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The Developmental Origins of Health¹

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Abstract

This paper argues that health economists should consider the costs and benefits of preventing rather than treating disease. It sketches a developmental approach to health that examines the costs and benefits of interventions over the life cycle.

Keywords

Health; Prevention; Remediation; Capabilities; Technology of Capability Formation

I congratulate the editors of *Health Economics* for twenty successful years. Continued success requires publishing research at the frontiers of knowledge. One frontier is the developmental origins of health.

Among early deaths in the United States, some claim that 40% are due to patterns of behavior, 30% are due to genetic predispositions, 15% are due to social circumstances, and 10-15% are due to shortfalls in medical care (McGinnis et al., 2002). It is a matter of record that the U.S. spends trillions of dollars on health, 95% of which is on treatment, not prevention. Much contemporary research in health economics studies the costs and benefits of alternative treatment and delivery systems. In contrast, research has only started to consider how early life prevention and later life remediation can extend the quality and length of life and avoid costly treatment¹.

Two distinct bodies of research suggest that the early years of childhood shape many adult behaviors and outcomes. The “fetal programming” literature surveyed in Gluckman and Hanson (2006) demonstrates that *in utero* environments affect adult health. The essays in Gluckman and Hanson discuss the importance of a variety of early environments on adult health. Fogel (1997, 2004) shows that early nutrition affects adult health. Barker (1998) demonstrates that environmental insults *in utero* and in infancy predict the onset of adult coronary disease, stroke, diabetes and hypertension. Fetal and maternal nutrition are important predictors of adult health. Currie (2009, 2011) and Almond and Currie (2011) survey empirical relationships between early-life conditions and adult health reported in the recent literature in economics.

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¹By prevention, I mean *primary prevention* that prevents the emergence of disease.

While epidemiologists typically adopt a life cycle, developmental, perspective (see, e.g., Davey-Smith, 2007), most health economists do not. For example, the influential analysis of Grossman (1972, 2000) focuses exclusively on adult health investment decisions, taking the childhood health endowment and adult preferences as given. Galama and van Kippersluis (2010) and Galama (2011) substantially extend the Grossman framework. However, they do not model how preferences or childhood endowments are determined.

Parallel to the epidemiological literature, an emerging developmental literature in economics demonstrates the importance of early environmental conditions on the evolution of adolescent and adult cognitive and noncognitive capabilities (see, e.g., Knudsen et al., 2006; Cunha and Heckman, 2007). These capabilities strongly influence educational attainment, criminal behavior, earnings, and participation in risky behaviors (see Almlund et al., 2011). Like the fetal programming literature, this literature documents critical and sensitive periods in the development of capabilities. Unlike the fetal programming literature, it also considers environmental influences on development over the entire life cycle from childhood through adulthood.

Remediation of early disadvantage and resilience in response to adversity receive much more attention in this literature than in the current literature in health economics. For policy purposes, it is not enough to know that early-life conditions matter. It is important to know the costs and benefits of remediating early life deficits.

Each literature has much to learn from the other. Evidence on the importance of early environments on a spectrum of health, labor market, and behavioral outcomes, suggests that common developmental processes are at work.

Cognitive and noncognitive capabilities — self-regulation, motivation, time preference, far-sightedness, adventurousness and the like — affect the evolution of health capital by influencing choices made by parents and children including educational choices. In turn, education shapes personality and cognitive traits (Almlund et al., 2011; Heckman et al., 2006, 2011). Grossman (2000), Cutler and Lleras-Muney (2010), Conti et al. (2010a,b), and Heckman et al. (2011) show that education also causally affects health. Personality and cognition determine health and healthy behaviors beyond their direct effects on education and through the effects of education on health (Conti et al., 2010a,b, 2011).

Those with greater self-control and conscientiousness better follow medical instructions and take care of themselves. Certain personality types are at greater risk for health and mental health disorders (Borghans et al., 2008; Deary et al., 2010; Almlund et al., 2011). Personality traits affect learning (Duncan et al., 2007; Raver et al., 2007; Cunha and Heckman, 2008). Adverse health conditions impair learning (Currie, 2009). Ram and Schultz (1979) show that raising life expectation promotes investment in human capital. People with longer horizons and lower rates of time preference invest more in themselves. Lower rates of time preference are associated with greater cognitive skills².

