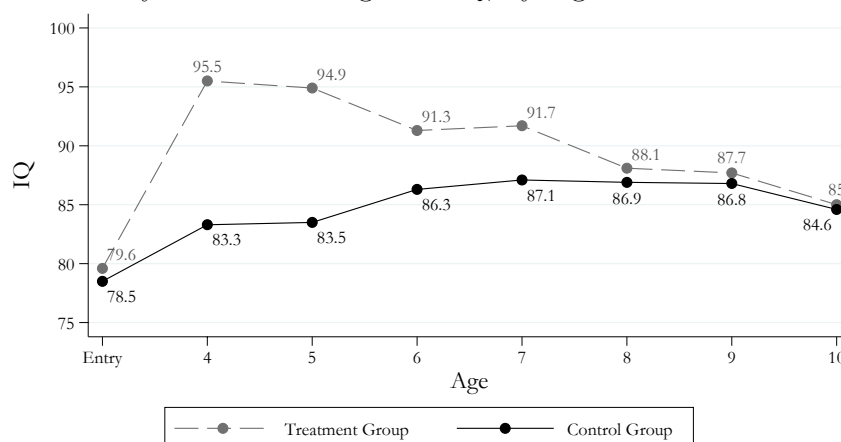

Notes: IQ measured on the Stanford Binet Intelligence Scale (Terman and Merrill, 1960). Test was administered at program entry and each of the ages indicated. Source: Heckman and Masterov (2007).

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[3]Dark matter is a concept developed in astrophysics to explain a variety of phenomena. It awaits experimental confirmation. Personality, on the other hand, has received direct empirical confirmation as I note below.

The Perry program promotes favorable personal behaviors. See Figure 8, where 1 = very bad, . . . , 5 = very good.

Figure 8: Personal Behavior Index by Treatment Group

(a) Control   (b) Treatment
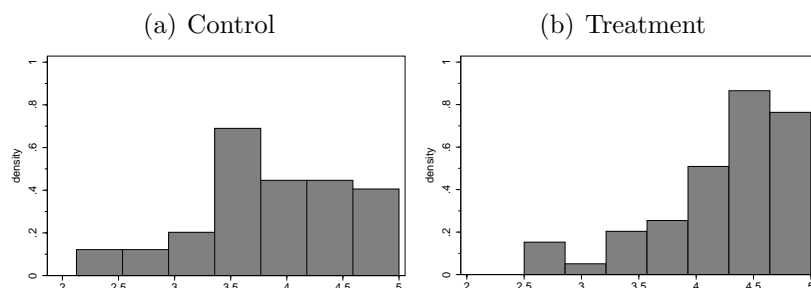
Notes: The Personal Behavior (Excluding Appearance/Hygiene) index is an unweighted average of four Pupil Behavior Inventory (PBI) measures: #8 (absences or truancies), #16 (lying or cheating), #21 (steals), and #28 (swears or uses obscene words), each an average over non-missing observations collected at ages 7–9. The original PBI "Personal Behavior" scale contains two more items in addition to those mentioned: #12 (inappropriate personal appearance) and #30 (poor personal hygiene). EFA analysis on Perry data showed that there are two separate factors behind the original "Personal Behavior" scale: one related to personal appearance/hygiene and the other to personal behavior excluding personal appearance/hygene. The latter proved to be very predictive for both genders. Source: Heckman, Malofeeva, Pinto, and Savelyev (2009)

It also promotes social development (Figure 9).

Figure 9: Social Development Index by Treatment Group

(a) Control   (b) Treatment
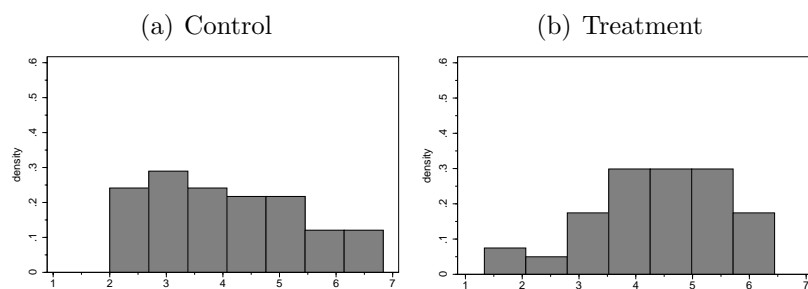
Notes: The Social Development Index is an unweighted average of four Perry Ypsilanti Rating Scale (YRS) measures: #1 (social relationships with class mates), #2 (social relationships with teacher), #7 (level of emotional adjustment), and #11 (extraversion), each an average over non-missing observations collected at ages 7–9. Source: Heckman, Malofeeva, Pinto, and Savelyev (2009)

