Web Appendix
Personality Psychology and Economics

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This appendix supports material in main text of the paper. We organize it by section. Amanda Agan and Pietro Biroli contributed to Appendix A7 on crime and health, respectively.

Contents

A1. **Introduction**

Section Contents

It is well established that measures of intelligence and academic achievement predict a variety of social and economic outcomes.[1] Table A1 displays the correlations of three widely used measures of cognition recorded in the adolescent years—IQ, an achievement test (the Armed Forces Qualifying Test or AFQT), and report card grades (in tenth grade)—with a variety of adult labor market and social outcomes.[2,3]

All of the reported correlations are 0.36 or less and most are below 0.25. However, most are statistically significant. The AFQT is more highly correlated with outcomes than conventional IQ tests, suggesting that standardized achievement tests capture traits valued in economic and social life other than measured intelligence. The correlation of grades with outcomes is usually intermediate between IQ and AFQT.[4] None of the measures of cognition predicts a great deal of the variance in the listed outcomes—at most 14% and for most measures less than 7%—leaving a lot of room for the operation of other factors. Adjusting for family background, most correlations remain statistically significant and the predictive ordering of IQ, grades, and AFQT is unchanged. See Table A2 in the Web Appendix.[5]

Why do grades and achievement test scores predict adult outcomes better than IQ? We show that up to 35% of the variance in the scores on achievement tests can be explained by

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[1] Cognitive traits include fluid intelligence, acquired skills and knowledge, processing speed, memory, etc. These are discussed in detail in Section 5. For evidence on their predictive power, see, for example, Herrnstein and Murray [1994], Gottfredson [2008], Cawley, Heckman and Vytlacil [1999], Heckman, Stixrud and Urzua [2006], Taubman and Wales [1973], Noyes [1945], Jencks, Smith, Acland et al. [1972], and Bowles, Gintis and Osborne [2001a].
[2] The AFQT consists of four subtests: word knowledge, paragraph comprehension, arithmetic reasoning, and mathematics knowledge (Roberts, Goff, Anjoul et al. [2000, p. 19]).
[3] Many interpret the AFQT as an IQ test. For discussion of the contrast between achievement and IQ tests see the collection of papers in Green [1974]. Many of the contributors to that book do not think any distinction is meaningful.
[4] Grades are not adjusted for schooling quality.
[5] http://jenni.uchicago.edu/personality_economics/. In that table, we report the partial correlations between the measures in Table A1 adjusting both variables for the effect of family backgrounds (i.e. we report the correlations between the residuals of the variables after removing the influence of family background variables).

measures of personality.[6] This may explain the greater predictive power of AFQT than of IQ

shown in Table A1. Grades are also associated with measures of personality which may explain

their generally higher predictive validity than of IQ as revealed in Table A1, especially for the

outcomes of women.[7,8] Another interpretation of this evidence is that acquired knowledge is

more predictive than fluid intelligence as measured by IQ. We demonstrate the role of

personality traits in promoting the acquisition of knowledge. Personality traits have both direct

and indirect effects on many economic and social outcomes.

Table A1. Validities from the National Longitudinal Survey of Youth, 1979

| | NLSY79 Correlation Table (tests and school performance) | | | | | |
| | Males | | | Females | | |
Outcomes	IQ	GPA (10th grade)	AFQT	IQ	GPA (10th grade)	AFQT
Hourly Wage Age 25	0.17***	0.17***	0.22***	0.14***	0.20***	0.25***
Hours Worked Age 25	0.08***	0.02	0.08***	0.14***	0.19***	0.28***
Wage Income Age 25	0.19***	0.17***	0.25***	0.21***	0.25***	0.36***
Weeks Worked Age 25	0.08***	0.04**	0.09***	0.16***	0.20***	0.30***
Weeks Unemployed Age 25	-0.14***	-0.11***	-0.18***	-0.12***	-0.11***	-0.12***
Weeks Out of Labor Force Age 25	-0.02	0.03	0.02	-0.11***	-0.15***	-0.26***
Total Jobs by Age 25	0.04	-0.08***	-0.04***	0.16***	0.03*	0.19***
Num. of Spouses/Partners by Age 25	-0.06**	-0.08***	-0.06***	0	-0.06***	-0.02
Any Welfare Age 25	-0.09***	-0.12***	-0.16***	-0.19***	-0.21***	-0.36***
Hourly Wage Age 35	0.03	0.05***	0.05***	0.11***	0.10***	0.13***
Hours Worked Age 35	0.10***	0.12***	0.21***	0.02	0.10***	0.17***
Wage Income Age 35	0.21***	0.21***	0.26***	0.08***	0.15***	0.19***
Weeks Worked Age 35	0.10***	0.15***	0.23***	0.11***	0.13***	0.23***
Weeks Unemployed Age 35	-0.10***	-0.11***	-0.15***	-0.17***	-0.11***	-0.14***
Weeks Out of Labor Force Age 35	-0.09**	-0.14***	-0.22***	-0.04	-0.11***	-0.18***
Total Jobs by Age 35	-0.02	-0.13***	-0.06***	0.09***	-0.02	0.18***
Num. of Spouses/Partners by Age 35	-0.05*	-0.10***	-0.05***	0.04	-0.05***	-0.01
Any Welfare Age 35	-0.09***	-0.11***	-0.23***	-0.20***	-0.23***	-0.36***

Notes: AFQT was administered in 1979. IQ is a percentile score obtained by equating IQ across different IQ tests from NLSY79 transcript data following the procedure in Borghans, Golsteyn, Heckman et al. [2010]. Tenth grade GPA is reported because after this grade attrition losses are substantial. (* $p<0.10$, ** $p<0.05$, *** $p<0.01$)
Source: National Longitudinal Survey of Youth 1979 (NLSY79). These estimates are taken from Heckman and Humphries [2010].

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[6] Borghans, Golsteyn, Heckman et al. [2010] and Duckworth, Quinn and Tsukayama [2010]. We discuss this evidence in Section 5.
[7] Bowen, Chingos and McPherson [2009b], Willingham, Pollack and Lewis [2002] and Duckworth and Seligman [2005].
[8] The predictive validity of grades would likely increase if data were available to condition on schooling quality and grading standards.

Associations are useful for predicting outcomes. Effective policy is based on causal relationships that establish if interventions work and how they work. This paper discusses causal evidence from a variety of interventions.

