

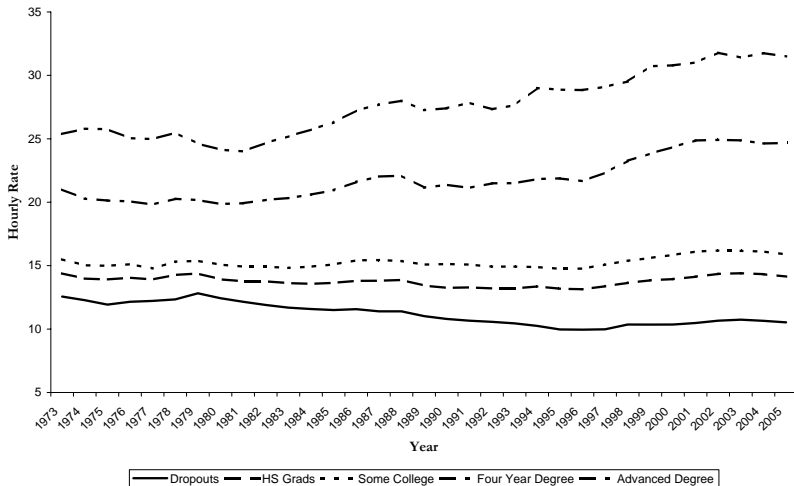
# Introduction:

## The Economics and Psychology of Human Development and Inequality

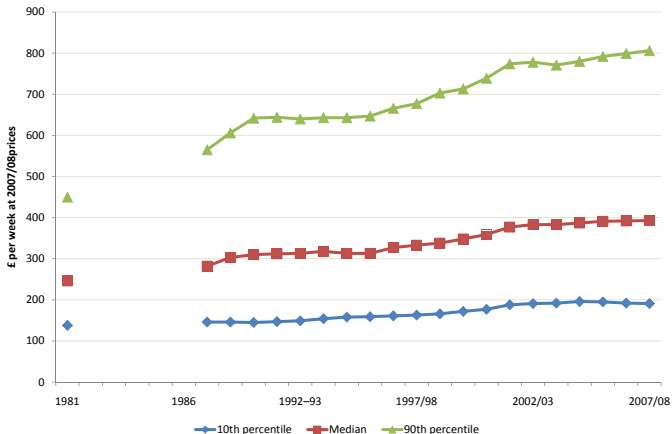
James Heckman  
University of Chicago  
University College Dublin

The Marshall Lectures 2010-2011  
Lady Mitchell Hall  
May 17, 2011

# Average Hourly Wages by Education Level, US 1973-2005



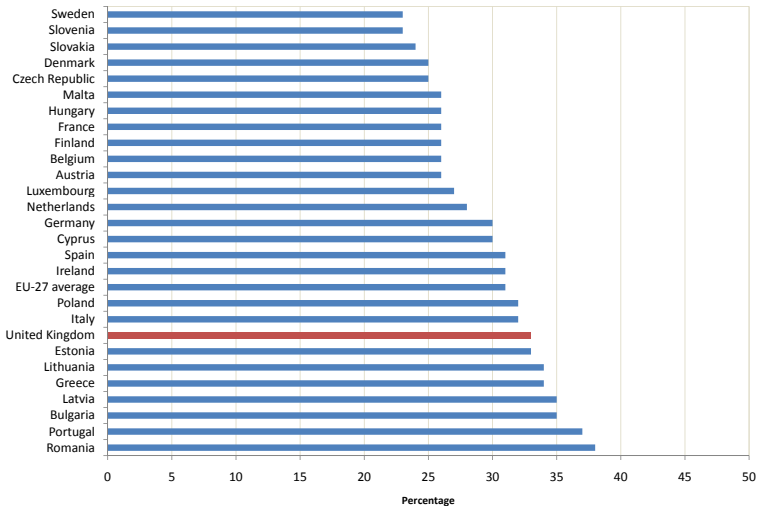
### Distribution of real household disposable income, UK



Comment: Income is adjusted to 2007/08 prices using the retail prices index less council tax/domestic rates. Equivalized household disposable is income before deduction of housing costs, using OECD equivalization scale. More information is available in "Social trends" 39 Appendix. Data for 1994/95 to 2001/02 are for Great Britain only.

Source: Office for National Statistics

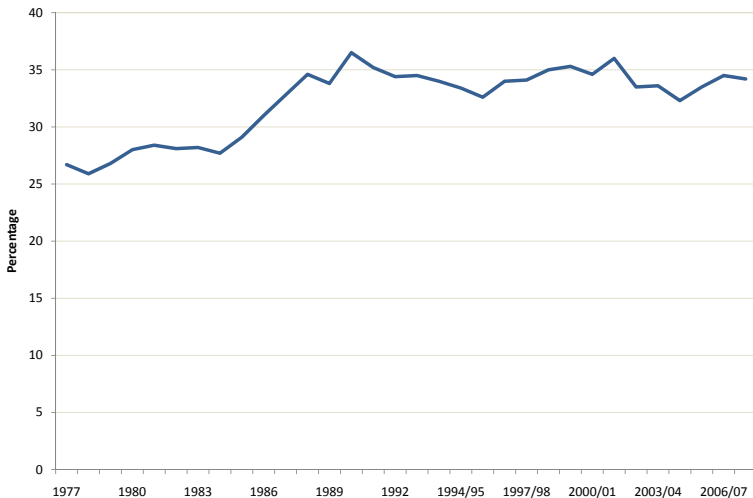
### Income inequality measured by Gini, EU-27 comparison, 2007



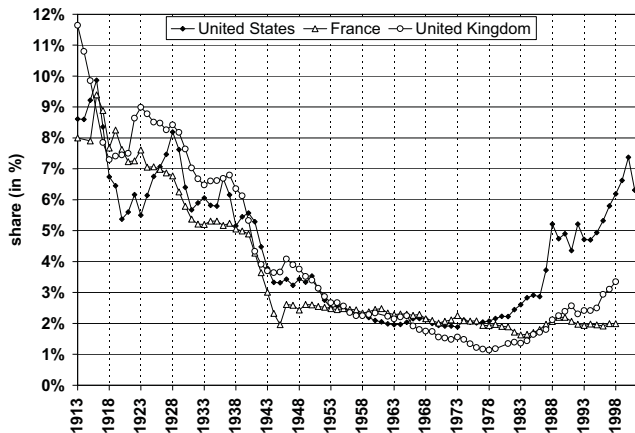
Source: Office for National Statistics



### Inequality (measured by GINI) of disposable income for all households, UK



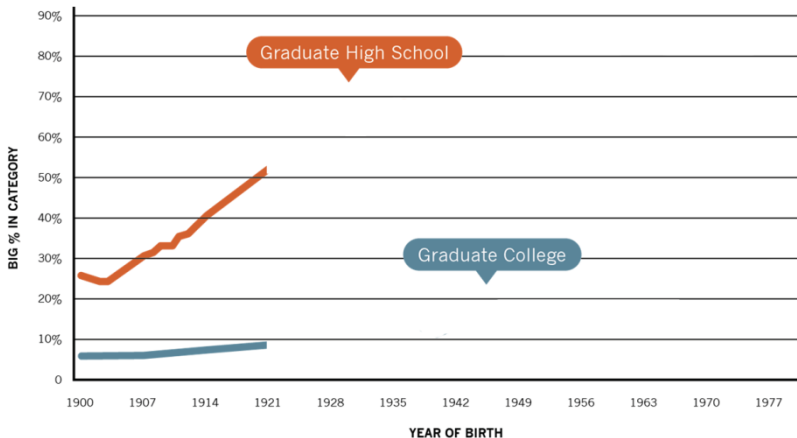
Source: Office for National Statistics



Top 0.1% Income Shares in the U.S., France, and the U.K., 1913-1998

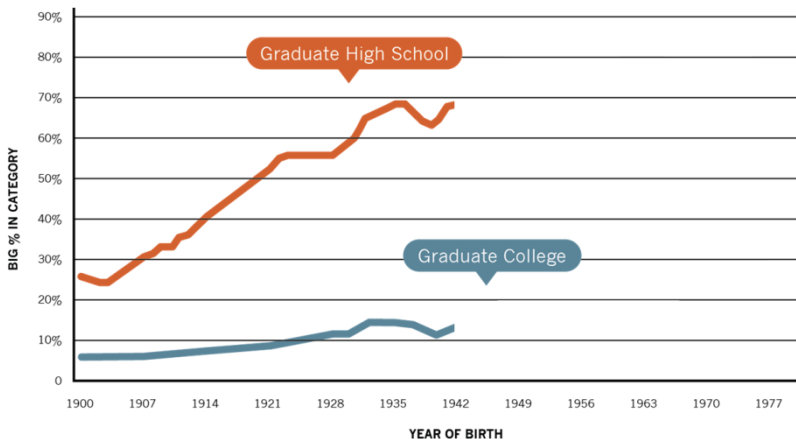
Source: Piketty and Saez (2009).

# The Decline of the American Blue-Collar Middle Class



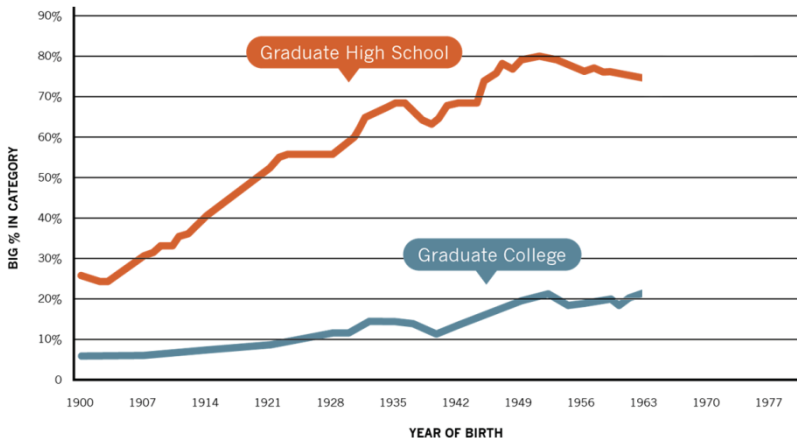
- Graduate High School
- Graduate College

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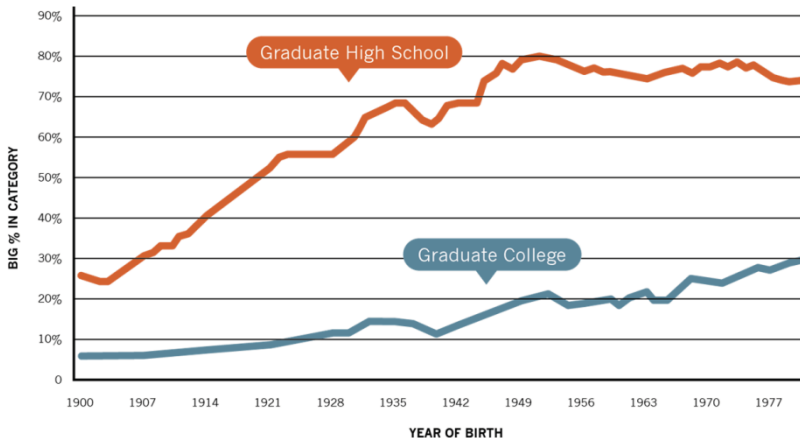
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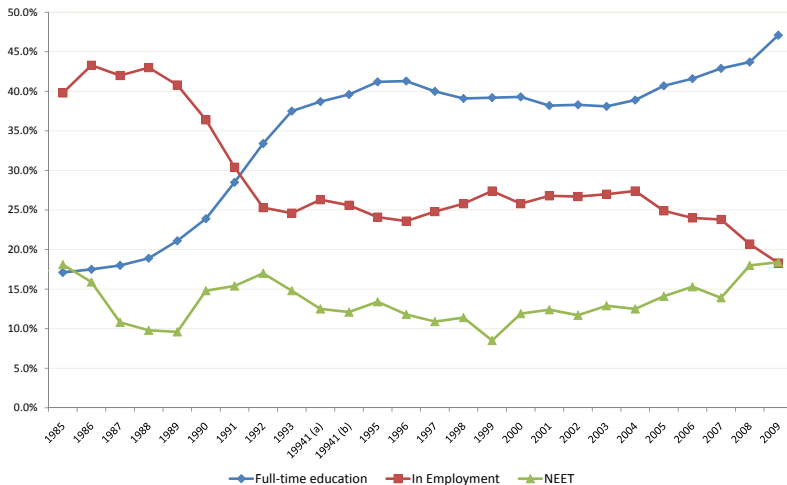
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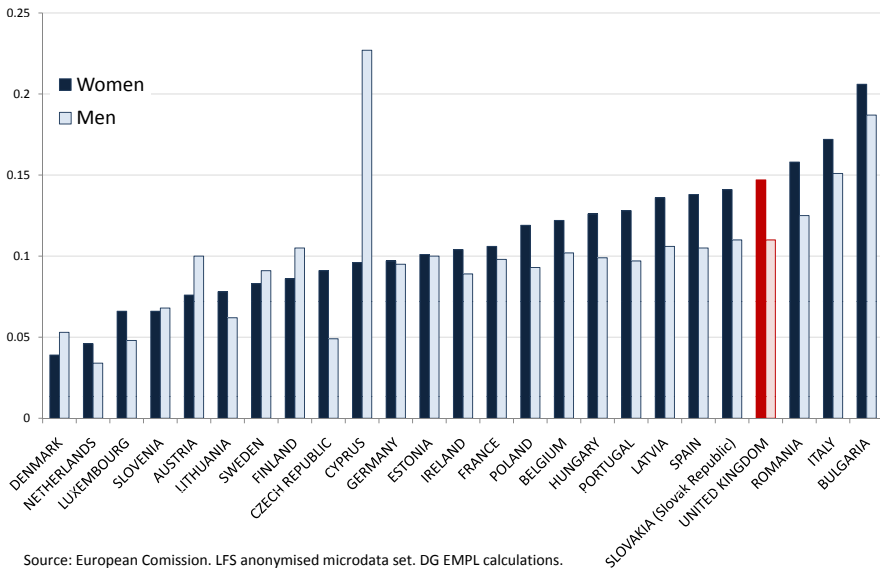
## Participation in full time education and employment of 18 year olds, England



Source: National Statistics

Comment: 1994a/1994b is the break in time series is due to changes in the source of further and higher education data

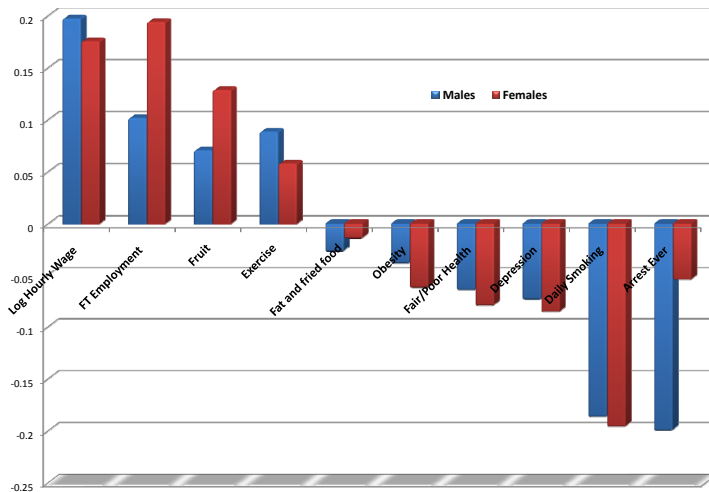
## Share of youth not in education, employment or training (NEET) Ages 15-24, EU, 2007



Source: European Commission. LFS anonymised microdata set. DG EMPL calculations.