Effects on socioemotional skills are strong for both gender groups (see Figures 10 and 11).
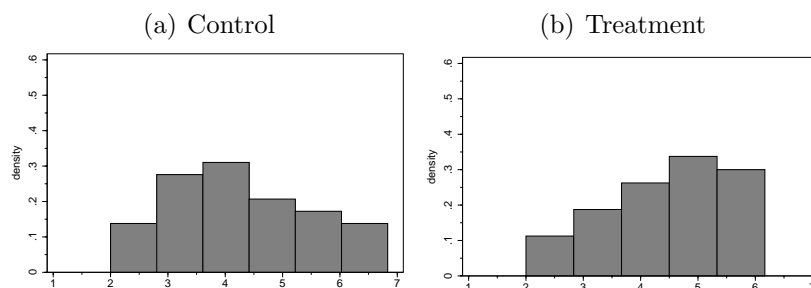
Figure 10: Social Development Index, Males

(a) Control   (b) Treatment

Figure 11: Social Development Index, Females

(a) Control   (b) Treatment
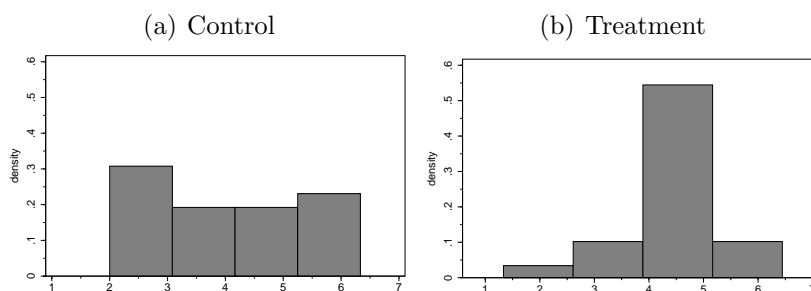

Treatment "cuts" the lower tail of the distribution of misbehavior. See Figure 12. Treatment extends the high tail of the distribution. (A high score means less misbehavior.)

Figure 12: Misbehavior Index by Treatment Group, ages 6–9.

(a) Control   (b) Treatment

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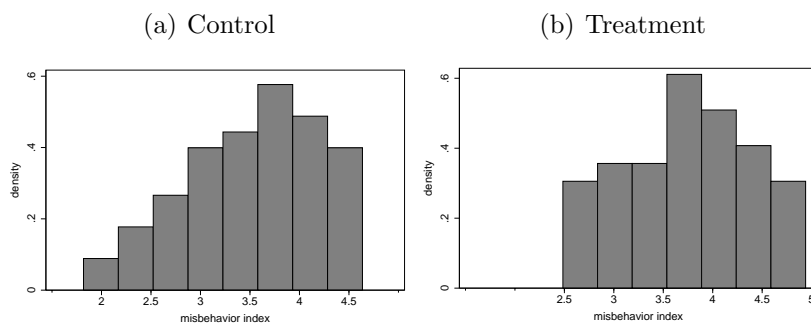
Even though IQ was not raised by the Perry program, scores on achievement tests were raised. See Figure 13. As noted by Borghans, Golsteyn, and Heckman (2009), achievement test scores depend as much on noncognitive skills as on IQ. Perry motivated children to learn, even if it did not make them any brighter.