Table A2. Validities from the National Longitudinal Survey of Youth, 1979 by Gender

	Males			Females		
NLSY79 Partial Correlation Table (tests and school performance) controlling for family background measures listed at the base of the table						
Outcomes	IQ	GPA (10th grade)	AFQT	IQ	GPA (10th grade)	AFQT
Hourly Wage Age 25	0.13***	0.13***	0.18***	0.07**	0.17***	0.19***
Hours Worked Age 25	0.02	-0.02	0.03*	0.11***	0.16***	0.21***
Wage Income Age 25	0.15***	0.13***	0.19***	0.14***	0.22***	0.28***
Weeks Worked Age 25	0.04	0.01	0.05***	0.12***	0.17***	0.21***
Weeks Unemployed Age 25	-0.11***	-0.07***	-0.11***	-0.06**	-0.08***	-0.06***
Weeks Out of Labor Force Age 25	0.02	0.04**	0.03*	-0.10***	-0.14***	-0.20***
Total Jobs by Age 25	-0.01	-0.11***	-0.01	0.03	-0.03**	0.11***
Num. of Spouses/Partners by Age 25	-0.05*	-0.09***	-0.06***	-0.05	-0.11***	-0.09***
Any Welfare Age 25	-0.06**	-0.09***	-0.14***	-0.11***	-0.16***	-0.20***
Hourly Wage Age 35	0.00	0.03*	0.03*	0.07**	0.09***	0.14***
Hours Worked Age 35	0.03	0.11***	0.12***	0.07*	0.10***	0.16***
Wage Income Age 35	0.14***	0.17***	0.21***	0.06**	0.14***	0.21***
Weeks Worked Age 35	0.03	0.13***	0.15***	0.12***	0.12***	0.17***
Weeks Unemployed Age 35	-0.08**	-0.10***	-0.09***	-0.12***	-0.07***	-0.08***
Weeks Out of Labor Force Age 35	-0.02	-0.11***	-0.15***	-0.06	-0.12***	-0.15***
Total Jobs by Age 35	-0.05	-0.15***	-0.06***	-0.02	-0.08***	0.07***
Num. of Spouses/Partners by Age 35	-0.04	-0.11***	-0.03*	-0.01	-0.12***	-0.08***
Any Welfare Age 35	-0.02	-0.10***	-0.16***	-0.08**	-0.16***	-0.19***

Notes: AFQT was administered in 1979. IQ is a percentile score obtained by equating IQ across different IQ tests from NLSY79 transcript data following the procedure in Borghans, Golsteyn, Heckman et al. [2010]. Tenth grade GPA is reported because after this grade attrition losses are substantial. (* p<0.10, ** p<0.05, *** p<0.01)
Source: National Longitudinal Survey of Youth 1979 (NLSY79). These estimates are taken from Heckman and Humphries [2010].

A2. **Personality and Personality Traits: Definitions and a Brief History of Personality**

Section Contents

A2.A.   A Brief History of Personality Psychology

Interest in how individuals can differ radically from one another in their responses to a common situation is as old as human history. The importance of personality traits for determining educational outcomes was recognized by the creators of the first IQ tests. Alfred Binet, architect of the first modern intelligence test that became the Stanford-Binet IQ test, noted that performance 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, in playing truant."* (Binet [1916, p. 254])

Lewis Terman, the psychologist who created the Stanford-Binet test in its modern form, wrote along similar lines. Comparing more successful high-IQ people to less successful ones, he wrote contrasting the A's (the high achievers) with the C's (the low achievers):

> *"The subjects, their wives, and their parents showed remarkable agreement in rating the A's far higher than the C's on Perseverance, Self-confidence, and Integration toward goals."* (Terman and Oden [1947, p. 351])

David Wechsler [1943], who helped usher intelligence testing into widespread practice, made a similar observation about the unfortunate neglect of "non-intellective" factors that, in conjunction with general intelligence, determine intelligent behavior.

At about the same time that Binet was writing, Charles Spearman, best known for his work on "g"—a unitary factor that is claimed to capture the structure of intelligence—along with his student, Edward Webb, undertook studies of "character" because of "the urgency of its practical application to all the business of life" (Webb [1915, p. 1]). Spearman and Webb

concluded that many positive aspects of character shared a relation to what modern personality

psychologists term "Conscientiousness."[9] This general factor, which Spearman and Webb chose

to call "persistence of motives," meaning "consistency of action resulting from deliberate

volition, or will," was distinct from a general intelligence factor (Webb [1915, p. 60]).[10]

Arthur Jensen, an intellectual heir of Spearman who is widely regarded as a proponent of

g as an explanatory factor of success and failure in many domains of life, writes:

> *"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"* Jensen [1998, p. 575].

One reason why traits related to Conscientiousness are so important to academic success

is that, according to William James [1899], in "schoolroom work" there is inevitably "a large

mass of material that must be dull and unexciting." In a series of essays entitled *Talks to*

Teachers, James observed:

> *"There is unquestionably a great native variety among individuals in the type of their*
>
> *attention. Some of us are naturally scatter-brained, and others follow easily a train of*
>
> *connected thoughts without temptation to swerve aside to other subjects."* (James [1899,*
>
> p. 112])

James notes that while classroom teachers should do their utmost to engage students in

learning, a dispositional advantage in the capacity for sustaining attention in spite of diversions

and distractions puts some students at a tremendous advantage. The importance of

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[9] Here and elsewhere through this essay, we capitalize personality traits.

[10] Many other psychologists who developed and promoted IQ tests expressed similar sentiments. See the Web Appendix Section 2.A.

Conscientiousness for predicting success both inside and outside of the classroom is a recurrent finding which we summarize in Section 7.

Progress and Regress in Personality Psychology

Over the past century, interest in personality among psychologists has fluctuated dramatically. During the first half of the twentieth century, many of the most prominent psychologists (e.g., Gordon Allport, Raymond Cattell, Hans Eysenck, Charles Spearman, Lewis Terman) were vigorously engaged in the study of individual differences, in personality traits as well as in intelligence, interests, and motivation. In 1968, Walter Mischel published a monograph entitled *Personality and Assessment*, challenging the most important theoretical assumptions and empirical findings of the field. An acrimonious "person-situation" debate ensued, which pitted those who favored situational factors as explaining behavior against those who considered person variables as more consequential. During this time, considered by many to be a fallow period in the history of personality psychology, the general Zeitgeist favored experimental social psychology research which focused on the importance of the situation compared to the individual traits featured in personality psychology. Arguably, the past three decades have witnessed a revival of interest in personality, though it would be an overstatement to say that personality psychology is as fashionable a discipline as it was a century ago.[11]

A more systematic approach to the study of personality was conceived by psychologists who believed that the most important dimensions on which human beings differed would be captured in natural language. These personality pioneers extracted words from the (English) dictionary that characterized individual differences between people (e.g., irritable, proud) and,

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[11] See Revelle, Wilt and Condon [2010] for an informative history of personality psychology.

after eliminating synonyms and non-trait words (e.g., laughing), administered these trait

inventories to large samples and applied the same factor analytic methods developed by Galton,

Spearman, Binet, Pearson, Cattell, and Thorndike to isolate "g" to identify the structure of

cognitive abilities.[12]

The fruits of several decades of research in this tradition beginning in the 1970s have

produced a widely (but not universally) shared consensus taxonomy of traits, known as the Big

Five, that is arrived at through factor analysis of observer and self-reports of behaviors. The Big

Five posits a hierarchical organization for personality traits, with five factors at the highest level

and progressively more narrowly defined traits (or facets) at lower and lower levels. Table 1

presents the Big Five traits. The Big Five factors are Openness to Experience (also called

Intellect or Culture), Conscientiousness, Extraversion, Agreeableness, and Neuroticism (also

called Emotional Stability).[13] The Big Five factors represent personality traits at the broadest

level of abstraction. They summarize a large number of distinct, more specific, personality

facets which we discuss in Section 5.