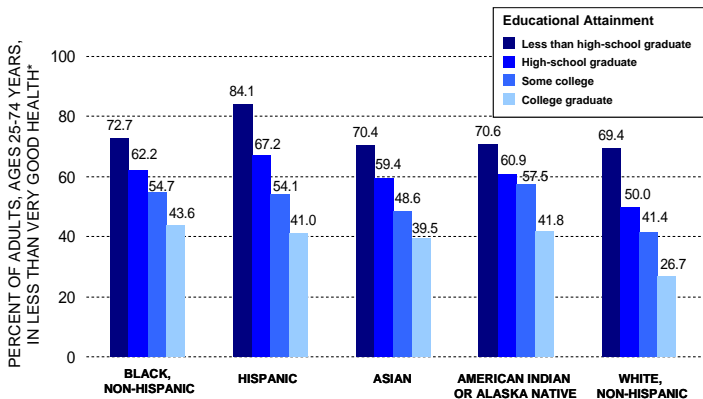


# Disparities by Education



Disparities at age 30: British Cohort Study of 1970 births (Conti, Heckman and Urza, 2010)

# Health by Education



Source: Behavioral Risk Factor Surveillance System Survey Data, 2005-2007.

† Based on self-report and measured as poor, fair, good, very good or excellent.

\* Age-adjusted.

Proportion of adults with fair/poor health, by education and race/ethnicity. Source: Robert Wood Johnson Foundation, Commission to Build a Healthier America.

## Income Mobility Over Generations

### Intergenerational Correlations

- $$\underbrace{y_{g+1}}_{\substack{\text{Income} \\ \text{of} \\ \text{Child}}} = \alpha + \beta \underbrace{y_g}_{\substack{\text{Income} \\ \text{of} \\ \text{Parent}}} + U_g$$

- $\beta = .65$  in US, .45–.57 in UK, .14 in Sweden
- Mobility higher in Nordic countries where income distribution is compressed.

*I have devoted myself for the last twenty-five years to the problem of poverty, and very little of my work has been devoted to any inquiry which does not bear upon that.*

— Alfred Marshall (Report to Royal Commission on the Aged Poor, 1893)

*The most valuable of all capital is that invested in human beings;  
and of that capital the most precious part is the result of the care  
and influence of the mother.*

— Alfred Marshall (1890, paragraph VI.IV.11)

*The human will, guided by careful thought, can so modify circumstances as largely to modify character; and thus to bring about new conditions of life still more favourable to character; and therefore to the economic, as well as the moral, well-being of the masses of the people.*

— Alfred Marshall (1907)

*He had no objection to commonplaces about human values and loved to preach the Gospel of the Noble Life . . . I confess that few things are so irritating to me as is the preaching of mid-Victorian morality, seasoned by Benthamism, the preaching from a schema of middle-class values that knows no glamour or passion.*

— Schumpeter, AER, 1941

# Recent Studies In The Economics of Human Development Establish That:

- 1 A core low-dimensional set of capabilities along with the incentives in situations explain a variety of diverse socioeconomic outcomes.



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# Recent Studies In The Economics of Human Development Establish That:

- ① A core low-dimensional set of capabilities along with the incentives in situations explain a variety of diverse socioeconomic outcomes.
- ② Cognitive and personality (“noncognitive”) capabilities are both important causal determinants of achievement.
- ③ Early biological factors including nutrition also play an important role in explaining adult health and a variety of other outcomes (e.g., education, wages).
- ④ Capabilities evolve over the life cycle as a consequence of investment.

5 Define a capability vector at age  $t$

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

Each subvector can be a vector.

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Each subvector can be a vector.

- 6 Outcome  $j$  at time  $t$ ,  $Y_{j,t}$  depends on capabilities  $\theta_t$  and effort  $e_{j,t}$  as well as social context variables  $\theta_{t,P}$ :

$$Y_{j,t} = \phi_{j,t}(\theta_t, e_{j,t}, \theta_{t,P}) \quad \begin{array}{l} j = 1, \dots, J \\ t = 1, \dots, T \end{array}$$

Effort in  $j$  at time  $t$ ,  $e_{j,t}$ , depends on rewards and endowments.

$$e_{j,t} = \eta_{j,t}( \underbrace{R_{j,t}}_{\text{Rewards to effort}} , \underbrace{\theta_t}_{\text{Capabilities}} , \underbrace{\theta_{t,P}}_{\text{Context and background}} )$$

- 7 Technology of Capability Formation (Cunha and Heckman, 2007, and Heckman, 2007).

$$\theta_{t+1} = f_t\left( \underbrace{\theta_t}_{\substack{\text{self} \\ \text{productivity}}}, \underbrace{I_t}_{\substack{\text{investment} \\ \text{(including} \\ \text{education)}}}, \underbrace{\theta_{t,P}}_{\text{background}} \right)$$

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- 8 This framework has been applied to analyze a variety of data sets on a variety of outcomes.

- 9 A variety of data sources show critical periods in early life for cognitive skills and sensitive periods for noncognitive skills later through adolescence. (Cunha, Heckman and Schennach, 2010)

Strong evidence of synergies:

$$\frac{\partial \theta_{t+1}}{\partial \theta_t} \geq 0$$

Complementarity:

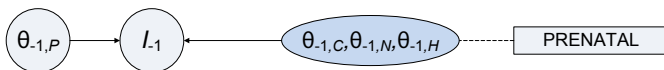
$$\frac{\partial^2 \theta_{t+1}}{\partial \theta_t \partial l'_t} \geq 0$$

Productivity of Investment:

$$\frac{\partial \theta_{t+1}}{\partial l_t} \geq 0$$



## A Life Cycle Framework for Organizing Studies and Integrating Evidence

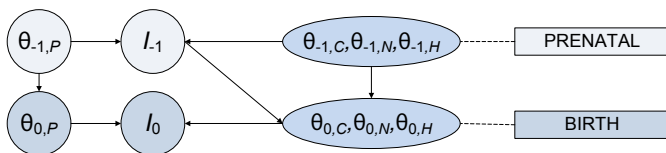
 $\theta_t = (\theta_C, \theta_N, \theta_H)$  capacities at  $t$  $I_t$ : investment at  $t$  $\theta_{t+1} = f_t(\theta_t, I_t, \theta_{t,P})$ 

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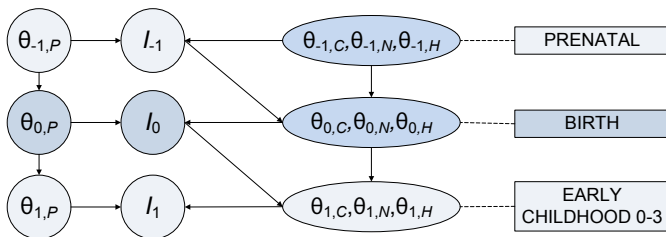


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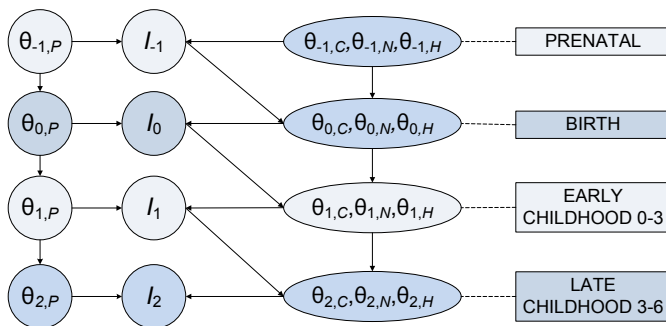


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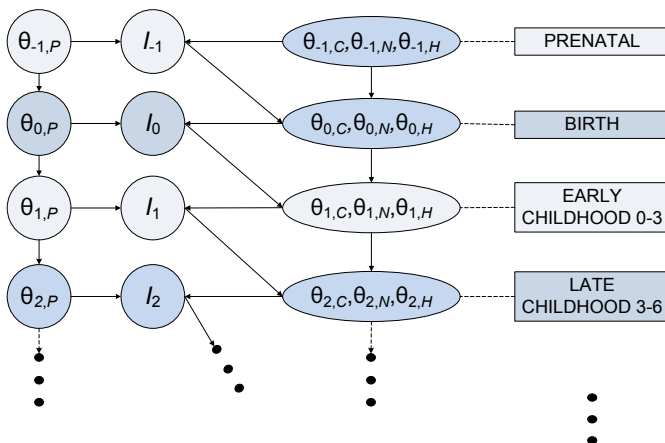


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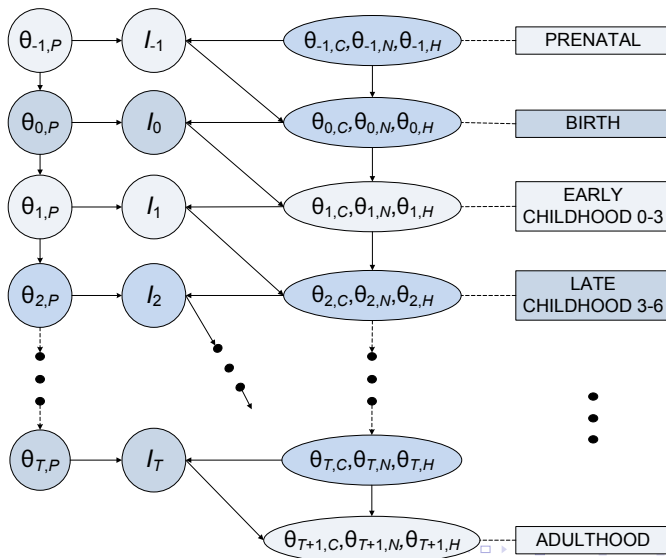
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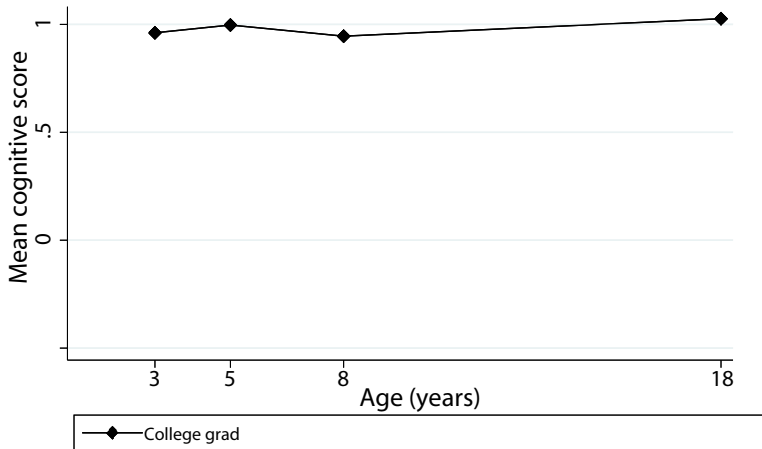
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- ⑩ Gaps in capabilities open up early; they persist at later ages. Little malleability for cognition after the first decade of life. Noncognitive—personality—traits are more malleable.

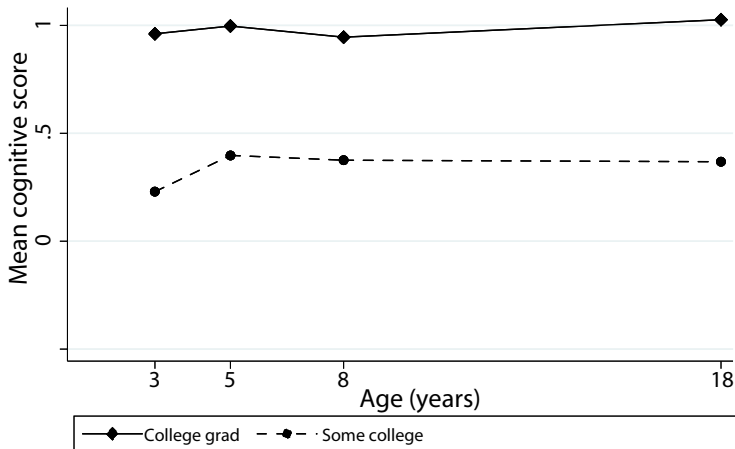


# Trend in mean by age for cognitive score by maternal education



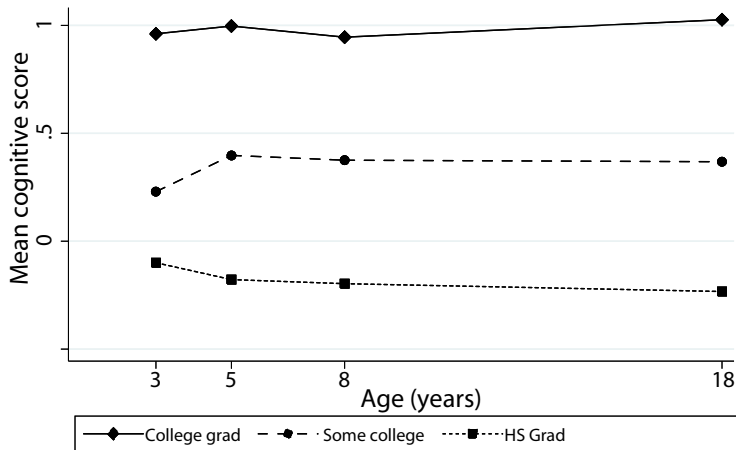
Each score standardized within observed sample. Using all observations and assuming data missing at random. Source: Brooks-Gunn et al. (2006).