Figure 13: Perry Age 14 Total CAT Scores, by Treatment Group
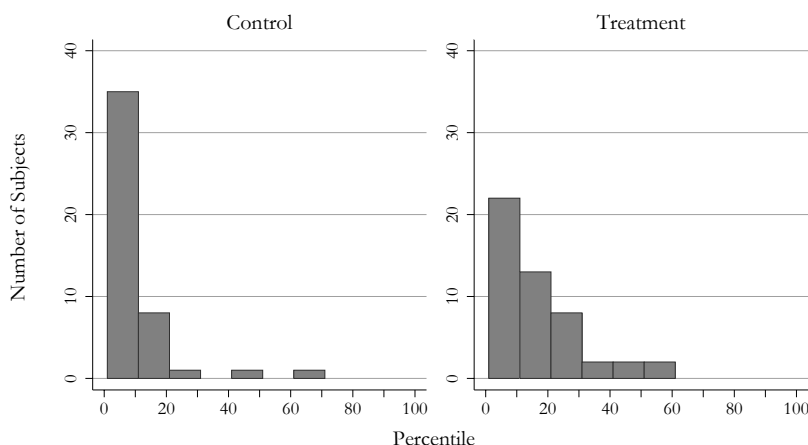
CAT = California Achievement Test
Treatment: $N = 49$; Control: $N = 46$
Statistically Significant Effect for Males and Females (p-values 0.009, 0.021 respectively)

Source: Heckman, Malofeeva, Pinto, and Savelyev (2009).

10 Decomposing Treatment Effects

To gain an idea of the importance of the role of cognitive and noncognitive skills and the effects of the Perry Program in boosting outcomes, Heckman, Malofeeva, Pinto, and Savelyev decompose the program treatment effects into cognitive and noncognitive components (see Heckman, Malofeeva, Pinto, and Savelyev, 2009). See Figures 14 (females) and 15 (males). Cognitive effects are relatively unimportant especially for males. Noncognitive effects are much stronger.

The Perry study has rich cognitive measures, reflecting its emphasis on cognition at the time the study was conducted. The available noncognitive measures are more meager. The *measured* noncognitive component of the treatment effects likely understate the contribution of noncognitive factors to explaining treatment effects.