The recent literature on personality and preference formation establishes causal impacts of parental inputs, social environments, schools, and other environmental factors in producing cognitive and noncognitive capabilities (Cunha and Heckman, 2007, 2009; Cunha et al., 2010). The parameters of the Grossman model and the models of Galama and van Kippersluis (2010) and Galama (2011) are the outputs of a developmental model.

²See the evidence reviewed in Almlund et al. (2011)

A developmental focus suggests new channels of policy influence to remediate well-documented health disparities. Early childhood interventions that affect the personality and cognitive traits that promote health can be effective policy tools to prevent and cure disease.

A simple investment framework unifies the literature on health and capability formation. It also reveals currently unexplored avenues for future research. The framework can be used to analyze synergies in producing health, cognitive and noncognitive capabilities. An econometric approach based on dynamic latent variables operationalizes this framework (see Cunha and Heckman, 2008, Cunha et al., 2010). This approach recognizes the proxy nature of variables like birthweight, height, nutrition, IQ scores, and measures of personality and mental illness that play prominent roles in empirical work in epidemiology, education and health economics.

1 The Economics of Human Development

Capabilities, incentives, and motivations jointly shape behavior. Capabilities emerge early. They are not set in stone and can be fostered. Families and environments play a powerful role in shaping these traits. A neglected avenue of investigation to promote health is interventions that form these capabilities by exploiting the synergisms among diverse policies. A good health policy may be a good family policy. This argument goes beyond considering education (e.g., Becker, 1964) or nutrition (Barker, 1998) but is consistent with both and integrates these more specialized emphases into a general framework.

Recent studies in the economics of human development establish that: (1) A core low-dimensional set of capabilities explains a variety of diverse socioeconomic outcomes; (2) Cognitive and noncognitive capabilities equally affect many outcomes; (3) Early health conditions also play a powerful role in explaining adult behaviors.

Early gaps in cognitive ability persist strongly, especially after the primary grades. Gaps in noncognitive capabilities persist less strongly. The fluidity of personality traits over the adolescent years is associated with the slowly emerging prefrontal cortex (see the evidence cited in Heckman, 2008 and Steinberg, 2008). Many early childhood interventions operate primarily through their effects on noncognitive capabilities. At current levels of practice, adolescent remediation for cognitive deficits is ineffective. Adolescent interventions in personality are far more effective (see Cunha et al., 2006; Cunha and Heckman, 2009; Almlund et al., 2011).

2 A Framework For Analyzing The Expression and Evolution of Capabilities

Cunha and Heckman (2007, 2009) and Heckman (2007) develop a framework for analyzing the expression and evolution of capabilities. Define a capability vector θ_t at age t :

$$\theta_t = \left(\underbrace{\theta_{C,t}}_{\text{Cognitive}}, \underbrace{\theta_{N,t}}_{\text{Noncognitive}}, \underbrace{\theta_{H,t}}_{\text{Health}} \right).$$

Each component may be a vector. Outcome j at time t , $Y_{j,t}$ depends on capabilities θ_t and effort $e_{j,t}$ devoted to the outcome as well as social context (background) variables $\theta_{t,B}$:

$$Y_{j,t} = \phi_{j,t}(\theta_t, e_{j,t}, \theta_{t,B}) \quad j=1, \dots, J \quad t=1, \dots, T.$$

Effort devoted to activity j at time t , $e_{j,t}$ depends on rewards and endowments:

$$e_{j,t} = \eta_{j,t} \left(\underbrace{R_{j,t}}_{\text{Rewards to effort}}, \underbrace{\theta_t}_{\text{Capabilities}}, \underbrace{\theta_{t,B}}_{\text{Background}} \right).$$

Cognition, personality and health stocks determine health outcomes and healthy behaviors.

The technology of capability formation (Cunha and Heckman, 2007; Heckman, 2007) represents the dynamics of capability formation as an equation of motion:

$$\theta_{t+1} = f_t \left(\underbrace{\theta_t}_{\text{Self Productivity}}, \underbrace{I_t}_{\text{Investment}}, \underbrace{\theta_{t,B}}_{\text{Background}} \right).$$

It has been applied to analyze a variety of data sets on a variety of outcomes including wages, crime, health and healthy behaviors, using a common core of capabilities.³ Estimates reveal sensitive periods in early life (before age 10) for cognitive capabilities and sensitive periods for noncognitive capabilities through adolescence (Cunha et al., 2010)⁴.