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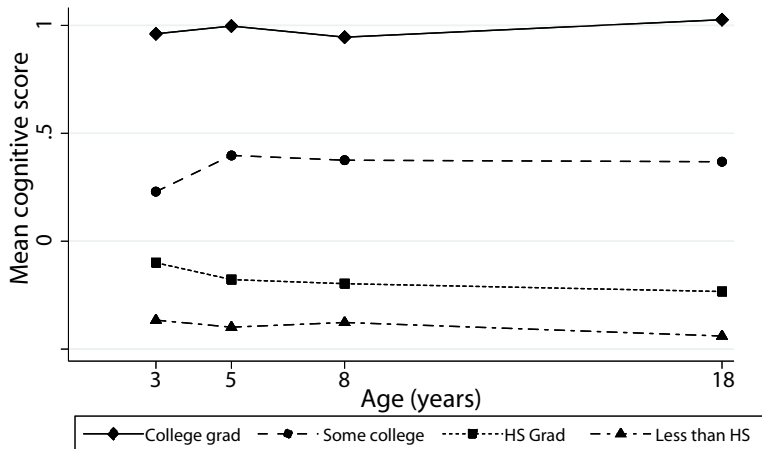
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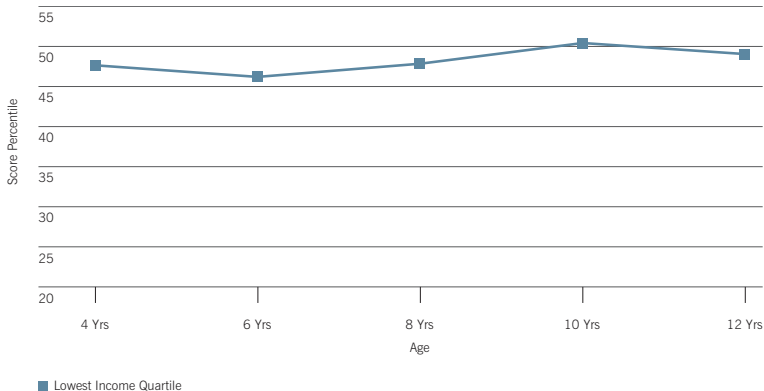
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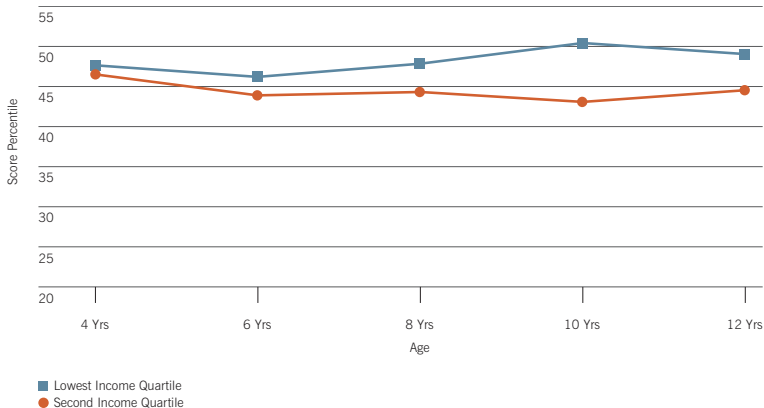
# Average percentile rank on anti-social behavior score, by income quartile

(The higher the score, the worse are behavioral problems)



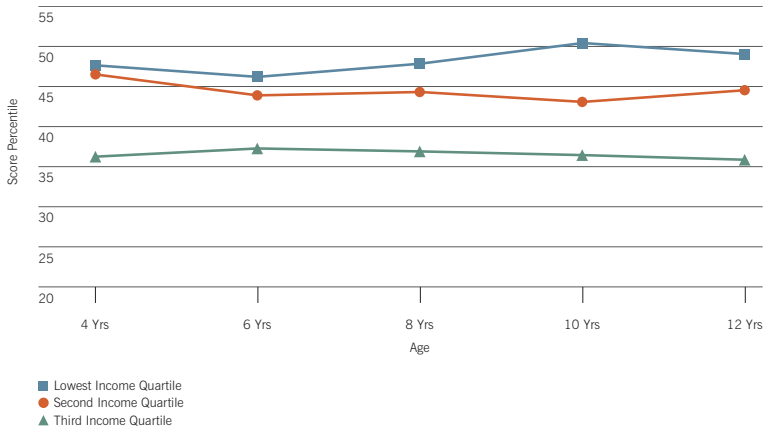
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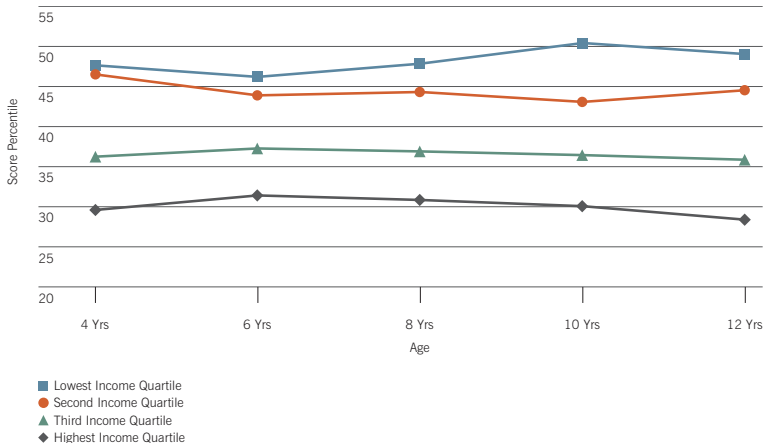
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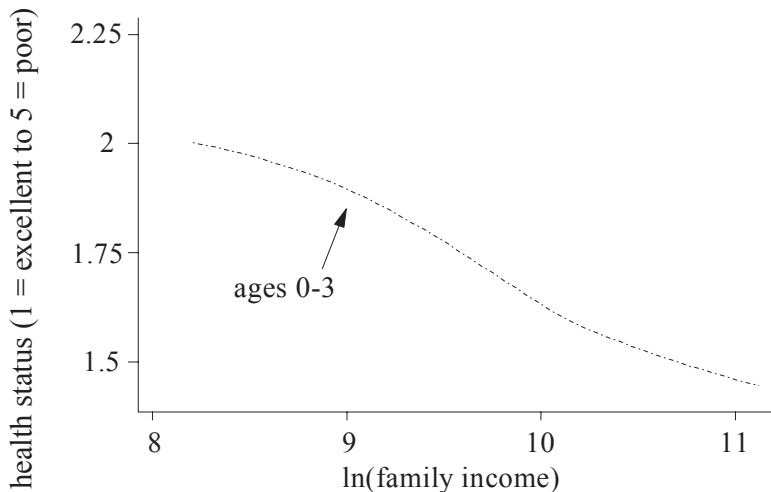
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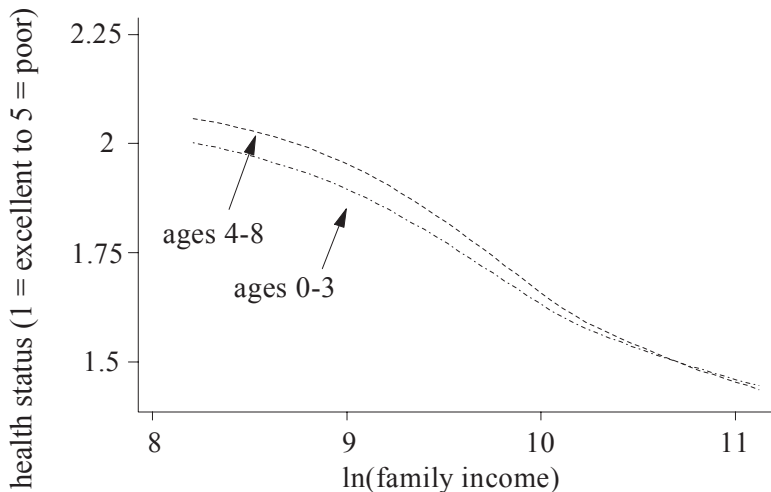




Health and income for children and adults, U.S. National Health Interview Survey 1986-1995. From Case, A., Lubotsky, D. & Paxson, C. (2002), American Economic Review, Vol. 92, 1308-1334.



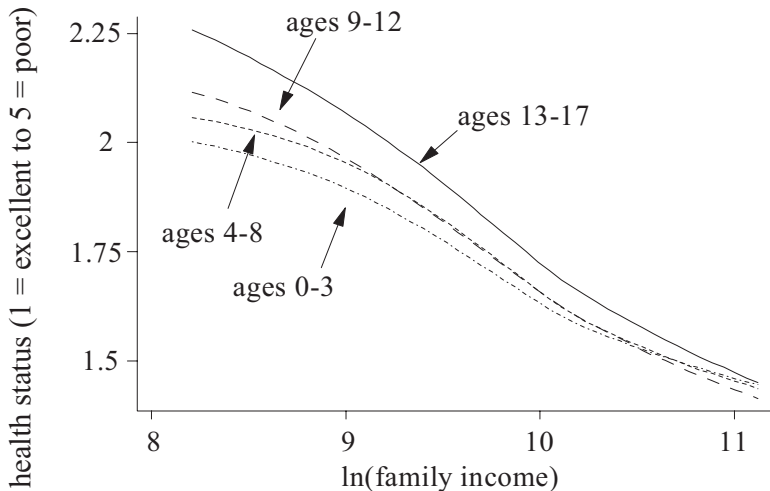
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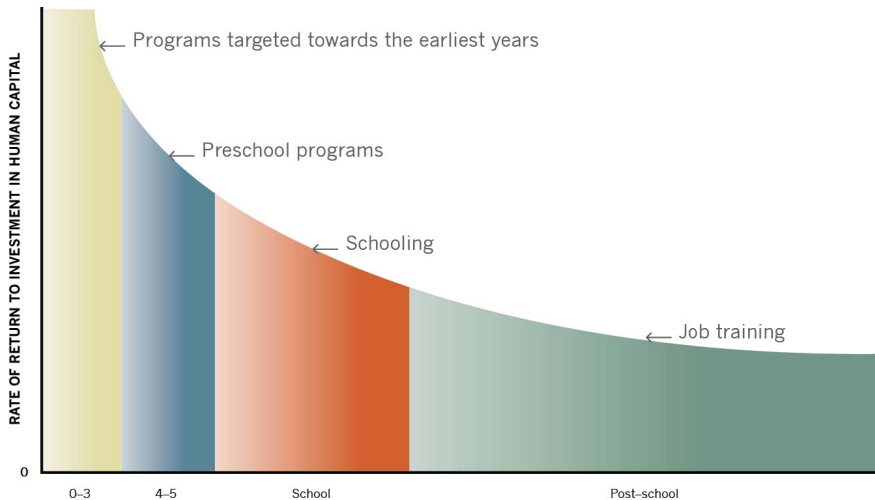
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- 12 Adolescent remediation is ineffective especially for cognitive deficits.

# Returns to a unit dollar invested.



Source Heckman (2008).

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- The evidence from the intervention studies suggests an important role for investments and family environments in determining adult capacities above and beyond genes, and also in interactions with the genes.
- Parental attachment is a powerful predictor of adult success.

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- How can economists think about it? Is it just time preference? Risk preference? Something new?
- How predictive are these personality traits? Do they have causal status?
- In my lecture tomorrow, I will discuss the evolution of capabilities, policies to foster capabilities and what recent evidence suggests is optimal policy.

# Lecture I: Personality Psychology and Economics

## Understanding and Producing “Character”

## Challenges

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- ③ Developing a common language and framework to promote interdisciplinary exchange.
- ④ Danger in assuming that basic questions of content and identification have been answered by psychologists at the level required for rigorous economic analysis.
- ⑤ In explaining outcomes, how important is the person? How important is the situation? How important is their interaction?



I draw heavily on

“Personality Psychology and Economics.”

Mathilde Almlund, Angela Duckworth, James Heckman and Tim Kautz.

Forthcoming, *Handbook of the Economics of Education*,

E. Hanushek, S. Machin and L. Wössman (eds.).

Amsterdam: Elsevier, 2011.

- Denoted: ADHK

## A Brief History of Personality Psychology

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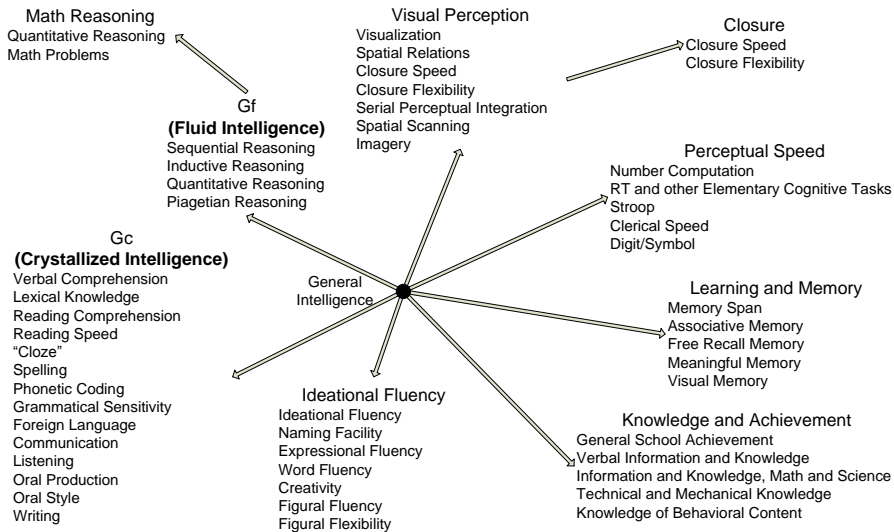
Binet [1916, p. 254]

*"...[success in school] admits of other things than intelligence; to succeed in his studies, one must have qualities which depend on attention, will, and character; for example a certain docility, a regularity of habits, and especially continuity of effort. A child, even if intelligent, will learn little in class if he never listens, if he spends his time in playing tricks, in giggling, is playing truant."*

Jensen [1998, p. 575]

*"What are the chief personality traits which, interacting with  $g$ , relate to individual differences in achievement and vocational success? The most universal personality trait is conscientiousness, that is, being responsible, dependable, caring, organized and persistent."*

**Figure 1: An Hierarchical Scheme of General Intelligence and Its Components**



Source: Recreated from Ackerman and Heggstad [1997], based on Carroll [1993].