Figure 14: Decompositions of Treatment Effects, Females
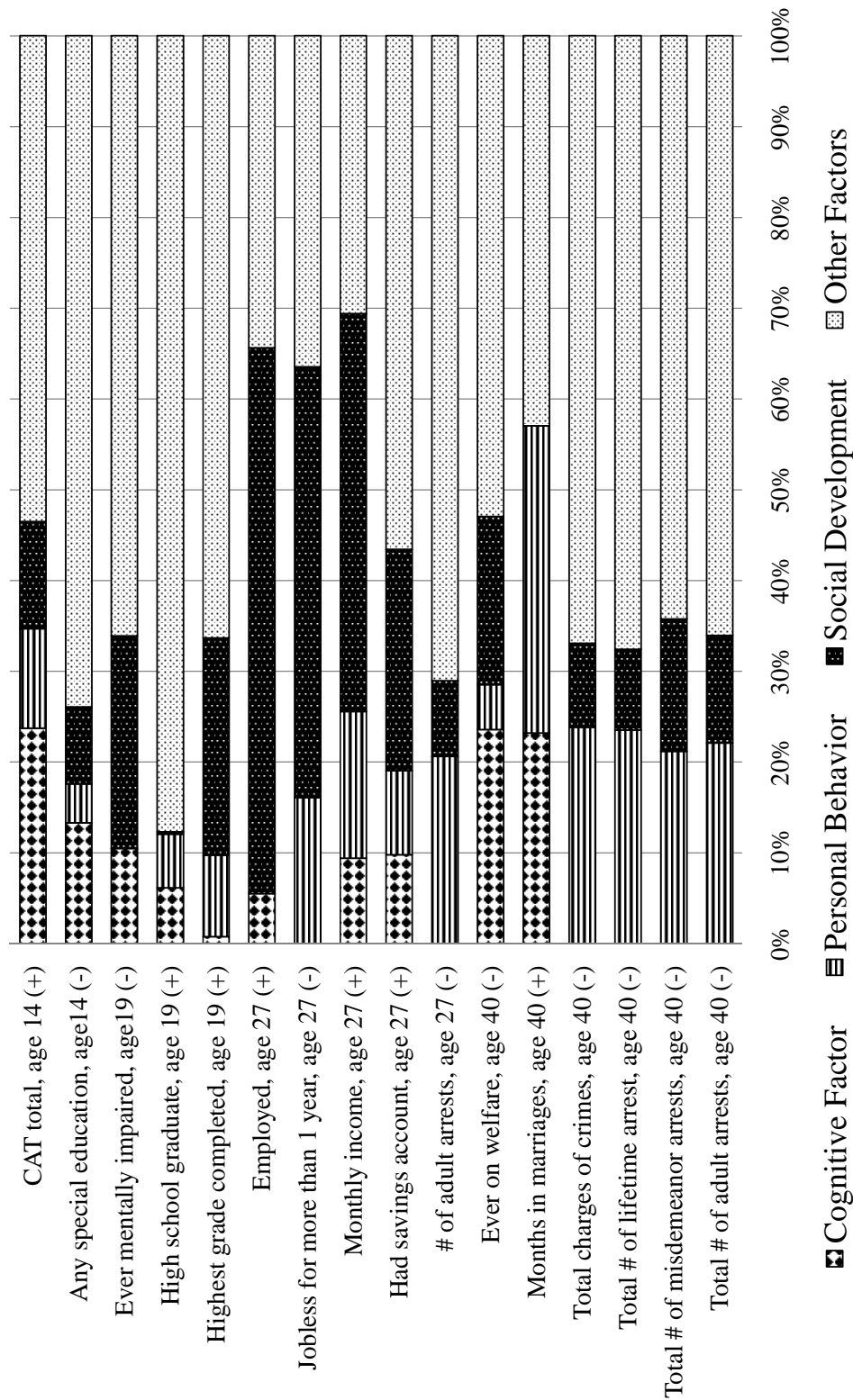
"(+)" denotes a positive treatment effect, "(-)" denotes a negative effect. The cognitive factor is based on three measures: the Stanford-Binet Intelligence Scale, the Peabody Picture Vocabulary Test (PPVT), and the Leiter International Performance Scale. The misbehavior factor is based on four Pupil Behavior Inventory (PBI) measures related to inappropriate social behavior. The social development factor is based on 4 Ypsilanti Rating Scale (YRS) measures describing social relationships and the extent of extraversion. Each measure is an average over non-missing items collected at ages 7–9.

Source: Heckman, Malofeeva, Pinto, and Savelyev (2009)