The Big Five are defined without reference to any context (i.e., situation). This gives rise

to the identification problem we discuss in Section 3. The behaviors used to measure the traits

are also determined by factors other than the traits. John [1990] and Costa and McCrae [1992a]

present evidence that most of the variables used to assess personality traits in academic research

in the field of personality psychology can be mapped into one or more of the dimensions of the

Big Five. They argue that the Big Five are the longitude and latitude of personality traits, by

which all more narrowly defined traits may be categorized (see also Costa and McCrae [1992a]).

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[12] Goldberg [1993], Barenbaum and Winter [2008], John and Srivastava [1999a], Krueger and Johnson [2008].
[13] The acronym OCEAN is sometimes used to summarize these traits.

We discuss the Big Five further in Section 5, where we also consider alternative measurement

systems.

Table 1. The Big Five Traits

Trait	Definition of Trait[*]
I. Openness to Experience (Intellect)	The tendency to be open to new aesthetic, cultural, or intellectual experiences.
II. Conscientiousness	The tendency to be organized, responsible, and hardworking.
III. 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.
IV. Agreeableness	The tendency to act in a cooperative, unselfish manner.
V. Neuroticism (Emotional Stability)	Neuroticism is a chronic level of emotional instability and proneness to psychological distress. Emotional stability is predictability and consistency in emotional reactions, with absence of rapid mood changes.

* From the American Psychological Association Dictionary [2007].

The Person-Situation Debate and its Influence in Economics

Renewed interest in personality traits runs counter to the disinterest and even suspicion with

which personality research is regarded by social psychologists. To understand the origins of this

stance, we go back to Mischel's [1968] monograph that fueled the person-situation debate.

Among other observations, Mischel commented that correlations between behavioral task

measures of personality and questionnaire measures seldom, if ever, exceeded 0.30.[14,15] The

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[14] There is great irony in the fact that none of the correlations of cognitive measures with outcomes that are reported in Table A1 in the Web Appendix are as high as .3, but no one questions the power of cognition in social life. Few studies in social psychology show correlations as high as .2 (see Richard, Bond and Stokes-Zoota [2003]).

implication of such within-individual behavioral heterogeneity suggested to Mischel that "the

behaviors which are often construed as stable personality trait indicators are highly specific and

depend on the details of the evoking situations and the response mode employed to measure

them" (p. 37). Mischel's wrote

> "…*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*" – Mischel [1968, p. 146]

Mischel went on to write that global (i.e., domain-general) traits (e.g., "impulsive", "confident")

measured in one situation did not predict future behavior and outcomes in other situations. His

view was that global traits, in attempting to summarize behavioral dispositions without regard to

situational contingencies, were "excessively crude, gross units to encompass adequately the

extraordinary complexity and subtlety of the discriminations that people constantly make" (p.

301).

More recently, Mischel [2009] writes that the loudest voices in the person-situation

debate were those of extremists arguing, quite unhelpfully, either that personality traits dictated

behavior or that people completely conformed to situation influences. In his own defense,

Mischel has argued that his message was much more nuanced:

> *"The main message of my 1968 monograph was that the situation has to be incorporated*
>
> *into the conception and assessment of personality"* Mischel [2004]

Mischel suggests now [2004] that there are consistencies in behavior across time, but that the

locus of consistency is to be found in highly contextualized if-situation/then-behavior

contingencies (e.g., "*If* I feel threatened, *then* I am aggressive"). Variance across situations was,

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[15] Psychologists often work with standardized variables (variables normalized by standard deviations). They report correlations between standardized variables as "effect sizes."

in Mischel's view, improperly treated by most personality psychologists as "error."[16] Indeed, in his view, the systematic variation of behavior across situations pointed to underlying motivations, beliefs, schemas, strategies, and other factors that collectively and interactively give rise to coherence in any individual's measured personality. His revised view of personality is broadly consistent with Robert's framework captured by Figure 2.

In Section 3, we formalize the "if-then" relationship using an economic model. We show that the person-situation debate boils down to an empirical question about the relative importance of person, situation, and their interaction in explaining behaviors. Although Mischel may have intended otherwise, proponents of the situationist view have used his monograph as ammunition in the battle against accepting evidence from personality psychology. As is characteristic of most heated debates in social science, this one occurred in the absence of much data. In Section 5, we discuss the body of evidence that has emerged over the past four decades on the existence of stable personality traits.

The debate over the relative importance of person and situation in the 1960s and 1970s was a manifestation of deeper currents in psychology and social science which still run quite strong. In the 1960s, behaviorism associated with B. F. Skinner posited, among other things, that all aspects of behavior can be explained by experience, was still influential, and the notion that situation and experience were all powerful—that people were born as blank slates.[17] Inter-individual heterogeneity in traits was ignored. Ross and Nisbett [1991] summarize the position of many social psychologists:

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[16] I.e. unobserved heterogeneity.
[17] Pinker [2002].

"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" (p. xiv).

A similar view is held by many behavioral economists and they often appeal to Mischel as a

guiding influence. For example, in a recent round table discussion, Richard Thaler noted that

"The great contribution to psychology by Walter Mischel [...] is to show that there is no

such thing as a stable personality trait" (Thaler [2008]).[18]

Many studies in behavioral economics attempt to establish inconsistency across situations, in

violation of standard assumptions of stable preferences used in mainstream economics. For

instance, several studies find very low correlations in risk-taking behavior across situations (e.g.,

Slovic [1962], Kogan and Wallach [1967], Slovic [1972], Blais and Weber [2006], Johnson,

Wilke and Weber [2004], and Weber, Blais and Betz [2002]). Slovic, a psychologist who has

had a strong influence on behavioral economics, writes:

"Although knowledge of the dynamics of risk taking is still limited, there is one important

aspect that has been fairly well researched—that dealing with the stability of a person's

characteristic risk-taking preferences as he moves from situation to situation. Typically,

a subject is tested in a variety of risk-taking tasks involving problem solving, athletic,

social, vocational, and pure gambling situations. The results of close to a dozen such

studies indicate little correlation, from one setting to another, in a person's preferred

level of risk taking." (Slovic [1972, p. 795])

Prospect theory proposed by Kahneman and Tversky [1979] is one attempt to reconcile

results on cross-situational inconsistencies in risk behavior. The study of context effects such as

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[18] Thaler [2008].

framing, time inconsistency, and heuristics seemed to suggest that there are no stable underlying preferences present across all situations (Schoemaker [1982], Hershey, Kunreuther and Schoemaker [1982]).[19]

Since one strand of behavioral economics stresses cross-situational inconsistencies, it is, as is economics in general, largely silent about personality traits. It was natural to extrapolate and connect the finding of inconsistency with standard economic theory to the predominant view in psychology at the time behavioral economics was being created—the inconsistency in behavior across situations that was perceived to have been established in social psychology. A specimen of this mindset is found in Thaler and Ziemba [1988] who write:

> *"The more basic question is whether individuals display a consistent 'trait' that can be captured in an index of risk aversion or risk seeking. Psychologists have found that most such traits are highly context specific, and risk taking is no exception."* (Thaler and Ziemba [1988, p. 170, Footnote 12]).

While the approach used by behavioral economists may be valid given the focus on inconsistencies within a person, the strong focus on situational differences may have falsely led some to conclude that interpersonal differences are irrelevant, and that personality traits have very low predictability.