## Personality Traits

**Table 1:** The Big Five domains and Their Facets

<b>Big Five Personality Factor</b>	<b>American Psychology Association Dictionary description</b>	<b>Facets (and correlated trait adjective)</b>	<b>Related Traits</b>	<b>Childhood Temperament Traits</b>
Openness to Experience	“the tendency to be open to new aesthetic, cultural, or intellectual experiences”	Fantasy (imaginative) Aesthetic (artistic) Feelings (excitable) Actions (wide interests) Ideas (curious) Values (unconventional)	—	Sensory sensitivity Pleasure in low-intensity activities Curiosity
Conscientiousness	“the tendency to be organized, responsible, and hardworking”	Competence (efficient) Order (organized) Dutifulness (not careless) Achievement striving (ambitious) Self-discipline (not lazy) Deliberation (not impulsive)	Grit Perseverance Delay of gratification Impulse control Achievement striving Ambition Work ethic	Attention/(lack of) distractibility Effortful control Impulse control/delay of gratification Persistence Activity*

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Big Five Personality Factor	American Psychology Association Dictionary description	Facets (and correlated trait adjective)	Related Traits	Childhood Temperament Traits
Extraversion	“an orientation of one’s interests and energies toward the outer world of people and things rather than the inner world of subjective experience; characterized by positive affect and sociability”	Warmth (friendly) Gregariousness (sociable) Assertiveness (self-confident) Activity (energetic) Excitement seeking (adventurous) Positive emotions (enthusiastic)	—	Surgency Social dominance Social vitality Sensation seeking Shyness* Activity* Positive emotionality Sociability/affiliation
Agreeableness	“the tendency to act in a cooperative, unselfish manner”	Trust (forgiving) Straight-forwardness (not demanding) Altruism (warm) Compliance (not stubborn) Modesty (not show-off) Tender-mindedness (sympathetic)	Empathy Perspective taking Cooperation Competitiveness	Irritability* Aggressiveness Willfulness



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Big Five Personality Factor	American Psychology Association Dictionary description	Facets (and correlated trait adjective)	Related Traits	Childhood Temperament Traits
Neuroticism/ Emotional Stability	Emotional stability is “predictability and consistency in emotional reactions, with absence of rapid mood changes.” Neuroticism is “a chronic level of emotional instability and proneness to psychological distress.”	Anxiety (worrying) Hostility (irritable) Depression (not contented) Self-consciousness (shy) Impulsiveness (moody) Vulnerability to stress (not self-confident)	<b>Internal vs. External Locus of control</b> <b>Core self-evaluation</b> Self-esteem Self-efficacy Optimism Axis I psychopathologies (mental disorders) including depression and anxiety disorders	Fearfulness/behavioral inhibition Shyness* Irritability* Frustration (Lack of) soothability Sadness

Notes: Facets specified by the NEO-PI-R personality inventory (Costa and McCrae [1992b]). Trait adjectives in parentheses from the Adjective Check List (Gough and Heilbrun [1983]). \* These temperament traits may be related to two Big Five factors. Source: Table adapted from John and Srivastava [1999].

## The Person-Situation Debate

## The Person-Situation Debate

Mischel [1968, p. 146]

*"... with the possible exception of intelligence, highly generalized behavioral consistencies have not been demonstrated, and the concept of personality traits as broad dispositions is thus untenable"*

## Ross and Nisbett [1991]

*“Manipulations of the immediate social situation can overwhelm in importance the type of individual differences in personal traits or dispositions that people normally think of as being determinative of social behavior.”*

Thaler [2008]

*"The great contribution to psychology by Walter Mischel [...] is to show that there is no such thing as a stable personality trait."*

## Personality Psychology After the Person-Situation Debate

## The Predictive Power of Personality Traits

## Difficulties in Synthesizing Studies of the Effects of Personality

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- 1 Measures of personality and cognition differ among studies.
- 2 Different studies use different measures of predictive power.
- 3 Many studies do not address the question of causality, i.e., does the measured trait cause (rather than just predict) the outcome?

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- This practice trades an endogeneity problem with an errors in variables problem if skills evolve past the point of measurement.
- Only recently have economists started to systematically address the question of causality.

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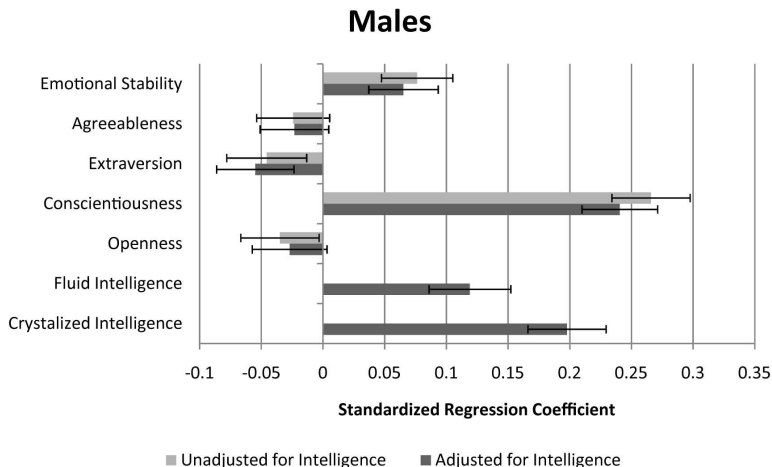
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- Other traits play roles at finer levels. (The “Facets” of the Big Five)

## Educational Attainment and Achievement

**Figure 2:** Association of the Big Five and Intelligence with Years of Schooling in GSOEP

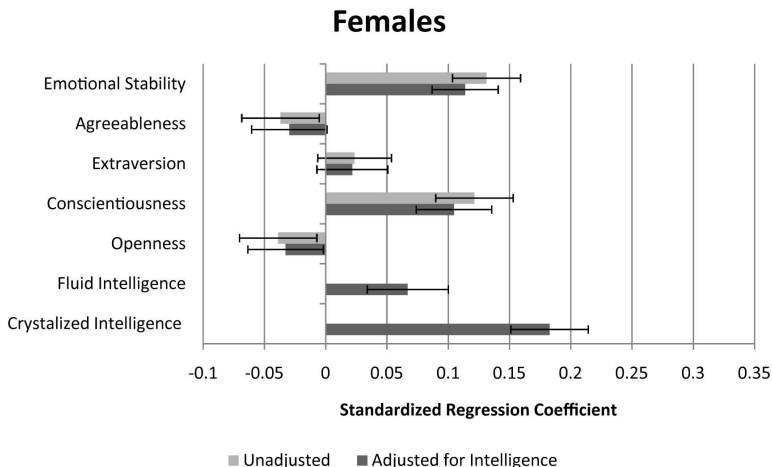


Note: The figure displays standardized regression coefficients from multivariate of years of school attended on the Big Five and intelligence, controlling for age and age-squared. The bars represent standard errors. The Big Five coefficients are corrected for attenuation bias. The Big Five were measured in 2005. Years of schooling were measured in 2008. Intelligence was measured in 2006. The measures of intelligence were based on components of the Wechsler Adult Intelligence Scale (WAIS). The data is a representative sample of German adults between the ages of 21 and 94.

Source: German Socio-Economic Panel (GSOEP), waves 2004–2008, own calculations.



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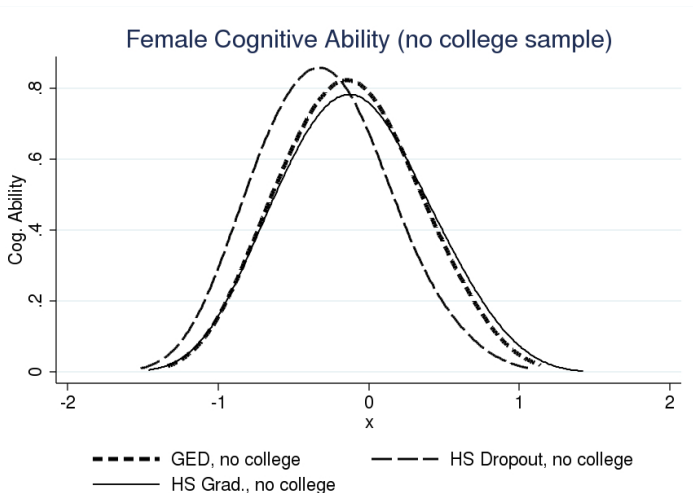


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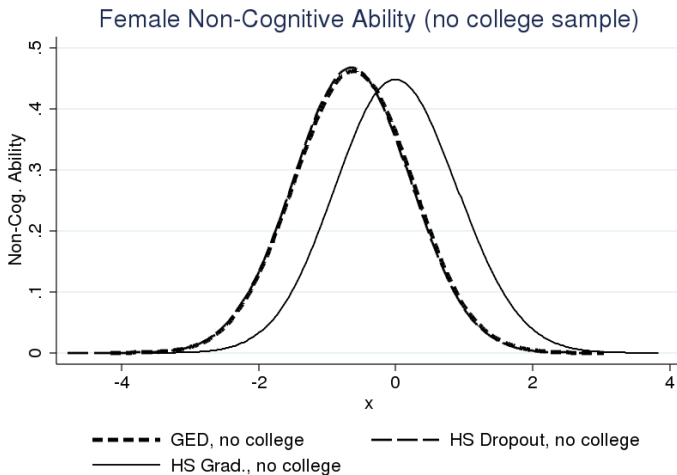
## GEDs

Figure 3: Distribution of Cognitive and Non-Cognitive Skills by Education Group



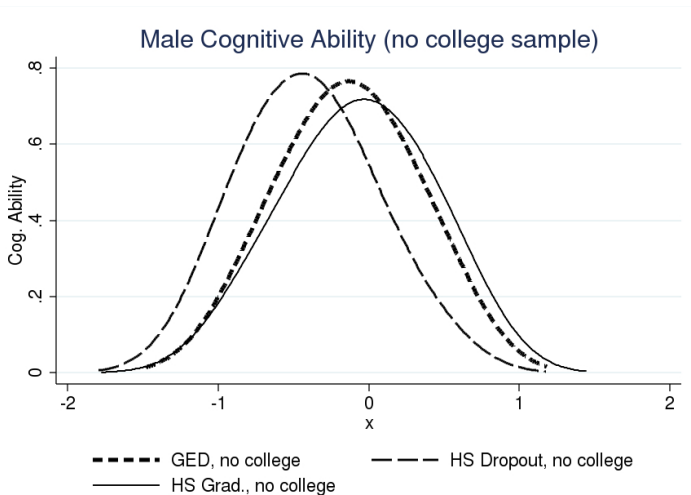
Source: Heckman, Humphries, Veramendi, and Urzua (2010).

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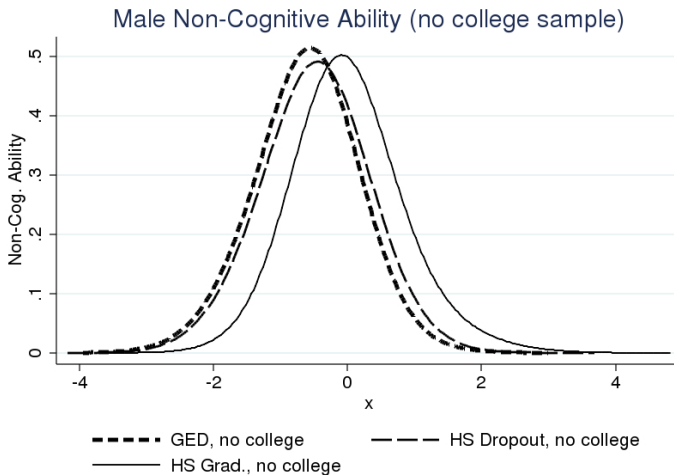
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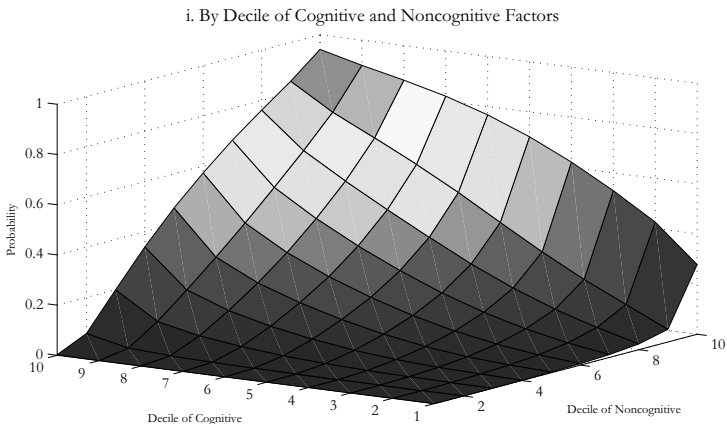
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- Yet GEDs, adjusting for their higher cognitive ability, earn at the level of dropouts.

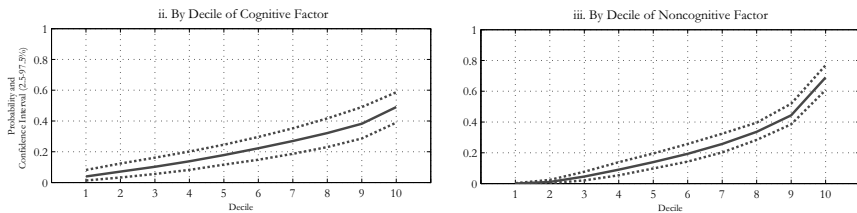
**Figure 4:** Probability of Being a 4-year-college Graduate or Higher at Age 30, Males



Notes: The data are simulated from the estimates of the model and the NLSY79 sample. Higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws). Solid lines depict probability, and dashed lines, 2.5%-97.5% confidence intervals. The upper curve is the joint density. The two marginal curves (ii) and (iii) are evaluated at the mean of the trait not being varied.

Source: Heckman, Stixrud and Urzua [2006, Figure 21].