Figure 15: Decompositions of Treatment Effects, Males
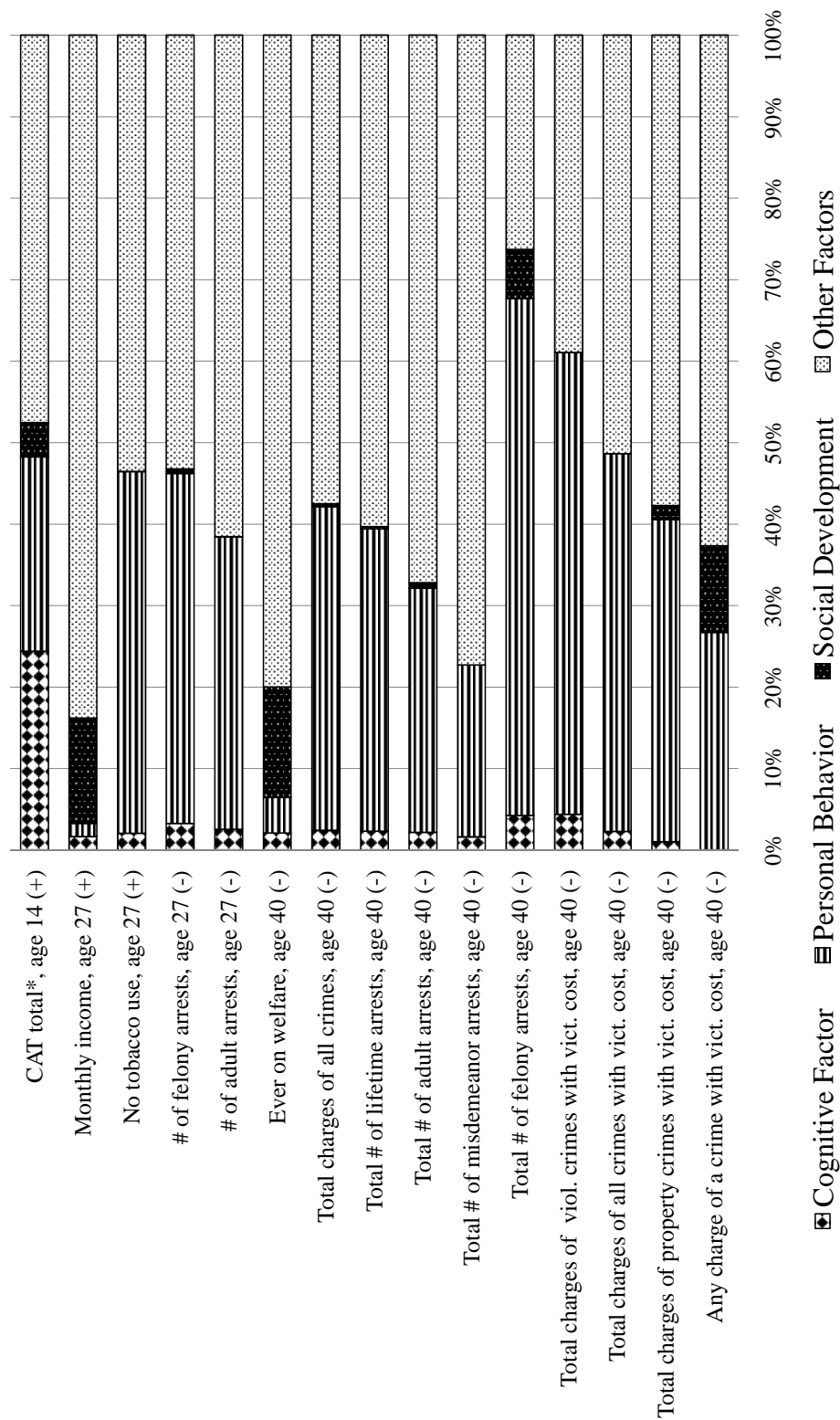
Source: Heckman, Malofeeva, Pinto, and Savelyev (2009)

10.1 Stability of Traits over the Life Cycle

Personality traits are not set in stone. They can be affected by experience and investment. Nor are they solely situationally specific. (See Borghans, Duckworth, Heckman, and ter Weel, 2008.) Overall IQ is stable after the early years. Fluid intelligence decreases over the life cycle while crystalized intelligence increases (see Figure 16). Conscientiousness increases with age (see Figure 17). For the life cycle paths of other traits, see Borghans, Duckworth, Heckman, and ter Weel (2008).

Figure 16: Fluid intelligence decreases and crystallized intelligence increases across the lifespan

Figure 17: Cumulative mean-level changes in personality across the life course
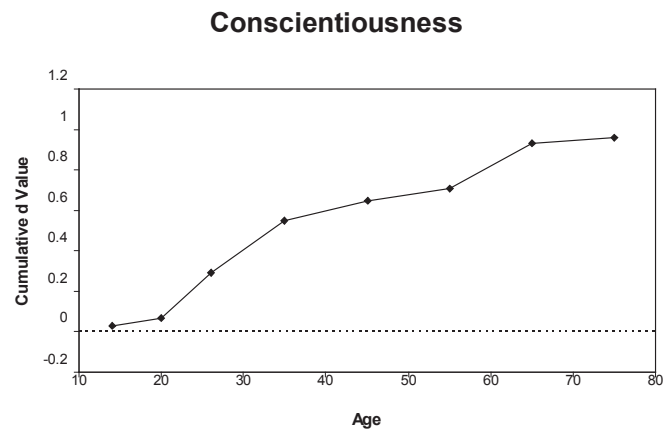
11 Later Remediation for Early Disadvantage is Costly and Often Ineffective

As *currently implemented*, most adolescent remediation efforts, especially those targeted toward the cognitive skills of disadvantaged adolescents have low economic returns. This is true of (1) active labor market programs, (2) class size reductions (reducing class size by five pupils per classroom), (3) adult literacy programs and public job training programs, and (4) tuition reduction programs. For evidence on this point, see Carneiro and Heckman (2003) and Cunha, Heckman, Lochner, and Masterov (2006).