This chapter examines the evidence on stability of preferences and personality across situations.

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[19] However, prospect theory does not explain why individuals in the same situation, framed the same way, differ in their reactions.

Revival

Personality psychology survived the Behaviorist assault. A rich body of correlational evidence, which we summarize in Sections 7 and 8, showed that for many outcomes, measured personality traits were as predictive, and sometimes more predictive, as standard measures of cognition. The evidence from behavioral genetics that measured personality traits were as heritable as cognitive traits strengthened the belief that something about measured personality was real. Studies in neuroscience that showed that alterations in brain structure and function through accidents, disease and experiment altered measured personality reinforced the evidence of heritability. We review this evidence in Section 8. For a more comprehensive discussion see the Web Appendix.

Recent interest in personality traits by psychologists has been partly motivated by advances in behavioral genetics and neuroscience. Behavioral genetic studies documenting substantial heritability of personality traits (often measured by the global trait measures such as the Big Five) provide evidence that enduring individual differences in personality exist.[20] Most twin studies report that genetic factors explain roughly one half of the variation in each of the Big Five domains across people; shared environment, including parenting, explains a trivial amount; and unshared environment explains half (Bouchard and Loehlin [2001]). Heritability estimates are higher among low-SES individuals and lower among high-SES individuals (Turkheimer, Haley, Waldron et al. [2003]).

Behavioral genetics studies using alternative paradigms reach slightly different conclusions. Studies comparing the personality measures of adopted children to the personality measures of biological children have found that heritability plays a smaller role than studies that use cohabitating twins (Krueger and Johnson [2008]). One study that used personality of twins as

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[20] Separating environmental and genetic influences on personality poses a fundamental identification problem. Behavioral genetics studies address the problem by comparing the traits of monozygotic (i.e., identical) twins who share the same genes to dizygotic (i.e., fraternal) twins who share only half of their genes. See Goldberger [1979].

visually assessed by professionals found a much bigger role for shared environment: across the Big Five, the median explained variation due to shared environment was 26% (Borkenau, Riemann, Angleitner et al. [2001]).[21]

Heritability studies might be confounded by gene-environment interactions. Some analysts have argued that choice of environment and perception of environment are shaped by genetics (Rowe [1981; 1983]). Others have found that the environment affects genetic expression (epigenetic effects). For example, a particular gene is associated with antisocial behavior, but only in combination with parental maltreatment (Caspi, McClay, Moffitt et al. [2002]). In sum, the recent evidence on heritability suggests that people do have genetic predispositions towards certain personality traits, but that environment also plays an important role in shaping measured personality, both directly and indirectly through interactions with genes.[22]

Neuroscience has also renewed interest in personality by demonstrating which parts of the brain are associated with personality traits. The evidence comes in two forms. First, brain lesions and other region-specific brain damage allow researchers to identify the function of parts of the brain. Perhaps the most famous example is Phineas Gage, a construction foreman who survived an accident in which a railroad spike passed completely through his prefrontal cortex. While he maintained his cognitive functioning, his personality took a turn for the worse – he transformed from being polite and dependable to profane and irresponsible. Re-analysis of his

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[21] Genome-wide association studies (GWAS) have moved beyond using genetic variation within families to using identifiable differences in specific genes. Typically, these studies examine how small differences in DNA sequences – known as single-nucleotide polymorphisms (SNPs) – are associated with outcomes. For example, one study finds that variations of a gene related to serotonin are associated with self-reported Neuroticism (Lesch, Bengel, Heils et al. [1996]). However, individual SNPs explain only a small amount of the variation in personality – one study found that no differences in any single gene or DNA sequence explained more than 1% of the variance in the heritability of Neuroticism (Shifman, Johannesson, Bronstein et al. [2008]). Therefore, it is likely that the heritability of these personality traits reflects many genetic differences, hence broad outcomes, such as Neuroticism, might be too coarse to have a close association with any single SNP.

[22] The recent research on gene-environment interactions also calls into question the evidence on heritability produced by traditional methods. See, e.g., Turkheimer, Haley, Waldron et al. [2003].

skull suggests that the spike pierced regions associated with social functioning (Damasio [1994]). Phelps [2006] reviews evidence from patients with brain damage that suggests emotions associated with personality traits are involved in learning, attention, and other aspects of cognition and that these relationships have a biological basis.

Second, the development of functional Magnetic Resonance Imaging (fMRI), a method that monitors blood flow in the brain, provides another way to link brain structure and function to personality traits. For example, Canli [2004] studies which regions of the brain are activated when people view pictures associated with negative and positive emotions. People who respond to positive images tend to be more extraverted, whereas those who responded more to negative images tended to be more neurotic. Similarly, DeYoung, Hirsh, Shane et al. [2010] find that the volumes of different brain regions systematically covary with measures of the Big Five traits except Openness to Experience. For example, Conscientiousness was associated with a region related to planning and control over behavior. However, other parts of the brain are correlated with self-reported personality, suggesting that broad measures of personality might not be specific to a single portion of the brain.[23] See Canli [2008] for a review of how molecular biology and neuroscience have advanced understanding of personality.

Recent studies have connected biology to economic decision-making. Kosfeld, Heinrichs, Zak et al. [2005] find that people who are given nasal sprays of oxytocin exhibit more trust in a game-theoretic trust game. Reuter, Montag, Altmann et al. [2009] find that people with a particular gene variant respond to oxytocin, suggesting that trust has a genetic basis. Similarly, Figner, Knoch, Johnson et al. [2010] find that magnetic disruption of the left lateral prefrontal

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[23] Many theories of personality are cognitively-oriented. For example, Mischel and Shoda [1995], Bandura [1999] and Revelle, Wilt and Condon [2010] suggest that behavior is driven by cognitive operations, beliefs, and representations of reality (how people process information, what they believe to be true, and how they interpret their perceptions).

cortex increases discount rates, providing evidence that individual differences in brain structure and function can cause differences in economic decision-making across people.

Evolutionary science provides another impetus for the revival of personality psychology. In general, natural selection promotes characteristics that better propagate genes. For example, jealousy may promote mate retention by arising when a mate is not faithful (Buss [2000]). More mysterious is why evolution leads to differences in people. Evolution can lead to heterogeneity in traits in at least three ways. First, some mutations might create traits that do not strongly affect genetic propagation, one way or the other. If heritable, these traits can persist in the population. This is like "white noise" (Buss [2000]). Similarly, single-period mutations could contribute to cross-sectional heterogeneity in traits.

Second, heterogeneity can arise from "balancing selection," evolutionary forces that actively promote heterogeneity. Different traits might be more useful under different environmental conditions. For example, some psychologists argue that people with higher levels of Extraversion could have thrived during relatively safe times, but could have suffered during hazardous ones (Nettle [2006]). Given that there is some variability in environmental conditions, differences in traits could have persisted over time. Third, different evolutionary strategies might be successful in the same environment.[24] Evolutionary theory helps guide thinking about why genetic mechanisms give rise to traits, but provides little hard evidence about the extent to which traits are heritable.

In summary, behavioral genetics, evolutionary theory, and neuroscience support the existence of personality traits. Personality psychologists have made parallel progress in demonstrating the predictive validity of measured personality for consequential, objectively

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[24] See Mealey [1995].

measured life outcomes. In Section 7, we summarize the evidence on the power of personality to

predict academic, social, health, and economic outcomes.