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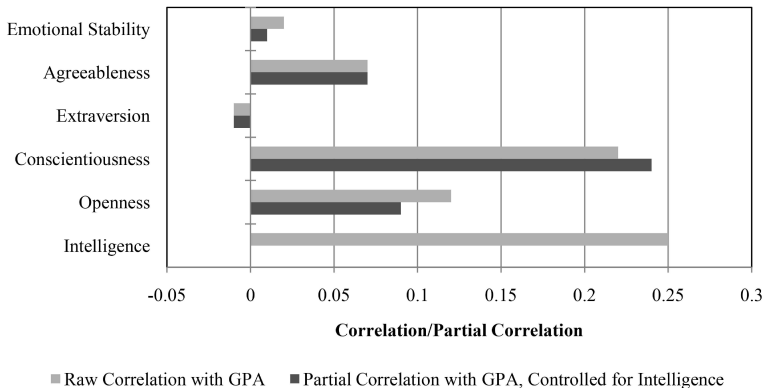
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## Course Grades

**Figure 5:** Correlations of the Big Five and Intelligence with Course Grades

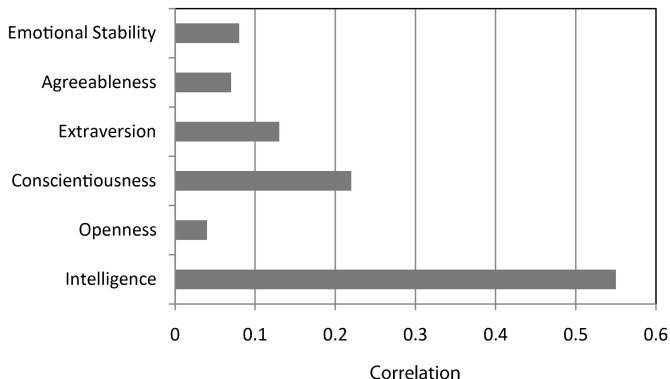


Notes: All correlations are significant at the 1% level. The correlations are corrected for scale reliability and come from a meta analysis representing a collection of studies representing samples of between  $N=31,955$  to  $N=70,926$ , depending on the trait. The meta-analysis did not clearly specify when personality was measured relative to course grades.

Source: Poropat [2009].

## Labor Market Outcomes

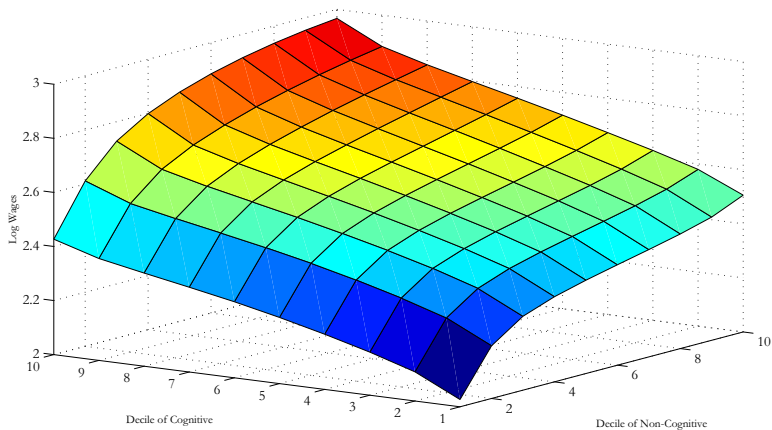
Figure 6: Associations with Job Performance



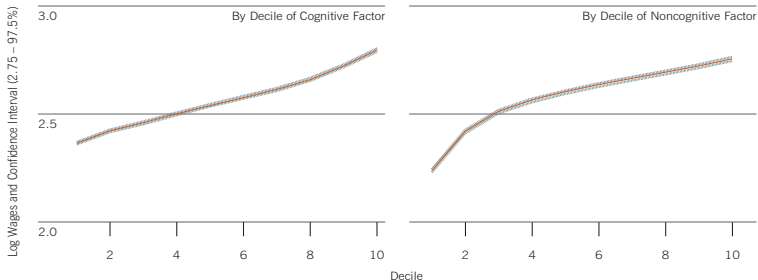
Notes: The values for personality are correlations that were corrected for sampling error, censoring, and measurement error. Job performance was based on performance ratings, productivity data and training proficiency. The authors do report the timing of the measurements of personality relative to job performance. Of the Big Five, the coefficient on Conscientiousness is the only one that is statistically significant with a lower bound on the 90% credibility value of 0.10. The value for IQ is a raw correlation.

Sources: The correlations reported for personality traits come from a meta-analysis conducted by Barrick and Mount [1991]. The correlation reported for IQ and job performance come from Schmidt and Hunter [2004].

# Mean log wages by age 30 (males)



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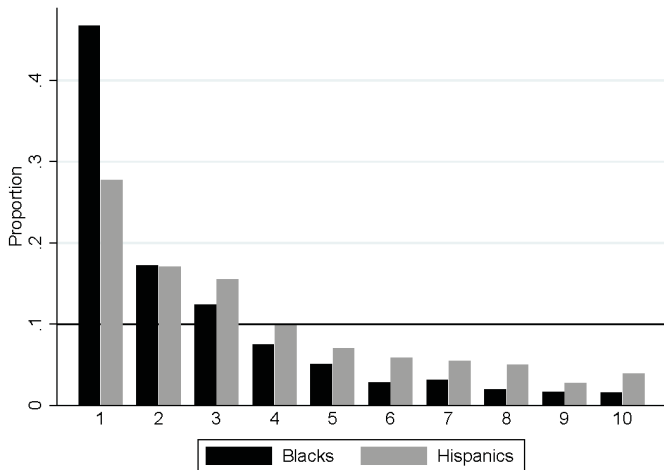
Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (50 draws).

## Overt Discrimination is No Longer a First-Order Problem in American Society

## Ability Gaps Are Major Determinants of Minority-Majority Differences in Performance



# Minority AFQT Scores Placed in the White Distribution



Source: National Longitudinal Survey of Youth 1979.

# Shortfalls in Hourly Wages for Blacks and Hispanics in the Last Twenty Years: Actual Disparity and Disparity Adjusted for Ability

	Males		Females	
	Actual			
Black	-25%			
Hispanic	-15%			

\*Denotes not statistically significant from zero, that is, the adjusted gap is likely to arise from chance. Source: Authors calculations from the National Longitudinal Survey of Youth. For details, see the Web appendix at [http://jenni.uchicago.edu/understanding\\_b-w\\_gap/](http://jenni.uchicago.edu/understanding_b-w_gap/). The wages are adjusted for age.

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	Males		Females	
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Black	-25%	-6%		
Hispanic	-15%	3%*		

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Black	-25%	-6%	-17%	
Hispanic	-15%	3%*	-7%	

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	Males		Females	
	Actual	Adjusted	Actual	Adjusted
Black	-25%	-6%	-17%	12%
Hispanic	-15%	3%*	-7%	17%

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# Differences in College Entry Proportions Between Minorities and Whites, Mid-1990s

	Black-White	Hispanic-White
Actual	-0.12	-0.14

Source: Stephen V. Cameron and James J. Heckman, "The Dynamics of Educational Attainment for Black, Hispanic, and White Males," *Journal of Political Economy* 109 (3) (2001).

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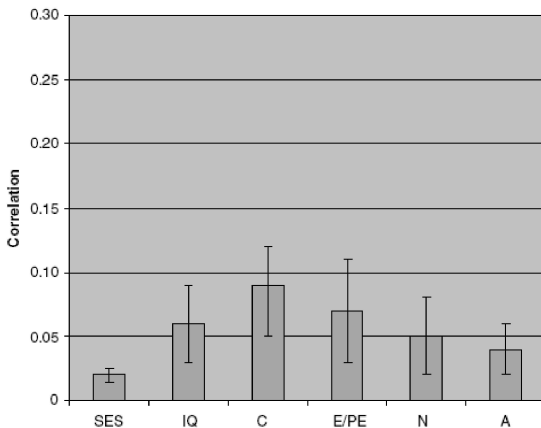
	Black-White	Hispanic-White
Actual	-0.12	-0.14
Adjusted	0.16	0.15

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## Personality and Health



## Figure 7: Correlations of Mortality with Personality, IQ, and Socioeconomic Status (SES)

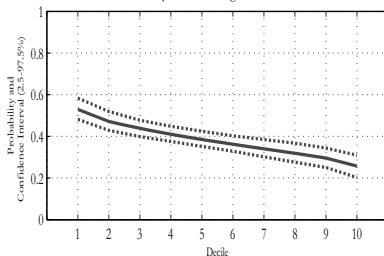


Notes: The figure represents results from a meta-analysis of 34 studies. Average effects (in the correlation metric) of low socioeconomic status (SES), low IQ, low Conscientiousness (C), low Extraversion/Positive Emotion (E/PE), Neuroticism (N), and low Agreeableness (A) on mortality. Error bars represent standard error. The lengths of the studies represented vary from 1 year to 71 years.

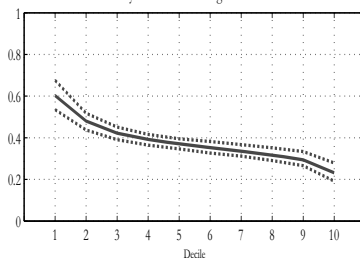
Source: Roberts, Kuncel, Shiner et al. [2007]

# Probability of daily smoking by age 18 (males)

ii. By Decile of Cognitive Factor

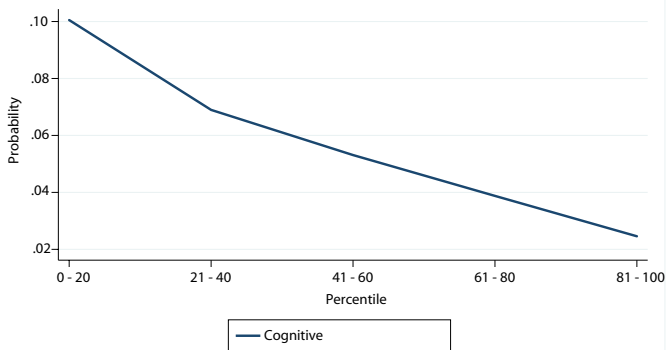


iii. By Decile of Noncognitive Factor



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).

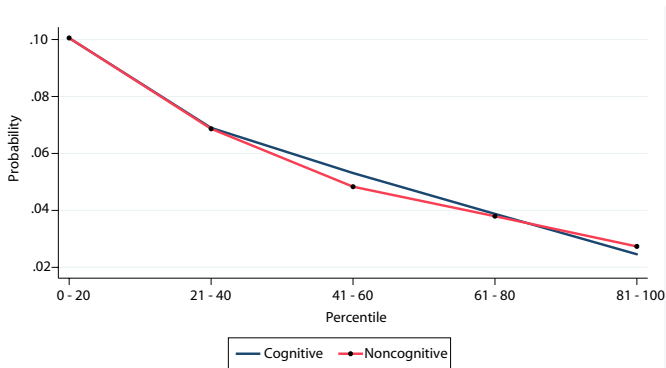
# Probability of being single with children (females)



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).

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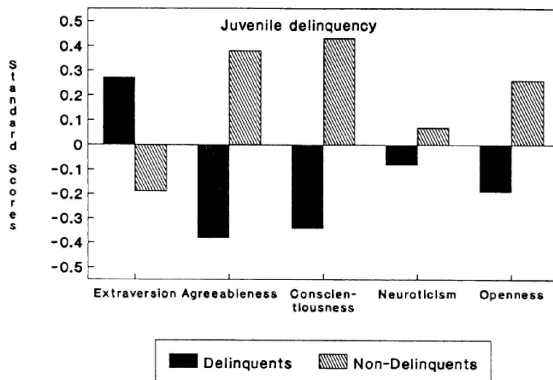


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## Personality and Crime

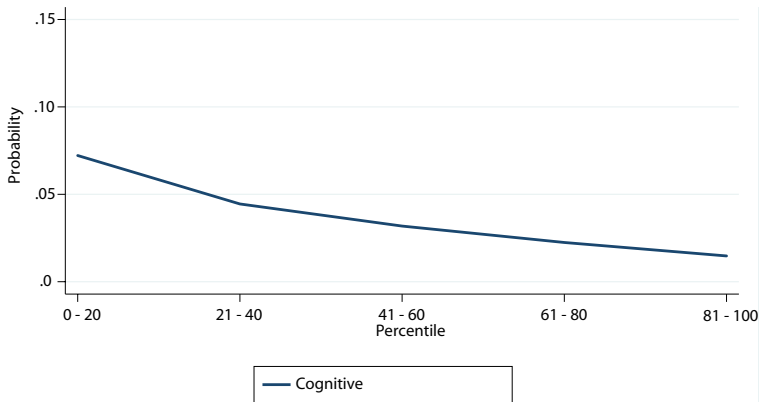
Figure 8: Juvenile Delinquency and the Big Five



Notes: Delinquents are those who have committed at least one of the following: breaking and entering, strongarming, or selling drugs. Non-delinquents have committed at most one of the following stealing at home, vandalism at home, or theft of something less than \$5. The y-axis reports mean differences in standardized scores of the Big Five measures based on mother's reports. The measures were taken at ages 12-13 and reflect cumulative delinquent behavior.

Source: John, Caspi, Robins et al. [1994].