There is a general pattern. The returns on later life programs are higher for the more able (where ability is measured in terms of both cognitive and noncognitive skills). There are lower returns for the less able adolescents (where, again, ability is measured in terms of both cognitive and noncognitive skills). However, nurturing motivational programs—programs that build social skills and promote social behavior—are effective in the adolescent years, but are very costly. It is economically more efficient to prevent human development problems than to remediate them.

12 Equity-Efficiency Tradeoffs

Economists often discuss equity/efficiency tradeoffs. A policy that improves efficiency often promotes inequality (e.g., a reduction in capital gains taxes). For adolescent and young adult interventions, there are substantial equity-efficiency tradeoffs for interventions in the lives of the less able, especially those that are targeted towards fostering cognitive capabilities. There is no equity-efficiency tradeoff for early interventions for the disadvantaged. This is a unique feature of early childhood intervention programs.

13 Characterizing Human Capabilities and their Formation

The following model of human capabilities and their formation explains the evidence on human development. An agent at age t is characterized by bundle of capabilities

$$\theta_t = (\ \underbrace{\theta_t^C}_{\text{cognitive}}\ ,\ \underbrace{\theta_t^N}_{\text{noncognitive}}\ ,\ \underbrace{\theta_t^H}_{\text{health}}).$$

The *outcome from activity k at age t is Y_t^k:*

$$Y_t^k = \psi_k \left(\theta_t, e_t^k \right), \quad k \in \{1, \ldots, K_t\}. \tag{1}$$

There are many tasks that people perform in life. Success in them depends on the endowment of traits (θ_t) and the incentives to exert effort to use the traits e_t^k. More formally, e_t^k is effort devoted to activity k at age t where the effort supply function depends on rewards and endowments. Effort depends on rewards and the situation in which persons find themselves as well as on personal goals and motives.

There are many ways to achieve a given level of performance on a task. For example, both cognitive and personality traits determine earnings. One can compensate for a shortfall in one dimension by having greater strength in the other. Different tasks require different capabilities. People pursue their *comparative advantage* by sorting into different tasks. Comparative advantage is a profound idea that has major implications for both economics and psychology.

Measurements of psychological traits are often context-specific. It is necessary to adjust for context (incentives to manifest traits) in comparing measurements of preference parameters or traits across situations. But traits are not *solely* situational specific. They persist across situations, but they do evolve over the life cycle. (See the discussion in Borghans, Duckworth, Heckman, and ter Weel, 2008.)

13.1   The Capability Formation Process

The capability formation process is governed by a multistage technology. Each stage corresponds to a period in the life cycle. The *technology of capability formation* (Cunha and Heckman, 2007b; Heckman, 2007) captures essential features of human and animal development. The stock of period $t + 1$ capabilities (θ_{t+1}) depends on period t capabilities, (θ_t), investments, (I_t), and parental environments (θ_t^P):

$$\underbrace{\theta_{t+1}}_{\substack{\text{Period } t \\ \text{Capabilities}}} = f_t(\underbrace{\theta_t}_{\substack{\text{Period } t+1 \\ \text{Capabilities}}} , \underbrace{I_t}_{\substack{\text{Period } t \\ \text{Investment}}} , \underbrace{\theta_t^P}_{\substack{\text{Parental} \\ \text{Environments}}}). \tag{2}$$

A crucial feature of the technology that helps to explain many findings in the literature on capability formation is *synergy* or *complementarity of capabilities with investment*. A higher level of period t capabilities raises the productivity of investment in period t in producing capabilities in the next period θ_{t+1}. Capabilities are self-productive and cross-productive.

For example, higher levels of noncognitive skills foster the production of cognitive skills (Cunha and Heckman, 2009). Those open to experience learn from it. For technology (2), more investment raises productivity:

$$\uparrow I_t \Rightarrow \theta_{t+1} \uparrow .$$

The effect of investment in period t in producing capabilities the next period is stronger the higher θ_t and θ_t^P (synergy or complementarity).