A3. **An Economic Framework of Personality**

Section Contents

This section discusses alternative economic models of personality from those introduce in Section 3 of the text. We draw on the research of Borghans, Duckworth, Heckman et al. [2008]. We use their notation to facilitate comparison with their paper. As noted in Section 6 of this paper, preference anomalies have attracted a lot of attention in the recent literature in behavioral economics. [25] However, choice is generated by preferences, expectations, and constraints, and psychology has something to say about each of these aspects of agent decision making.

We show how psychological variables, which define capacities and constraints, can enter standard choice models. Some traits can be enhanced through investment and experience. Traits may be divisible so that more of a trait used in one activity may reduce the supply of traits to other activities. Some traits may be public goods, available at the same level to all tasks. We create a taxonomy of traits to motivate future research on the economics of personality.

Bowles and Gintis [1976], Mueser [1979], Bowles, Gintis and Osborne [2001], Hartog [2001], and Mueller and Plug [2006]) consider how specific traits affect earnings capacities. Our discussion is more comprehensive than theirs because we consider how traits affect performance in many distinct areas of economic and social life. We also speculate about the relationship of the Big Five personality factors to conventional economic preference parameters. As yet, no tight link has been established. Cognition and personality likely both affect conventional preference parameters. Despite a hundred years of intelligence testing, IQ remains to be systematically integrated into economic theory apart from its direct effect on earnings.

A3.A.   *Psychological Variables as Constraints*

Capacities may be physical (beauty and strength, for example), cognitive (abstract reasoning) and those related to personality. Capacities determine, for example, how effectively

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[25] See Camerer and Loewenstein [2004] for a good introduction to behavioral economics and the papers in Camerer, Loewenstein and Rabin [2004]. Fudenberg [2006] presents a critical review of the literature.

persons process information, cope with uncertainty, adjust to setbacks, envision counterfactual states, project into the future as well as their sense of pride in their work. These capacities affect learning, social engagement and even the definition of self. They are in part acquired, and there is evidence that aspects of these capacities are heritable.

The conventional neoclassical model of economics postulates quasiconcave preferences embedded in a model with uncertainty and constraints. A large literature analyzes this model under a variety of constraints, market arrangements and expectation schemes (see Mas-Colell, Whinston and Green [1995] for an example). Versions of the model emphasize how information revelation in different market settings affects agent choices. Preferences postulated a priori play a central role in this theory as they do in most research in behavioral economics.

However, individual differences in personality and cognition shape the constraints of individuals and hence their choices. To show how far one can go in developing models that recognize the centrality of constraints to economic choice theory, it is instructive to consider a simple model without standard preferences where constraints alone (including expectations of feasible states) shape choices. A constraint-driven model need not produce a unique choice outcome for all persons with the same constraints.[26] In this framework, agents have no preferences and act like molecules in a Brownian motion constrained only by choice sets. As the choice sets change, the constrained molecules must change their choices to respect the boundaries created by the constraints. As emphasized by Becker [1962] and Sanderson [1974], with sufficient generality in the specification of the constraint set, one can generate all of the predictions of neoclassical choice theory from constraints and not preferences.

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[26] Thurstone [1927], Block and Marschak [1960], Marschak [1960], Becker [1962], Bock and Jones [1968], McFadden [1974],McFadden [1981], and Falmagne [1985] develop models that recognized that constraints (choice sets) may largely determine behavior. Becker's random consumer model and the extension of Sanderson [1974] extension of it are the most radical versions of this approach. List [2004] is a recent application of this model.

Thurstone [1927], Block and Marschak [1960], Bock and Jones [1968], McFadden [1974],and McFadden [1981]write the utility of agent i for choice l as $U_{i,l}$. In terms of the literature in psychology, $U_{i,l}$ is the motivation for choice (goal) l by agent i. There is a distribution of utilities across consumers. Choice sets, B_i, differ among persons depending on their capacities. These capacities are determined by agent cognitive and personality traits as well as the usual time and material constraints. In models with uncertainty, agents form expectations of constraint sets. Agent i chooses $\hat{l}_i$ as the maximal element in the choice set B_i:

$$\hat{l}_i = \underset{l \in B_i}{\operatorname{argmax}}\{U_{i,l}\}.$$

Consider a familiar model which writes $U_{i,l} = \bar{v}_l + \varepsilon_{i,l}$, where $\bar{v}_l$ is the mean valuation for l and $\varepsilon_{i,l}$ is a random "taste" shock. When $\varepsilon_{i,l}$ is iid extreme value type 1, the probability that l is selected from choice set B_i is

$$\Pr(l \mid B_i) = \begin{cases} \dfrac{\exp(\bar{v}_l)}{\sum_{j \in B_i} \exp(\bar{v}_j)} & \text{for } l \in B_i, \\ 0 & \text{for } l \notin B_i. \end{cases}$$

(A.1)

If agents have zero mean scale preference among the choices ($\bar{v}_l$=0) so that all choices (goals) have the same mean utility, we obtain a version of the Becker [1962] model of rational random behavior as extended by Sanderson [1974]where choices are generated by random shocks and the budget set determines choice behavior. Under an iid assumption for preference shocks, all possible choices are equally likely.[27]

Depending on how the constraints are determined, one can capture a variety of aspects of choice behavior. Thus a shy person may limit her options in a way an extravert does not. An

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[27] The "taste" shock may be interpreted as either a utility (preference) or as a random element that determines which bundle of B_i is selected by agent i.

intelligent person may have a much richer choice set not only because of greater earnings

capacity but also because of much greater imagination. Much like greater pixel resolution in

imaging machines, those with higher IQ may resolve reality in a more fine-grained and less

biased way. The negative relationship between IQ and risk aversion noted in Section 6 may be

due, in part, to the greater resolution of reality (removal of components of uncertainty) by the

more intelligent. [28] We capture the effect of these traits on the choice sets, which may also

depend on material endowments. Applied to intertemporal settings, this framework captures the

phenomenon of high time preference as an inability of an agent to imagine future states or as an

inability to accurately measure future states.[29]

A3.B. *Incorporating Personality and Cognitive Ability into Conventional Economic Models: A Simple Framework for Organizing the Evidence*

How should one incorporate psychological traits into conventional economic models?

One could think of them as public goods, freely available to all activities or tasks undertaken by

agents. This is the approach implicitly adopted by most personality psychologists. One could

also think of psychological traits as excludable private goods. More of a trait used in one activity

means less of the trait available for use in other activities.

In addition, one might augment, complement or override the supply of a trait to any

activity by supplying more time, or energy, to the activity in which the trait is used. Thus a trait

that is a public good may be more evident in a given activity if more time or energy is allocated

to the activity. On the other hand, "energy," e, which can be vector valued, may be used to

moderate the manifestation of the trait (for example, energy may be spent controlling anger in a

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[28] Allowing personality traits to determine, or screen out certain elements of possible choice sets is reminiscent of Tversky's elimination by aspects (EBA) model (see Tversky [1972a] Tversky [1972b]). McFadden [1981] discusses this model and its relationship to other random utility choice models. In our setup, psychological constraints eliminate certain components of choice.