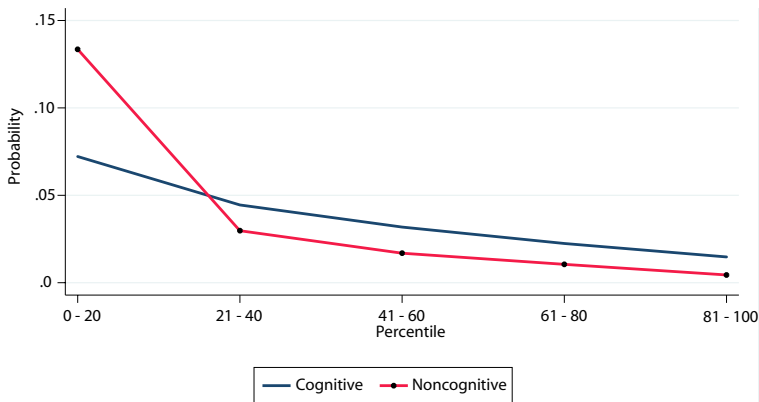
# Ever been in jail by age 30, by ability (males)



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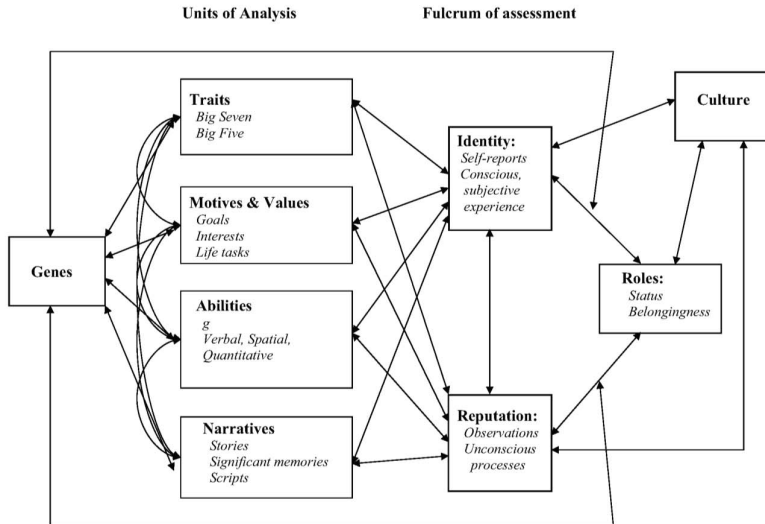
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- Definition of personality by a leading **psychologist**:

Roberts [2009, p. 140]

“Personality traits are the relatively enduring patterns of thoughts, feelings, and behaviors that reflect the tendency to respond in certain ways under certain circumstances.”



Figure 9: Roberts's Model of Personality Psychology



Source: Roberts [2006].

# An Economic Framework for Conceptualizing and Measuring Personality and Personality Traits

## How to interpret personality measurements within economic models?

Through

- Preferences? (Standard Approach)

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or
- All three?

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- “Productivity” can be very general—performance on tests, in workplace, observer reports.
- All measurement systems in psychology are based on performance on these tasks gauged in various ways.

- The productivity in task  $j$  depends on the traits of agents represented by  $\theta$ , and the “effort” they expend on the task,  $e_j$ :

$$P_j = \phi_j(\theta, e_j), \quad j \in \mathcal{J} = \{1, \dots, J\}, e_j \in \mathcal{E}, \theta \in \Theta. \quad (1)$$

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- $R_j \uparrow e_j \uparrow$

## A Fundamental Identification Problem: Identifying Personality Traits From Measured Performance on Tasks

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- $\theta_\mu$  and  $\theta_\pi$ , each of which may be a vector.

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- One must standardize for the effort at a benchmark level, say  $e^*$ , to use  $P_j$  to identify a measure of the trait  $\theta_{1,j}$ .

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- Otherwise produces variation in the measured trait across situations with different incentives.

## A Fundamental Identification Problem

- Consider the following case of two productivity measures for the two tasks  $j$  and  $j'$ :

$$\begin{aligned}P_j &= \phi_j(\theta_{1,\mu}, \theta_{1,\pi}, e_j) \\P_{j'} &= \phi_{j'}(\theta_{1,\mu}, \theta_{1,\pi}, e_{j'}), \quad j \neq j'.$$

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- Standardize measurements at a common level of effort  $e_j = e_{j'} = e^*$ .
- If the system of equations satisfies a local rank condition, then one can solve for the pair  $(\theta_{1,\mu}, \theta_{1,\pi})$  at  $e^*$  *assuming that the  $\phi_k()$  are known*.

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- **Only the pair is identified.**
- In the absence of **dedicated constructs** (constructs that are generated by only one component of  $\theta$ ), there is an intrinsic identification problem that arises in using measures of productivity in tasks to infer traits.

## Examples of Nonidentification Problems

IQ and Achievement Test Scores Reflect Incentives and Efforts, and Capture Both Cognitive and Personality Traits

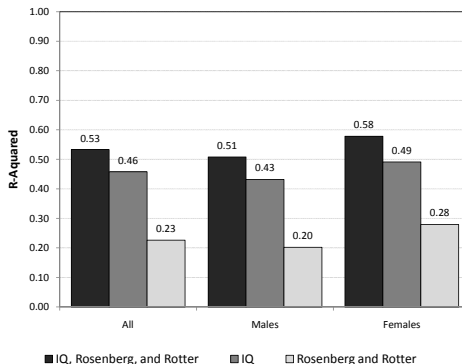


## Table 2: Incentives and Performance on Intelligence Tests

Study	Sample and Study Design	Experimental Group	Effect size of incentive (in standard deviations)	Summary
Edlund [1972]	Between subjects study. 11 matched pairs of low SES children; children were about one standard deviation below average in IQ at baseline	M&M candies given for each right answer	Experimental group scored <u>12 points</u> higher than control group during a second testing on an alternative form of the Stanford Binet (about 0.8 standard deviations)	"...a carefully chosen consequence, candy, given contingent on each occurrence of correct responses to an IQ test, can result in a significantly higher IQ score."(p. 319)
Breuning and Zella [1978]	Within and between subjects study of 485 <i>special education</i> high school students all took IQ tests, then were randomly assigned to control or incentive groups to retake tests. Subjects were below-average in IQ.	Incentives such as record albums, radios (<\$25) given for improvement in test performance	Scores increased by about 17 points. Results were consistent across the Otis-Lennon, WISC-R, and Lorge-Thorndike tests.	"In summary, the promise of individualized incentives contingent on an increase in IQ test performance (as compared with pretest performance) resulted in an approximate 17-point increase in IQ test scores. These increases were equally spread across subtests... The incentive condition effects were much less pronounced for students having pretest IQs between 98 and 120 and did not occur for students having pretest IQs between 121 and 140." (p. 225)

- Many other studies (see ADHK).

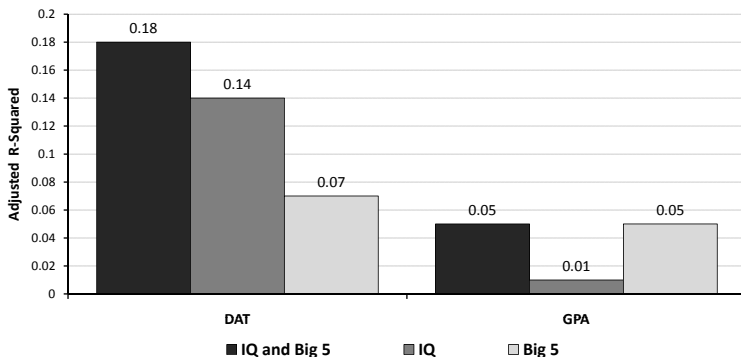
Figure 10: AFQT Score Decomposed by IQ, Rosenberg, and Rotter



Notes: The data come from the NLSY. Rosenberg, and Rotter were administered in 1979. The ASVAB was administered in 1980. To account for varying levels of schooling at the time of the test, scores have been adjusted for schooling at the time of the test conditional on final schooling using the method developed in Hansen, Heckman and Mullen [2004]. AFQT is constructed from the Arithmetic Reasoning, Word Knowledge, Numeric Operations, and Paragraph Comprehension ASVAB subtests. DAT and DAT percentile, IQ, and GPA are from high school transcript data. IQ is pooled across several IQ tests using IQ percentiles. GPA is the individual's core-subject GPA from each year of school. Sample excludes the military over-sample. Background variables include mother's highest grade completed, father's highest grade completed, southern residence at age 14, urban residence at age 14, living in a broken home at age 14, receiving newspapers in the household at age 14, receiving magazines in the household at age 14, and the household having a library card at age 14.

Source: Borghans, Golsteyn, Heckman et al. [2010].

Figure 11: DAT scores and GPA decomposed by IQ and Personality



Notes: Data is from Stella Maris, a high school in the Netherlands. Students were administered part of a Raven's IQ test and personality questions based on the Big 5. DAT and GPA are from high school records.

Source: Borghans, Golsteyn, Heckman et al. [2010].

## Digression: The Mechanics of Measuring Personality Using Linear Factor Analysis

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- $P_{n,l}^q$ :  $q$ th measurement on trait  $l$  for person  $n$ .
- The  $q$ th measurement of factor  $l$  for person  $n$  is

$$P_{n,l}^q = \mu_l^q + \lambda_l^q T_{n,l} + \epsilon_{n,l}^q, \quad (4)$$
$$q = 1, \dots, Q_l, n = 1, \dots, N, l = 1, \dots, L$$

- More general case:

$$P_{n,l}^q = \mu_l^q + (\lambda^q)' T_n + \epsilon_{n,l}^q, \quad q = 1, \dots, Q_l. \quad (5)$$



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## **Convergent Validity**

- b A factor  $T_I$  is assumed to account for the intercorrelations among the items or tests within a construct  $I$ .
- c Item-specific and random error variance are low (intercorrelations among items are high within a cluster).



## Predictive Validity

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- An alternative criterion for validating measurement systems is based on the predictive power of the tests for real world outcomes, that is, on behaviors measured outside of the exam room or observer system.

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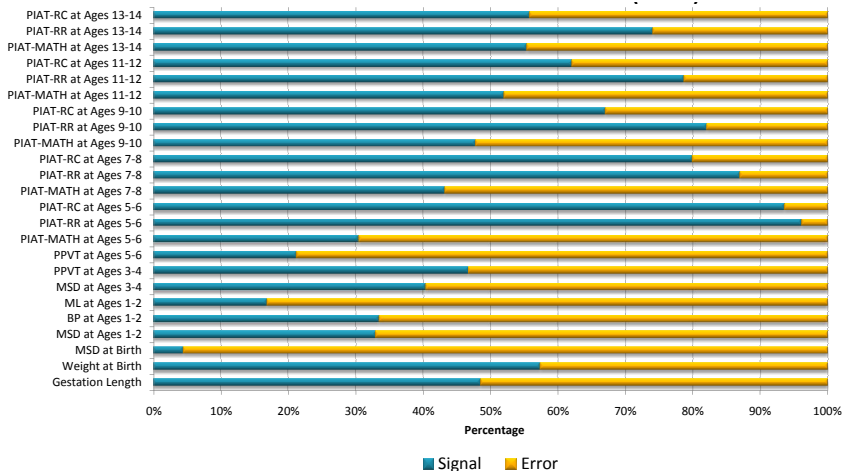
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- 1 All measurements of factor  $T_{n,l}$  can claim incremental predictive validity as long as each measurement is subject to error ( $\epsilon_{n,l}^q \neq 0$ ).
- 2 *Reverse causality.*
- 3 Especially problematic when interpreting contemporary correlations between personality measurements and outcomes.

## The Quantitative Importance of Measurement Error

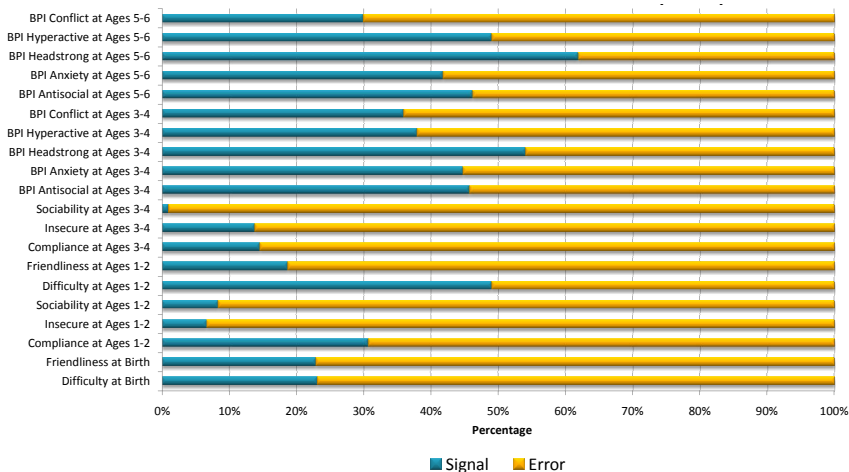
**Table 3:** Share of Residual Variance in Measurements of Cognitive Skills Due to the Variance of Cognitive Factor (Signal) and Due to the Variance of Measurement Error (Noise)



Source: Cunha, Heckman and Schennach [2010].

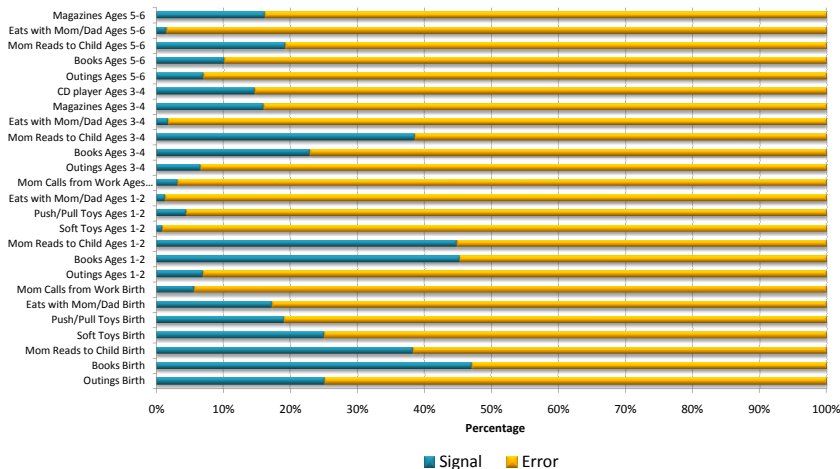


**Table 4:** Share of Residual Variance in Measurements of Socioemotional Skills Due to the Variance of Socioemotional Factor (Signal) and Due to the Variance of Measurement Error (Noise)



Source: Cunha, Heckman and Schennach [2010].

**Table 5:** Share of Residual Variance in Measurements of Investments Due to the Variance of Investment Factor (Signal) and Due to the Variance of Measurement Error (Noise)



Source: Cunha, Heckman and Schennach [2010].

## Extending The Simple Economic Models in Order to Produce a Precise Definition of Personality

## Adding Preferences and Goals

- Preferences and goals (see Figure 9) may also shape effort.