There is substantial evidence of synergies among productive traits, $\frac{\partial \theta_{t+1}}{\partial \theta_t} \geq 0$, as well as for dynamic complementarity, $\frac{\partial^2 \theta_{t+1}}{\partial \theta_t \partial I_t} \geq 0$, and for productivity of investment, $\frac{\partial \theta_{t+1}}{\partial I_t} \geq 0$.

Figure 1 summarizes the framework graphically. Some progress has been made in estimating the linkages displayed in this figure but most remain unknown. The figure suggests both opportunities and dangers. Investments and environments shape capabilities. There are many possible stages and strategies for intervention. Understanding at what stages investments are most effective for shaping which capabilities will inform policy. To make wise policy choices, it is necessary to have a deep understanding of the mechanisms displayed in Figure 1.

Knowing that early-life conditions causally affect adult health does not tell us the channels through which early-life conditions operate or the mechanisms through which effective remediation might operate. Early-life conditions might trigger a series of later-life events that shape the capabilities that produce adult outcomes. Perhaps later-life interventions can be highly effective. Alternatively, early-life conditions might affect biology in an irreversible way. In that case, early life interventions are essential. The current literature offers only hints at answers to these questions. When the causal links of Figure 1 are fleshed out, health economists will be better able to suggest wise policies for promoting the capabilities that produce health.

3 Does Education Promote Health?

Consider an example of research on one channel of influence displayed in Figure 1. Is education policy a promising avenue for promoting health? Specifically what is the effect of education in the adolescent years (an investment) on health and healthy behaviors? What is the relative importance of adolescent education compared to factors formed before the adolescent years?

³See the review in Almlund et al. (2011)

⁴Sensitive periods are periods where investment is more productive than other periods. Critical periods are the only periods where investment is productive. See Cunha and Heckman (2009) for precise definitions of these concepts

The developmental approach recognizes that schooling promotes cognition and personality. Schooling promotes health and healthy behaviors (Cutler and Lleras-Muney, 2010; Lochner, 2011; Conti et al., 2011; Currie and Moretti, 2003). There is a feedback loop as suggested in Figure 1. Enhanced capabilities promote schooling. Cognitive and noncognitive traits promote health and healthy behaviors.

Figure 2, based on British data analyzed by Conti et al. (2010a,b), shows the effect (by gender) of attendance beyond compulsory schooling on health and healthy behaviors measured at age 30. There is a strong causal effect of compulsory education on health and healthy behaviors. Factors formed before adolescence also matter but to different extents for different outcomes. Effects of education are heterogeneous across individuals, not only in magnitude but also in terms of sign. Recent research estimates the distribution of health responses to education (see Conti and Heckman, 2010). An important finding of this literature is that failure to control for personality traits overstates the relative importance of cognitive traits in predicting adult health (Conti et al., 2010a,b, 2011).

4 Summary

The developmental approach to the study of health promises to produce a deeper understanding of both prevention and remediation strategies. Understanding the dynamic mechanisms of causation is essential for devising wise policies. It is not enough to know that early-life conditions help shape later-life outcomes. We need to trace the effects of early-life outcomes on intermediate-life investments and environments in order to understand when and for what intervention can be effective.