[29] Frederick, Loewenstein and O'Donoghue [2002] review the classical literature in economics relating time preference to a failure of imagination.

given activity). Individuals differ in their endowment vector of the trait $\bar{f}$ or in terms of the

energy (possibly including time) denoted $\bar{e}$. Thus there may be a time constraint as in Becker

(1965) or, more generally, there may be energy constraints (constraints on effort capacity).

To develop these concepts and their consequences, we sketch a simple one-period model

of consumer choice under certainty. We consider models with uncertainty in the next subsection.

The framework developed in this subsection is rich enough to make some useful distinctions.

Following Becker [1965], assume that there are $J+1$ activities with outputs $Z_j, j=1,...,J+1$

undertaken by the agent. We add one activity to account for market earnings. Z_j is produced by

combining tasks, T_j with purchased market goods, X_j. We allow the task functions to include

levels of energy, and time, in vector e^j:

(A.2) $$T_j = h_j(f^j, e^j), \quad j=1,...,J+1.$$

f^j is to be distinguished from f_j, the jth component of vector f. f^j is the vector of f used

in task j. There is a parallel notation for e^j which may also be vector valued (for example, time

and energy may be separate components). Thus the first component of e, e_1, could be time; the

second component effort, and so on. e^1 is the amount of the vector e allocated to the first task.

The more time or energy devoted to a task, the greater the output from the task. For a fixed input

of psychological traits, higher levels of e^j may raise the output of the task. It may also happen

that unless a minimum amount of time or energy is devoted to a task, there is no productivity in

the task. Thus if $e^j = 0$, the trait vector f^j may be switched off. However, if some traits have

negative productivity in some tasks, more energy may be allocated to those tasks to offset the

negative trait. The effect of a trait in a task will depend on the bundle of other inputs used in the

task. It is necessary to identify these other inputs to identify the traits used in any activity.

Output in activity Z_j is

(A.3)
$$Z_j = \varphi_j(T_j, X_j), \quad j = 1, \ldots, J+1.$$

The outputs in activity j depend on the task output T_j and the goods input X_j. Agents have

preferences over Z_j and e^j. The effort expended in an activity may have psychic costs or

benefits. There may be psychic costs in using e^j to suppress the expression of a trait. Allowing

for full generality, we allow each e^j to have potentially different effects on utility. Preferences

may also depend on f as well as other variables which we keep implicit. The utility function is

(A.4)
$$U = U(Z_1, \ldots, Z_J, e^1, \ldots, e^{J+1}, f)$$
.

It captures the motivation of the agents for the outputs and "energy." As previously noted,

personality psychologists do not typically study motivation.[30] As embodied in utility functions,

motivation is central to most economic models of choice. Income is return on asset flow Y plus

labor earnings which we denote $Z_{J+1} = \varphi_{J+1}(T_{J+1}, X_{J+1})$. The budget constraint for goods is thus

(A.5)
$$\sum_{j=1}^{J+1} P_j X_j = Y + Z_{J+1}$$
.

Z_{J+1} is a hedonic earnings function which prices out traits and energy in the market, and

produces a flow of income.[31]

It is possible to distinguish two different cases for f. For psychological traits, we can

distinguish the case where f is a public good, $f^j = \overline{f}$ for all $j = 1, \ldots, J+1$, from the case where

it is a private good, $\sum_{j=1}^{J+1} f^j = \overline{f}$. In the former case, the same psychological traits enter as inputs

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[30] But see McAdams [2006] and McAdams and Pals [2006].
[31] See Sattinger [1993] for a discussion of hedonic models of earnings. This specification subsumes the conventional labor-leisure model as a special case where e^{J+1} is time allocated to market and $Z_{J+1} = we^{J+1}$, where w is the wage rate which may be person specific.

into all tasks and activities. In the latter case, the traits applied to different tasks are excludable

and rivalrous. More traits applied in one activity means fewer traits in other activities. People

are not stuck with their personality in all activities. Some components of f may be public and

others private. Thus extraversion and conscientiousness may be private goods that are more

productive in some activities than others and the limited and divisible supply of these traits will

be allocated according to preferences and productivity. Openness to experience may be a public

good. One can classify all traits by this schema. One could consider all possible combinations

of public and private good possibilities for all of the traits. For simplicity, we consider the pure

private goods case and the pure public goods case. A similar distinction could be made for the

energy inputs, but this seems less natural. To focus on main cases, we assume that e is a private

good. Thus we analyze the two cases displayed in the table:

$$f$$

	Public	Private
e Private	I	II

In case I, the additional constraint operating on the consumer beyond the budget

constraint (A.5) is

(I) $$f^j = \bar{f}, \quad \sum_{j=1}^{J+1} e^j = \bar{e}, \quad \text{for all } j = 1,\dots,J+1.$$

In case II, the operative constraints are

(II) $$\sum_{j=1}^{J+1} f^j = \bar{f}, \quad \sum_{j=1}^{J+1} e^j = \bar{e}$$
.

A3.B.i. Case I: Traits as Public Goods

In case I, different bundles of $\bar{f}$ across persons create comparative advantages for agents

in different tasks and thus produce comparative advantages in different activities. These

endowments affect consumption patterns of agents and the derived demand for X_j through scale

and complementary effects in the production of activities and through demand effects in

preferences. Case I is a version of the model in Michael [1973] of environmental variables in a

household production framework.[32]

For analytical simplicity, suppose that Z_j and T_j, $j = 1,...,J+1$, display constant returns

to scale in non-public inputs. The assumption of constant returns neutralizes any scale effects in

the determination of the shadow prices of tasks and activities. Traits may have negative

productivities. Persons with higher levels of traits with negative productivity require the

allocation of more energy and time to produce any given task. Thus hot tempered people exert

greater effort in controlling themselves in some activities.

In terms of the technologies expressed in (A.2), when f is a public good, we assume

constant returns to scale in e^j but that $f^j = \bar{f}$ is a fixed, environmental variable. Different levels

of $\bar{f}$ produce different productivities in different tasks. Feeding $\bar{f}$ into the activity functions

(A.3), which are also assumed to be constant returns to scale, we can analyze the agent's

problem of allocating effort among tasks and goods among activities using the analysis of

Michael [1973]. Financial and energy resources are not changed by $\bar{f}$ except for its effect on

Z_{J+1}. Holding energy and money resources fixed, changes in $\bar{f}$ produce reallocations across

budget categories.

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[32] Michael [1973] analyzes a scalar environmental variable (education) that plays the role of public goods in our analysis. The environmental variable is not chosen but affects the productivity of the other inputs.

Thus if $\bar{f}$ raises the productivity of inputs in task j, it reduces the shadow price of activity j. This has the usual income and substitution effects. The income effects produce a greater demand for all normal activities and sets in motion an increase in the derived demand for the inputs used in the activities. Since in general $\bar{f}$ appears as an input in multiple activities, increases in $\bar{f}$ will set off a chain of substitution effects among the activities. Depending on the preferences (motivations) over the Z_j, $j=1,...,J+1$, demands for inputs may increase or decrease.