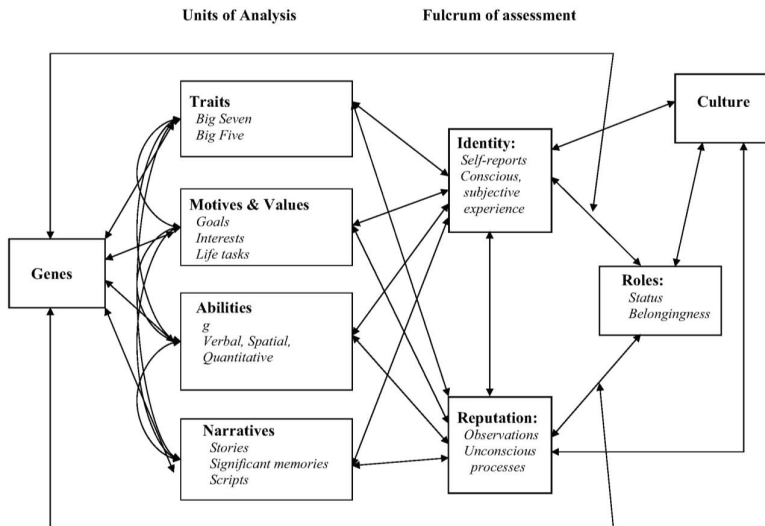
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- These are central features of “social-cognitive” theories of personality: Bandura and Mischel.
- Consider a model with multitasking.

Figure 9: Roberts's Model of Personality Psychology



Source: Roberts [2006].

- Preferences:

$$U(X, P, e \mid \psi), \quad (6)$$



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- A Freudian version: Agents may not act on what they know but rather on what subconscious motives drive them.

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- We observe **measured personality**—behaviors generated by incentives, goals, and traits.

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- To capture these more general notions, we introduce a set of “actions” broader than what is captured by  $e$ .

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- The  $i^{\text{th}}$  possible action to perform task  $j$ :  $a_{i,j}$ ,  $i \in \{1, \dots, K_j\}$ .
- Array actions in a vector  $a_j = (a_{1,j}, \dots, a_{K_j,j}) \in \mathcal{A}$ .

- The productivity of the agent in task  $j$  depends on the actions taken in that task:

$$P_j = \tau_j(a_{1,j}, a_{2,j}, \dots, a_{K_j,j}). \quad (10)$$

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where

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- Actions generalize the notion of effort to a broader class of behavior.

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$$a_{i,m} = \nu_{i,m}(\theta, e_{i,m}), \quad m \in \mathcal{M}$$
$$\mathcal{A} \subseteq \mathcal{M}.$$

- The agent solves

$$\max E[U(a, X, P, e \mid \psi) \mid \mathcal{I}]$$

with respect to  $X$  and  $e$  given the stated constraints.



## Introduce “Situations”

- Situations indexed by  $h \in \mathcal{H}$ .

## Personality is a response function.

$$\text{Personality} \left\{ \begin{array}{ll} X = X(R, W, T, h, Y, \mathcal{I}) & (13) \\ e = e(R, W, T, h, Y, \mathcal{I}) & (14) \\ a = a(R, W, T, h, Y, \mathcal{I}) & (15) \end{array} \right.$$

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- The behaviors that constitute personality are defined as a pattern of actions in response to the constraints, endowments, and incentives facing agents given their goals and preferences.
- Personality *emerges* from this system.

- Many personality psychologists (e.g. Roberts as previously quoted) define personality as

*“enduring patterns of thoughts, feelings and behaviors”*

that reflect tendencies of persons to respond in certain ways under certain circumstances.

- For task  $j$  and trait vector  $t$ , the average action for information set  $\mathcal{I}$  can be defined as

$$\bar{a}_{T,j,\mathcal{I}} = \int_{S_{T,\mathcal{I}}(h,e_{i,j})} \nu_{i,j}(\theta, e_{i,j}, h) g(h, e_{i,j} \mid T = (\theta, \psi, \bar{e}), \mathcal{I}) dh de_{i,j}.$$

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- $\mathcal{S}_{T,\mathcal{I}}(h, e_{i,j})$  is the support of  $(h, e_{i,j})$  given  $T$  and  $\mathcal{I}$ .

- $g(h, e_{i,j} \mid T = (\theta, \psi, \bar{e}), \mathcal{I})$  is the density of  $(h, e_{i,j})$  given  $T = (\theta, \psi, \bar{e})$  and information set  $\mathcal{I}$ .

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- $\bar{a}_{T,j,\mathcal{I}}$  is the “enduring action” of agents across situations in task  $j$  with information  $\mathcal{I}$ , i.e., the average personality.
- If  $\nu_{i,j}$  is separable in  $T$ , the marginal effect of personality trait vector  $\theta$  is the same in all situations.

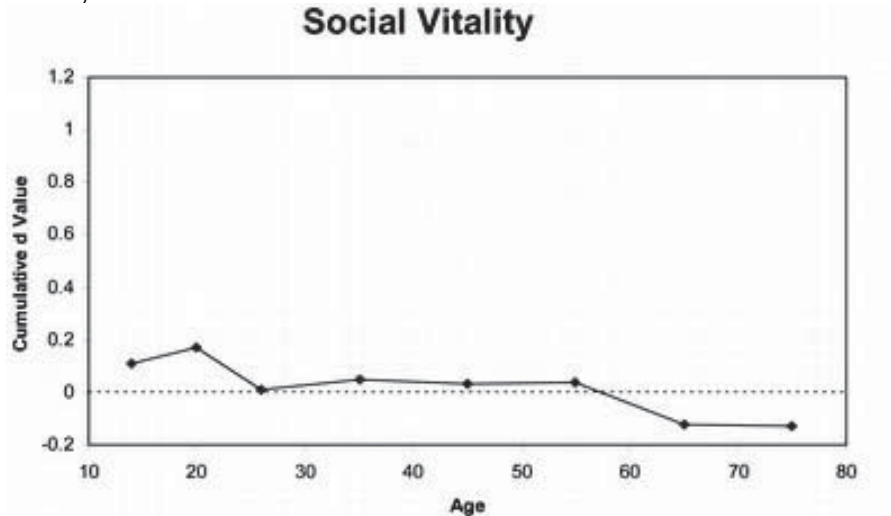
## Stability and Change in Personality Traits and Preferences

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- They are *not* set in stone.

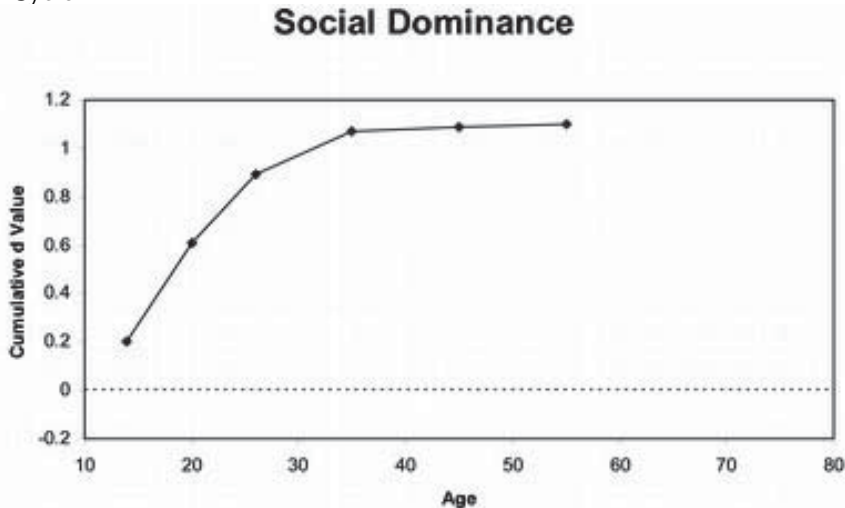
**Figure 12:** Cumulative Mean-Level Changes in Personality Across the Life Cycle



Note: Social vitality and social dominance are aspects of Big Five Extraversion. Cumulative d values represent total lifetime change in units of standard deviations ("effect sizes").

Source: Figure taken from Roberts, Walton and Viechtbauer [2006] and Roberts and Mroczek [2008]. Reprinted with permission of the authors.

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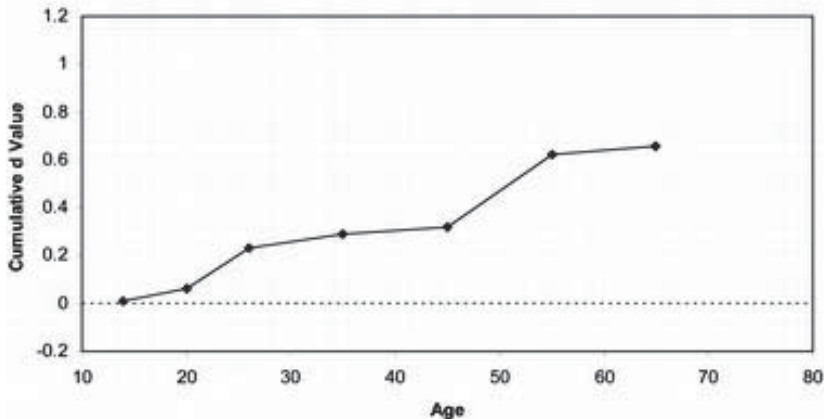


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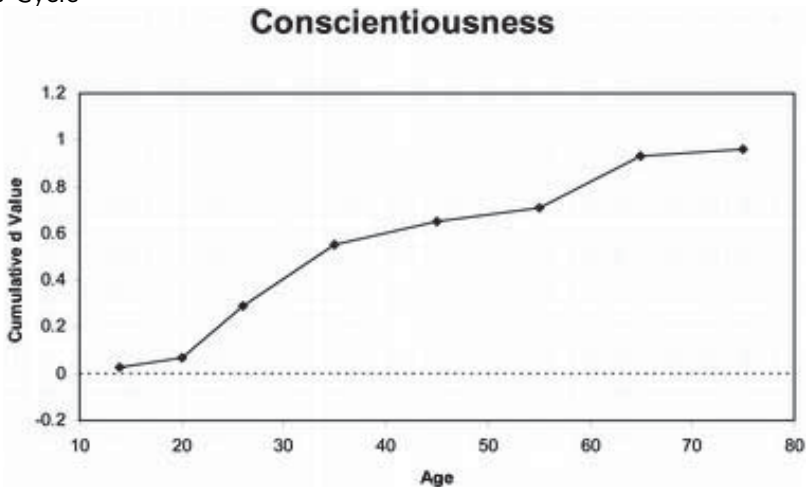
### Agreeableness



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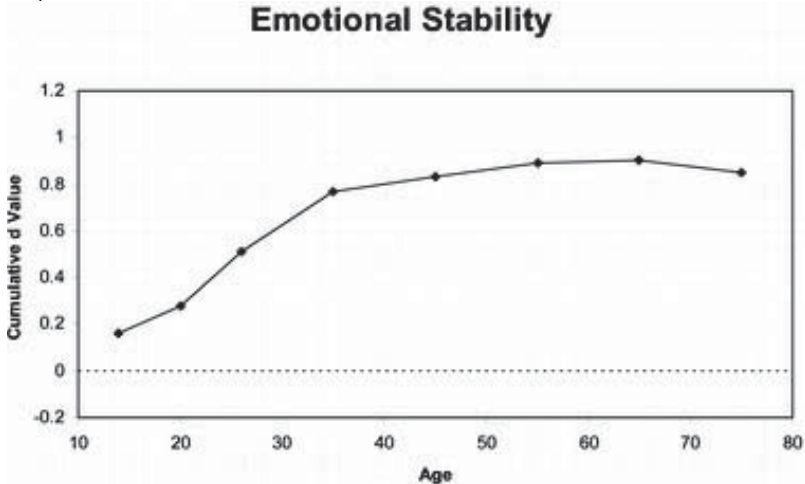
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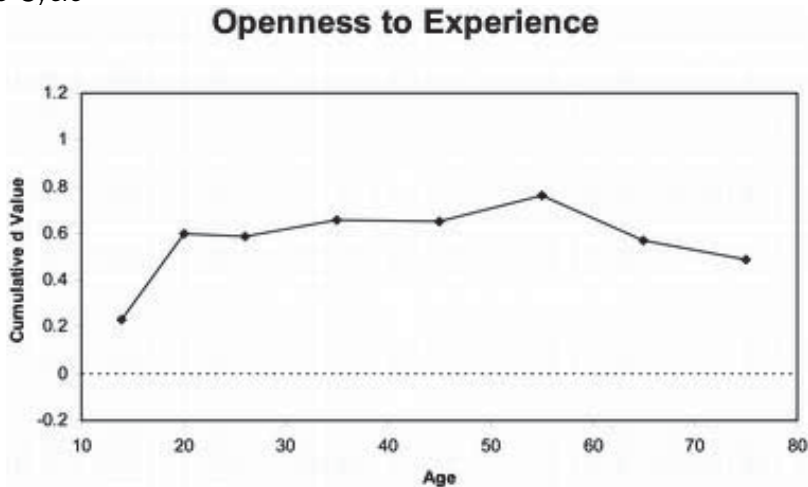


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Source: Figure taken from Roberts, Walton and Viechtbauer [2006] and Roberts and Mroczek [2008]. Reprinted with permission of the authors.



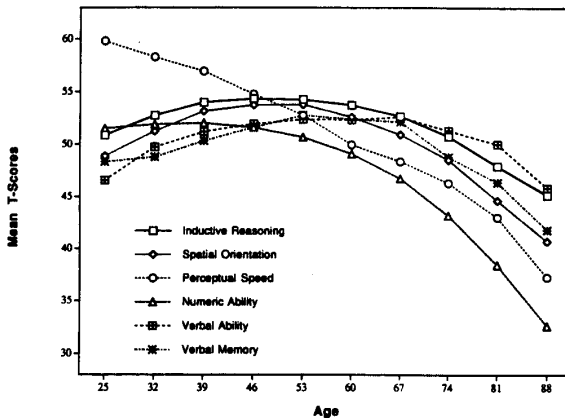
**Figure 12:** Cumulative Mean-Level Changes in Personality Across the Life Cycle



Note: Social vitality and social dominance are aspects of Big Five Extraversion. Cumulative d values represent total lifetime change in units of standard deviations ("effect sizes").

Source: Figure taken from Roberts, Walton and Viechtbauer [2006] and Roberts and Mroczek [2008]. Reprinted with permission of the authors.

Figure 13: Longitudinal Analysis of Cognitive Skills



Notes: T-scores on the y-axis are standardized scores with a mean of 50 and a standard deviation of ten.

Source: Figures taken from Schaie [1994]. Used with permission of the publisher.

## Three Processes of Development Discussed in the Literature

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- Ontogeny (programmed developmental processes common to all persons).
- Sociogeny (shared socialization processes).
- Personality changes through external forces above and beyond common ontogenic and sociogenic processes that operate through alterations in normal biology, such as brain lesions and chemical interventions.