Synergy explains the evidence that early nurturing environments affect the ability of animals and humans to learn. It explains why investments in disadvantaged young children are so productive. They enhance the productivity of later investments. Synergy also explains why investment in low ability adults often has such low returns—because their stock of θ_t is low. Early environments determine the success or failure of investment in later environments.

13.2 Estimating the Technology of Skill Formation: The Dynamics of the Evolution of Capabilities and Their Implications for Social Policy

Cunha, Heckman, and Schennach (2009) use psychological measurements linked to tangible outcomes to estimate the technology of capability formation (2). They report evidence of sensitive periods—periods in the life cycle where the productivity of investment (I_t) is high. Sensitive periods for cognitive skills occur early in life. Sensitive periods for noncognitive skills occur in the adolescent years and are associated with the flourishing of traits in adolescence.

For simplicity, consider two periods of childhood corresponding to early childhood and adolescence. Using their estimated technology, Cunha, Heckman, and Schennach (2009) consider investment strategies that maximize the amount of schooling in society for a fixed level of expenditure. The optimal policy is to invest relatively more in the early lives of the most disadvantaged children. See Figure 18.[4] Contrary to what optimality would dictate, children born into advantageous environments typically receive *more* parental investment than children from less advantaged environments. (See Moon, 2009.)

For later periods, the optimal policy is relatively even-handed across children of different socioeconomic backgrounds. In fact, an optimal policy slightly favors more advantaged children. It is socially optimal to invest more in the adolescent years in the lives of *advantaged* children than in disadvantaged children. This is a manifestation of the dynamic complemen-

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[4]In that figure, the light shading represents relatively greater investment.

tarity that produces an equity-efficiency tradeoff that characterizes later stage investment but not early investment.

Figure 18: Optimal Early (Left) and Late (Right) Investments by Child Initial Conditions of Cognitive and Noncognitive Capabilities Maximizing Aggregate Education
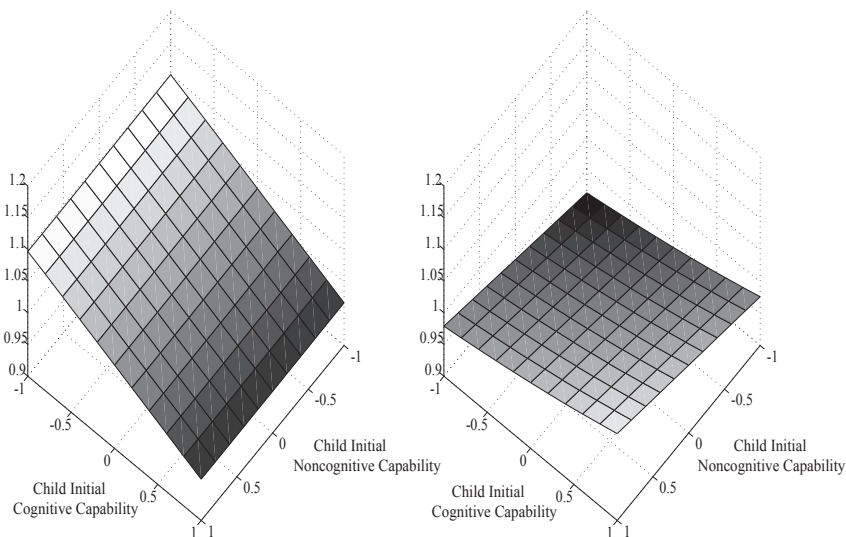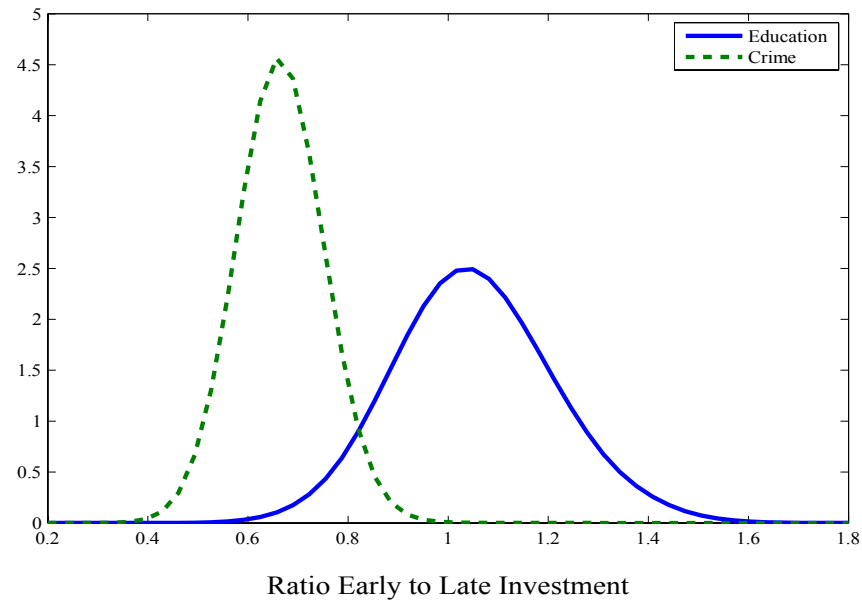