It is instructive to reason through several cases. Consider an increase in conscientiousness. This will likely increase earnings (via Z_{J+1}), and will enhance productivity in some tasks intensive in conscientiousness and activities based on those tasks more than other tasks and activities. The increased income will support more of all activities. The differential shift in productivity across tasks and activities will reduce the prices of activities that are more intensive in the use of conscientiousness. If the demands for those activities are price elastic compared to the demands for the less conscientiousness-intensive activities, the demand for the inputs used in those activities will increase. If the demands are relatively inelastic, the demands will decrease because of the greater productivity for the inputs.

If a trait reduces productivity, the chain of logic just presented runs in reverse. With increases in, for example, neuroticism, shadow prices of activities intensive in that trait will increase. Labor earnings will tend to decrease. In the price-elastic case, consumers will tend to substitute away from activities intensive in the trait and the demand for inputs will decrease. In the inelastic case, input demands will increase as agents substitute goods and energy inputs into the activities that are inelastically demanded.

The same level of the traits is found in all activities, but in general, energy or time will be allocated differentially among activities. A person who allocates more energy or time to a task

will manifest more of the trait.[33] If inputs are complementary, at the same scale of output more

of the task will be demanded. Unless one controls for these inputs, one may fail to capture the

uniformity of traits across tasks and activities. In all of these cases, purchase patterns of market

goods will provide information on endowments and allocation of energy and traits. [34]

A3.B.ii. Case II: Traits as Private Goods

The case when traits are private goods produces the possibility of different levels of traits

being used in different tasks and activities. Responses of activity levels to changes in rewards

across activities will be more price-elastic when traits can be allocated across activities than

when traits are fixed. Equiproportionate expansions in $(\overline{f},\overline{e})$ differentially expand the

consumption possibility set for activities differentially intensive in (f,e) and reduce their

shadow prices, producing substitution effects in task production and activity consumption that

promote consumption in activities intensive in the traits. Because of the ability of agents to

reallocate traits across tasks and activities, an increase in endowment produces a stronger effect

on consumption of f-intensive activities than in the public goods case. This greater elasticity of

response to endowment is a consequence of the LeChatelier Principle (Samuelson [1947]). The

public goods case imposes more constraints on the system than the private goods case.

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[33] One specification of the task functions writes, in the case of scalar e, $T^{j} = h_{j}(f^{j}e^{j})$ so that the task depends on

the product of f^{j} and e^{j}. In the case of public goods for traits $(f^{j} = \overline{f})$, the level of energy applied to a task

augments or reduces the output of the traits. Thus, if $e^{j} = 0$, the trait is effectively not allocated to the task. For
example, agreeable people could decide not to be agreeable in certain situations. Borghans, ter Weel and Weinberg
[2008] argue that suppressing certain psychological traits is harder for some people than others. In our framework,
the utility cost of e^{j} is higher for such persons.

[34] Baumeister has recently proposed that the trait of self-control be conceived of as a limited resource, the finite
capacity of which varies from individual to individual. Self-control entails overriding lower-level processes (for
example, impulses and emotions) by higher-level processes (that is, processes that are mediated by frontal areas and
therefore are classified as executive functions). All brain functions rely on glucose and are metabolically expensive,
but higher-level processes are particularly impaired by decreases in available glucose. (SeeBaumeister, Bratslavsky,
Muraven et al. [1998]; Gailliot, Baumeister, DeWall et al. [2007]). Their analysis corresponds to a public goods case
with glucose as a component of e, with f a public good and with $\overline{f}$ differing among people.

Compared to the case of public goods for traits, agents will reduce their allocation of the trait from activities where their productivity is negative and will spend less effort (*e*) in overriding the effects of negative traits in productivity.[35] The trait will be shifted into less costly activities and less energy will be spent controlling it.[36] In this case, in different tasks and activities, different traits will in general be observed. This will produce a low correlation in traits across activities.

The evidence summarized in Sections 6 and 7 of the main text would seem to favor case II, since different levels of traits are often found in different activities. However, since most of the estimates reviewed in this paper do not adjust for the inputs that affect the manifestation of the traits, one must be cautious in reaching this conclusion. Such adjustments are indicated by the theory but are not yet standard in economics or psychology.

The roles of time and energy in amplifying or reducing the effects of the traits in activities needs to be systematically explored to make the theory empirically operational as are the effects of traits on the purchase of related goods (for example, shy people may seek to live in secluded areas, have houses with high walls and seek jobs with little human contact). In the private goods specification of the model (case II), the motivation for the supply of traits to different activities depends on preferences (utility rewards *U*), on productivity in Z_j, and in productivity in the tasks T_j. In this framework, it is possible to formalize many of the currently disparate concepts of personality psychology. However, much more empirical research is required to make the framework just sketched operational. It would be very informative to estimate both versions of the model and to test between them.

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[35] In both cases, as emphasized by Pollak and Wachter [1975], non-constant returns to scale produce additional substitution effects. Our public goods case captures one aspect of their analysis of jointness in production.
[36] Thus an angry person may transfer his or her anger to the home sector and thus avoid the costs of overriding his or her anger on the job. Alternatively, in a public goods case, the person would allocate more effort to controlling anger on the job than in controlling it at home.

We now turn to more general economic models with risk aversion, intertemporal choice, and investment. For simplicity, we assume that personality, other psychological traits and energy are public goods. The private goods version of the models follows from a direct application of analysis of this section.

A3.C.   Integrating Psychology into More General Economic Models

Economic theory at the single agent level separates two distinct aspects of behavior and decision making: preferences and constraints. Included among the constraints are (a) information acquisition constraints; (b) static budget constraints and endowments that affect the flow of resources available for consumption in any period; and (c) dynamic constraints connected with asset, skill and trait formation. The constraints facing agents are also determined by available market arrangements and trading opportunities. Psychology is potentially informative about all aspects of agent decision making.

Preferences are central to conventional economic choice models. In their most general form, we may write utility for an agent with decision horizon $\mathcal{T}$ over bundles of goods (attributes), X_τ, $\tau = 1,...,\mathcal{T}$, in an environment of perfect certainty with cognitive and personality attributes f as

$$(A.6) \qquad\qquad U(X_1,...,X_{\mathcal{T}}; f),$$

where it is assumed that U is neoclassical.[37] At this level of generality, cognitive and personality traits can affect all aspects of choice for all goods including the valuation of leisure, the intertemporal tradeoffs among goods, and risk aversion. A general non-separable intertemporal preference function is consistent with substantial departures from standard utility theory such as hyperbolic discounting (Ainslie [1991]; Laibson [1998]; Phelps and Pollak [1968]) and a variety

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[37] That is, increasing in its arguments and twice differentiable. Henderson and Quandt [1958] formulate such a general model.

of "exotic" or nonstandard preferences as discussed in, for example, Backus, Routledge and Zin [2005] and Hansen [2005]. Preference specifications as in (A.6) are consistent with different rates of time preference for different goods and across different periods as is found in the literature reviewed in Section 6.[38]

Few economists would embrace the high level of generality of specification (A.6). Fruitful economic models are more tightly structured. Specification (A.6) can characterize a one-shot model of lifetime decision making under certainty. Agents choose their lifetime consumption bundles at the beginning of life and are fully committed to those choices.