**Investment:** educational interventions and parental investment can affect personality throughout the life cycle.

## Life Cycle Dynamics of the Model

- $T^v$ : traits at age  $v$ ,  $v \in \{1, \dots, V\} \in \mathcal{V}$ .

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## Life Cycle Dynamics of the Model

- $T^v$ : traits at age  $v$ ,  $v \in \{1, \dots, V\} \in \mathcal{V}$ .
- Information  $\mathcal{I}^v$  may be updated through various channels of learning.
- The technology of skill formation (Cunha and Heckman [2007; 2009]):

$$T^{v+1} = \eta^v \left( \underbrace{T^v}_{\text{self-productivity}}, \underbrace{IN^v}_{\text{investment}}, h^v \right), v = 0, \dots, V-1 \quad (16)$$



- Situations may change over time as a function of past actions, past situations, investment, information, and the like:

$$h^{v+1} = \chi^v(h^v, IN^v, a^v). \quad (17)$$

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- Information  $\mathcal{I}^v$  may also change over the life cycle through experimentation and learning:

$$\mathcal{I}^{v+1} = \rho^v(\mathcal{I}^v, a^v, T^v, IN^v, h^v). \quad (18)$$

## Personality and Economic Preference Parameters

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- Since personality psychologists define traits as relatively stable, person-specific determinants of behavior, preferences are the natural counterpart of these traits in economics.
- Preferences are also, at least in most models, unaffected by changes in constraints.
- While personality might relate to preferences, the exact link remains unclear.

**Table 6:** Standard preference parameters and conceptually similar measures in the psychology literature

Preference parameter	Personality measures
Time preference	Conscientiousness Self-control Affective mindfulness Consideration of future consequences Elaboration of consequences Time preference
Risk aversion	Impulsive sensation seeking Balloon Analogue Risk Task
Leisure Preference	Achievement Striving Endurance Industriousness
Social preference	Warmth Gregariousness Trust Altruism Tender-mindedness Hostility



**Table 7:** Overview of empirical studies of the links between preferences and traits

Preferences	Personality measure	Empirical study
Time Preference	Conscientiousness, Self-control, Affective mindfulness, Elaboration of consequences, Consideration of future consequences.	Daly, Delaney and Harmon [2009]
	Extraversion Time Preference	Dohmen, Falk, Huffman et al. [2010]
Risk Aversion	Sensation Seeking	Zuckerman [1994], Eckel and Grossman [2002]
	Openness	Dohmen, Falk, Huffman et al. [2010]
	Neuroticism, ambition, Agreeableness	Borghans, Golsteyn, Heckman et al. [2009]
	Balloon Analogue Risk Task	Lejuez, Aklin, Zvolensky et al. [2003]
Social Preferences		
Altruism	Neuroticism, Agreeableness	Ashton, Paunonen, Helmes et al. [1998], Osinski [2009], Bekkers [2006]
Reciprocity	Neuroticism, Agreeableness, Conscientiousness	Dohmen, Falk, Huffman et al. [2008]
Trust	Neuroticism, Agreeableness, Openness, Conscientiousness	Dohmen, Falk, Huffman et al. [2008]

**Figure 14:** Pairwise Correlations between Time Preference (Impatience), Risk Tolerance, Personality, and Cognitive Ability for Males and Females

Time Preference							
0.008 0.86	O						
0.068 0.13	0.109 0.00	C					
0.066 0.14	0.416 0.00	0.105 0.00	E				
0.083 0.06	0.083 0.01	0.290 0.00	0.049 0.12	A			
0.060 0.18	0.193 0.00	0.064 0.04	-0.013 0.69	-0.012 0.71	N		
-0.119 0.01	0.162 0.00	-0.152 0.00	0.146 0.00	-0.137 0.00	-0.064 0.05	Symbol Test	
-0.101 0.03	0.154 0.00	-0.130 0.00	0.117 0.00	-0.183 0.00	-0.082 0.02	0.404 0.00	Word Test

Notes: \*statistically significant at the 10 percent level; \*\*statistically significant at the 5 percent level; \*\*\*statistically significant at the 1 percent level. O-Openness to Experience; C-Conscientiousness; E-Extraversion; A-Agreeableness; N-Neuroticism. The value in each box is the pairwise correlation. Darker shaded boxes have lower p-values. The measures of the Big Five are based on 3 questions each. The measures of cognitive ability (symbol test and word test) are based on timed modules similar to the Wechsler Adult Intelligence Scale (WAIS). Time preference and risk tolerance were elicited through a real-stakes experiment.

Source: The data come from Dohmen, Falk, Huffman et al. [2010], available online. The calculations were conducted by the authors.

## Table 8: Link between Personality Traits and Preferences

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Altmann, Dohmen and Wibrat [2008]	<p><u>Outcome(s)</u>: <i>trust</i> – amount the first-player sends in a real-stakes experimental trust game</p> <p><u>Explanatory Variable(s)</u>: <i>reciprocity</i> – amount returned by the second player in a real-stakes experimental trust game; <i>risk aversion</i> – certainty equivalent as measured by real-stakes choices over lotteries</p>	<p><u>Data</u>: Collected by authors; 240 students from the University of Bonn</p> <p><u>Methods</u>: OLS</p>	<p><u>Controls</u>: gender</p> <p><u>Timing of Measurements</u>: The measures are contemporaneous.</p> <p><u>Theory</u>: People might generally value adhering to social norms associated with trust and reciprocity.</p>	<p>Reciprocity and trust are positively related (<math>p &lt; 0.01</math>). Risk aversion and trust are positively related (<math>p &lt; 0.05</math>).</p>
Borghans, Golsteyn, Heckman et al. [2009]	<p><u>Outcome(s)</u>: <i>risk aversion</i> – choices over real-stakes lotteries; <i>ambiguity aversion</i> – comparison of the willingness to bet on lotteries when the probability distribution is unknown</p> <p><u>Explanatory Variable(s)</u>: <i>gender</i>; <i>personality</i> – self-reported measures of The Big Five, ambition, flexible thinking, and self-control</p>	<p><u>Data</u>: Collected by authors; 347 students aged 15 to 16 from a Dutch high school</p> <p><u>Methods</u>: OLS, F-test</p>	<p><u>Controls</u>: n/a</p> <p><u>Timing of Measurements</u>: The measures are contemporaneous.</p> <p><u>Theory</u>: Risk aversion and ambiguity aversion represent different preferences and might reflect different personality traits.</p>	<p>Men are less risk averse than women (<math>p &lt; 0.001</math>) but more ambiguity averse (<math>p &lt; 0.05</math>). Risk-aversion is mediated by personality (<math>p &lt; 0.05</math>), while ambiguity aversion is not. Risk-aversion is positively associated with Agreeableness and Neuroticism and is negatively associated with ambition (<math>p &lt; 0.05</math>).</p>

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Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Borghans, Meijers and ter Weel [2008]	<p><u>Outcome(s)</u>: <i>cognitive ability</i> – number of correct answers on an IQ test; <i>effort</i> – time spent on each question</p> <p><u>Explanatory Variable(s)</u>: <i>risk aversion</i> – survey response to lotteries; <i>time preference</i> – survey response to trade-offs across time; <i>leisure preference</i> – survey response; <i>experiment incentives</i> – payment for correct answers to the IQ test; <i>personality</i> – self-reported Big Five, performance motivation, positive and negative fear of failure, locus of control, social desirability, curiosity, resilience, enjoyment of success, attitude toward work</p>	<p><u>Data</u>: Collected by authors; 128 university students from a Dutch University</p> <p><u>Methods</u>: probit</p>	<p><u>Controls</u>: type of cognitive test, the amount of incentive pay, and time constraints</p> <p><u>Timing of Measurements</u>: They measured IQ both before and after providing incentives.</p> <p><u>Theory</u>: People with different personalities and preferences might be willing to expend different amounts of mental effort during a test.</p>	<p>Performance motivation, fear of failure, internal locus of control, curiosity, low discount rates, and risk aversion are positively associated with more correct answers (<math>p &lt; 0.05</math>). Negative fear of failure, Extroversion, Openness to Experience, and Agreeableness are negatively associated with answering the question correctly (<math>p &lt; 0.05</math>). Incentives did not affect the number of questions answered correctly. Intrinsic motivation, curiosity, internal locus of control, Emotional Stability, Conscientiousness, and discount rates are negatively associated with responsiveness to incentives (<math>p &lt; 0.05</math>). Risk aversion is negatively associated with responsiveness to incentives (<math>p &lt; 0.10</math>). Leisure preference and Openness to Experience are positively associated with responsiveness (<math>p &lt; 0.05</math>).</p>

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Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Burks, Carpenter, Goette et al. [2009]	<p><u>Outcome(s)</u>: <i>risk aversion</i> – choices over real-stakes lotteries; <i>time discounting</i> – choices over real-stakes payments at different times; <i>inconsistent risk and time preference</i> – making at least one inconsistent choice in the experiments eliciting preferences; <i>job performance</i> – whether a worker leaves before the end of the first year</p> <p><u>Explanatory Variable(s)</u>: <i>cognitive ability</i> – IQ as measured by an adaptation of Raven's Standard Progressive Matrices</p>	<p><u>Data</u>: Collected by authors, administrative data; 892 trainee truckers from a U.S. trucking company (2005-2006)</p> <p><u>Methods</u>: OLS, interval regressions, linear probability model, Cox proportional hazard</p>	<p><u>Controls</u>: race, age, age squared, education, household income, absorption, achievement, aggression, alienation, control harm avoidance, social closeness, social potency, stress reaction, traditionalism, and well-being</p> <p><u>Timing of Measurements</u>: The measures are contemporaneous, except for job-turnover which was evaluated after the experiment.</p> <p><u>Theory</u>: People with higher IQ can better forecast the future.</p>	<p>An increase in IQ from the bottom quartile to the top quartile is associated with an increase in risk-taking consistency of 25 percentage points (<math>p &lt; 0.001</math>), an increase of intertemporal consistency of 15 percentage points (<math>p &lt; 0.001</math>), a decrease in discount rate (<math>p &lt; 0.001</math>), and a decrease in risk aversion (<math>p &lt; 0.001</math>). People in the lowest quartile of IQ are about twice as likely to leave the job within the first year (<math>p &lt; 0.001</math>).</p>

## Table 8: Link between Personality Traits and Preferences

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Daly, Delaney and Harmon [2009]	<p><u>Outcome(s)</u>: <i>time preference</i> – discount rate measured by a real-stakes choices over delayed payments</p> <p><u>Explanatory Variable(s)</u>: <i>health</i> – blood pressure, body fat, blood glucose, weight, height, heart rate; <i>personality</i> – questionnaire measures of The Big Five, self-control, consideration of future consequences, elaboration of potential outcomes, emotional regulation, cognitive and affective mindfulness, suppression of unwanted thoughts, experiential avoidance</p>	<p><u>Data</u>: Collected by authors; 204 students from Trinity College Dublin</p> <p><u>Methods</u>: factor analysis, OLS</p>	<p><u>Controls</u>: age and sex</p> <p><u>Timing of Measurements</u>: The measures are contemporaneous.</p> <p><u>Theory</u>: Personality traits and health indicators might be associated with willingness to delay gratification.</p>	Age and sex do not predict the estimated discount rate. A factor that loads heavily on self-control, consideration of future consequences, elaboration of consequences, affective mindfulness, and Conscientiousness is negatively associated with the discount rate ( $p < 0.01$ ). A factor that loads on blood pressure is positively associated with the discount rate ( $p < 0.10$ ).

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Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Dohmen, Falk, Huffman et al. [2011]	<p><u>Outcome(s):</u> <i>experimental risk measure</i> – measured by real-stakes choices over lotteries and cash payments</p> <p><u>Explanatory Variable(s):</u> <i>survey risk measure</i> – survey responses on an 11-point scale, relating to general risk preference and risk preference relating to car driving, financial matters, leisure and sports, career and health</p>	<p><u>Data:</u> Collected by the authors; 450 adults from Germany</p> <p><u>Methods:</u> OLS</p>	<p><u>Controls:</u> gender, age, height, and other personal characteristics</p> <p><u>Timing of Measurements:</u> The measures are contemporaneous.</p> <p><u>Theory:</u> Survey and experimentally-elicited risk measure the same concept</p>	Survey measures of general risk attitude predict incentive compatible, experimentally elicited measures of risk attitude ( $p < 0.01$ ).
Ding, Hartog and Sun [2010]	<p><u>Outcome(s):</u> <i>experimental risk measure</i> – measured by real-stakes choices over lotteries and cash payments</p> <p><u>Explanatory Variable(s):</u> <i>survey risk measure</i> – responses on an 11 point scale, relating to general risk preference and risk preference relating to car driving, financial matters, leisure and sports, career and health, survey responses to hypothetical lotteries</p>	<p><u>Data:</u> Collected by the authors; 121 students of PKU in Beijing who participated in an experiment (2008)</p> <p><u>Methods:</u> OLS, correlations</p>	<p><u>Controls:</u> major, gender, family income, and class rank</p> <p><u>Timing of Measurements:</u> The measures are contemporaneous.</p> <p><u>Theory:</u> There could be an underlying risk parameter that applies in all situations.</p>	The survey measures of risk explain at most 10 percent of the variance in the experimental measures of risk (general risk attitude and financial risk are the best). Self-assessed risk depends much on the domain or context; the highest correlation between context-based survey questions is $r = 0.55$ . Women are more risk averse than men; risk-aversion decreases with parental income; and risk attitudes depend on domain (context). People view winning and losing money differently.

## Open Question

Given the disappointing knowledge currently available from much of personality psychology it may well prove more fruitful to use economics to define and measure personality parameters.

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- 20 years from now, psychology may well be based on preferences elicited by economic personality choice data.
- See the essay by Corr, Ferguson and Heckman (2011) that summarizes a new literature *by psychologists* eliciting personality traits from economic choice experiments.

## Summary and Conclusions

**What can economists take from and contribute to personality psychology?**

**What do we learn from personality psychology?**

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- 4 Personality traits are not set in stone. They change over the life cycle. They are a possible avenue for intervention and policy.

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- ⑤ In explaining outcomes, how important is person? How important is situation? How important is their interaction?
- ⑥ To develop a new choice-based, behavior-based taxonomy of traits to supplement or improve on the Big Five.