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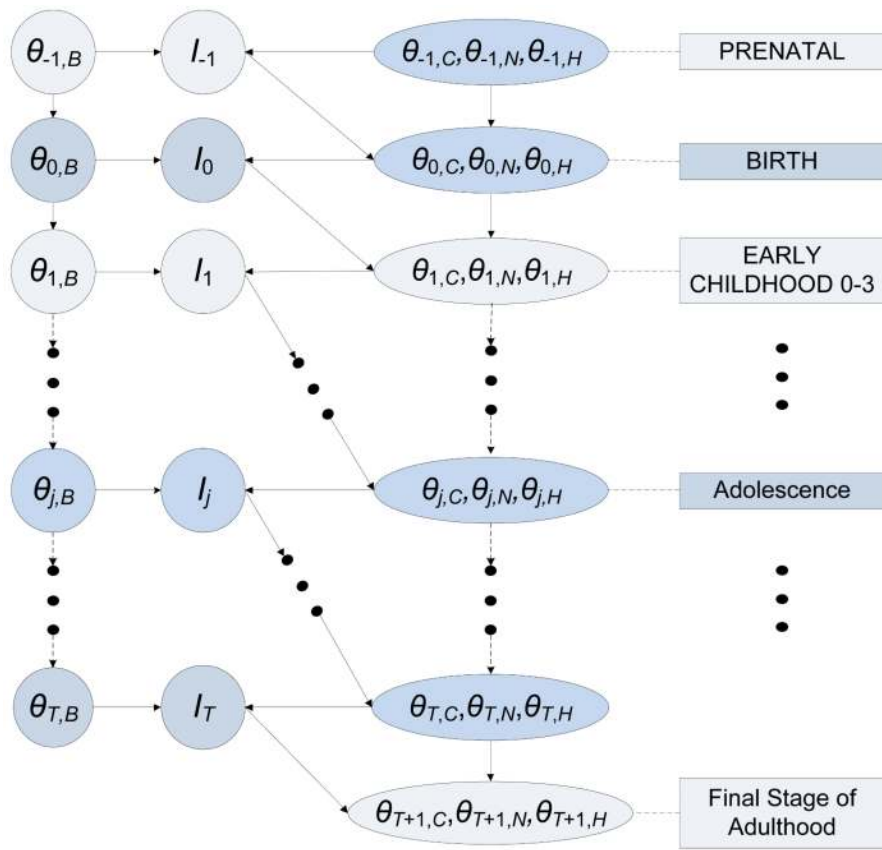


Figure 1.
 A Life Cycle Framework for The Development of Capabilities
 $\theta_t = (\theta_{C,t}, \theta_{N,t}, \theta_{H,t})$ capacities at t
 I_t : investment at t
 $\theta_{t,B}$ background factors (context)
 $\theta_{t+1} = f_t(\theta_t, I_t, \theta_{t,B})$

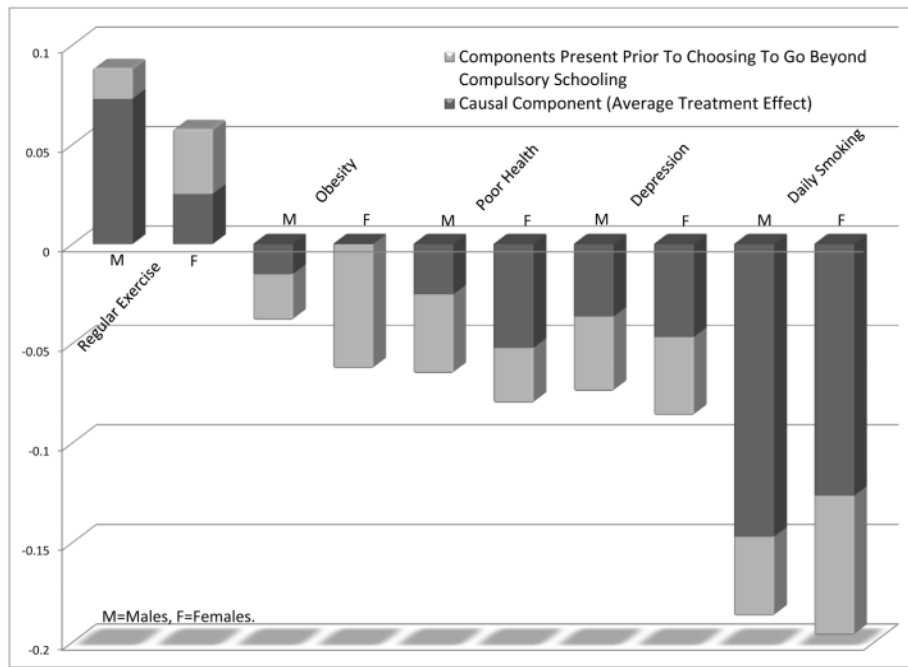


Figure 2.
 The Causal Effect of Education Beyond Compulsory Schooling on Health and Healthy Behaviors
 Source: Conti et al. (2010a,b), British Cohort Study 1970