Source: Cunha, Heckman, and Schennach (2009)

The optimal ratio of early-to-late investment depends on the desired outcome, the endowments of children and the available budget. Consider the distribution of the optimal ratio of early-to-late investment for education and crime. The optimal policy for producing either outcome is not uniform across people. It depends on the conditions of disadvantage into which a child is born. Hence there is a distribution of optimal investment ratios across the population.

Participation in crime turns out to be relatively more strongly determined by noncognitive traits. It is more intensive in noncognitive skills than educational attainment, which depends relatively much more strongly on cognitive skills. Because Cunha, Heckman, and Schennach (2009) establish that compensation for adversity in noncognitive skills is less costly in the second period than in the first period, while the opposite is true for cognitive skills, it is optimal to weight first and second period investments in the directions indicated in Figure 19. Relatively more investment in the early years than in later years promotes education. Relatively more investment in the later years is optimal if the goal is to reduce crime.

Figure 19: Densities of Ratio of Early to Late Investments Maximizing Aggregate Education versus Minimizing Aggregate Crime

Ratio Early to Late Investment

Source: Cunha, Heckman, and Schennach (2009)

Because the timing and level of optimal interventions for disadvantaged children depend on the conditions of disadvantage and the nature of desired outcomes, targeted strategies are likely to be effective especially for different target outcomes that weight cognitive and noncognitive traits differently.

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14 Summary and Conclusions

A full understanding of child development draws on knowledge from economics and psychology. Both cognitive and noncognitive capabilities produce a variety of behaviors and outcomes. An emerging literature relates psychological measurements of personality and cognition to economic preference parameters and extends conventional preference specifications in economics. Comparative advantage is an empirically important feature of economic and social life. The same bundle of personal traits has different productivity in different tasks, and people with different bundles sort into tasks according to their comparative advantage.

Recent empirical work on the technology of capability formation provides an operational empirical framework that captures these ideas (see Cunha and Heckman, 2009). Capabilities are not invariant traits and are causally affected by parental investment and early social environments. Moreover, capabilities are not solely situational specific. They are stable, but they evolve over the life cycle. Measures of capabilities should standardize for the environments in which they are taken — a basic tenet of science. Otherwise traits may appear to be unstable across situations (Borghans, Duckworth, Heckman, and ter Weel, 2008).

The technology of capability formation rationalizes a large body of evidence in economics, psychology, and neuroscience. Capabilities are self-productive and cross-productive. Synergies in the technology (2) explain why it is so productive to invest in the cognitive skills of disadvantaged young children but why the payoffs are so low for cognitive investments in disadvantaged older children and are even lower for disadvantaged adults. There is no equity-efficiency trade-off for investment in the capabilities of young disadvantaged children. There is a substantial equity-efficiency trade-off for investment in the capabilities of older disadvantaged children. Later remediation should focus on fostering noncognitive traits related to personality.

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