A basic problem with these specifications is time inconsistency.[39] In open markets, persons are not committed to their initial desired choices. After period 1, there is ambiguity about the appropriate representation of the remaining lifecycle utility function. One possibility is expressed in (A.6) with the first period choices as fixed arguments. Then, agents will stick to the lifetime program they initially select. Such an approach seems artificial because each period, people start anew and are free to make new decisions from a fresh time perspective. However, compulsive personality types may stick to the same plans no matter what, as long as they are feasible.

More generally, agents may look at future decisions differently in period 2 than they did in period 1. Let U^τ be the utility of the agent at stage τ for the remainder of life $U^\tau = G^\tau\left(X_\tau,...,X_T;f\right)$. Without further restrictions, there is no reason why in period τ, the agent is compelled to value the utilities of previous period consumption bundles or account for past consumption behavior in the way done prior to period τ in evaluating future consumption

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[38] We note, however, that the evidence on differences in discount rates across goods is sensitive to the role of markets in intertemporal arbitrage. In the absence of transaction costs, market and personal rates of time preference must be in agreement.
[39] See Samuelson [1937] and Strotz [1955].

streams. The problem of preferences changing over time is distinct from the problem of revised information sets although both produce possible departures from initial decisions based on (A.6).[40] In both cases, decisions made in early periods affect resources available to later periods and, retrospectively, there may be regret about initial consumption choices. Economists have traditionally addressed this problem by specializing (A.6). The conventional specification of the general preference function assumes a constant rate of discount ρ for utility across periods:

$$(A.7) \qquad U(X_1,...,X_T,f) = \sum_{\tau=1}^{T} \frac{1}{(1+\rho)^{\tau-1}} U(X_\tau,f).$$

Specification (A.7) is not required to achieve time consistency of choices.[41] This is an important point, because there is a lot of evidence that speaks against (A.7), as previously noted in Section 6. Notice that (A.7) is just a special case of equation (A.6), which is also a standard model of economic preferences. Discounting is implicit in specification (A.6), which generates goods-specific discounting that depends on future and past consumption choices, a phenomenon ruled out by (A.7). A more general form of discounting than specification (A.7) that is consistent with (A.6) is

$$(A.8) \qquad U(X_1,...,X_T,f) = \sum_{\tau=1}^{T} \prod_{j=2}^{\tau} \left(\frac{1}{1+\rho_j} \right) U(X_\tau,f),$$

where discount rates may vary with age. Even more generally, both preferences and discount rates may vary with time-dependent variables (for example, children, health, mood, personality

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[40] We consider uncertainty below.
[41] See Johnsen and Donaldson [1985]. The model of Becker and Murphy [1988] is an example of a non-separable model that is time consistent.

variables, and cognition).[42] Following our analysis in Section 3 and 8, factor f can evolve over time.

Let f_τ denote personality and cognitive traits at age τ. We can use $U_\tau(X_\tau, f_\tau)$ in place of $U(X_\tau, f)$, allowing for personal traits to evolve over time, and we can allow for utility in period τ itself to change, even after controlling for f_τ and X_τ. The analysis of Becker and Mulligan [1997] and Mulligan [1997] models the evolution of the discount rate through investment decisions. Becker and Murphy [1988] model the evolution of preferences for addiction where f_τ is a stock of addictive capital.

A wide variety of special cases of lifetime preferences are subsumed in specification (A.6). Personality factors like deliberation, future time perspective, and the capacity to inhibit impulses likely determine discount factors or preferences more generally. So may aspects of cognitive ability. Loewenstein, Weber, Hsee et al. [2001] discuss how decisions are affected by moods and emotions, which are influenced by personality variables. There is some evidence that higher-IQ persons have lower discount rates (see Frederick [2005] and Dohmen, Falk, Huffman et al. [2010]).

The standard model of social interaction in economics is interaction through markets (see Arrow and Hahn [1971]). More recently, economists have begun to analyze interactions in more general settings. They consider interactions in learning, in workplace productivity and in consumption.[43]

This aspect of human interaction is not captured by specifications (A.6)-(A.8) unless the X_τ include outcomes, choices or utilities of other persons. As noted previously in Section 6, a

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[42] See the evidence on age dependent preferences in Browning and Meghir [1991] and the survey of the evidence presented in Browning, Hansen and Heckman [1999].
[43] Durlauf and Fafchamps [2005] and Durlauf and Young [2001] survey this literature.

large literature in economics discusses the implications of altruism (see Becker [1981]; Laferrère and Wolff [2006], for a survey). Fehr and Gächter [2000] discuss the consequences of social preferences for economic decisions. Models of social preferences have been developed by Fehr and Schmidt [1999] and Falk and Fischbacher [2006]. See the surveys by Fehr and Schmidt [1999] and Meier [2007]. One of the major findings of personality psychology noted in Section 7 is that sociability, empathy, and the capacity to get along with others are important predictors of success in some activities. These traits are not the same as altruism or social preferences, but they are facets related to Big Five agreeableness and extraversion. It would be useful to clarify the relationships among these measurements.

Sociability and empathy may affect preferences for group activity which may be a source of pleasure (or displeasure) for some and which may also affect productivity in group activities in the workplace or in learning environments. Dohmen, Falk, Huffman et al. [2008] present evidence on how trust, positive reciprocity, and negative reciprocity relate to Big Five personality traits. These and other personality traits play dual roles. They are a source of pleasure and they can also be a source of productivity in certain contexts. Agents making choices under any of the standard preference schemes, including those that recognize social interactions, are constrained in their information, the resources required to support consumption and in their ability to accumulate financial assets and skills.

Uncertainty and risk are essential aspects of life. Economists have devoted much attention to the specification of the preferences of agents and the effect of uncertainty on choice (see Mas-Colell, Whinston and Green [1995]). Revisions of information sets over time are another reason why agents may deviate from initial choices apart from time inconsistency.

Alternative specifications of information and preference are used in the literature.

Individuals who are more intelligent or more open to experience (that is, more intellectually

curious and motivated to learn) may acquire information more cheaply. Other personality traits

may affect the basic attribute spaces perceived by agents.

The conventional model of uncertainty in economics is the expected utility model. Break

X into values that occur in different states $s=1,...,S_\tau$, at different times $\tau=1,...,\mathcal{T}$, $(X_{\tau,s})$.

Expected utility represents preferences by

$$U(X) = \sum_{\tau=1}^{\mathcal{T}} \sum_{s=1}^{S_\tau} P_{\tau,s} U(X_{\tau,s}), \text{ where } \sum_{s=1}^{S_\tau} P_{\tau,s} = 1, \ \tau=1,...,\mathcal{T}$$

where $X_{\tau,s}$ is a state s, time τ-specific bundle of traits and $P_{\tau,s}$ is the probability that state s

occurs in period τ.

There is considerable empirical evidence against this model. Many departures from it

have been proposed to rationalize the available evidence.[44] Some departures break the additive

separability assumption and assume a variety of alternative preference structures. A more

general specification is based on (A.6) or its "exotic preference" specializations augmented to

include as arguments different states of nature at each time period ($X_{\tau,s}$) and probability

distributions over these states of nature. These models allow for much richer specifications of

the information sets on which agents act than is permitted in the expected utility model.

Personality factors may affect the arrival and processing of information and vice versa.

People not open to experience fail to learn from it. Impulsive people who do not act with

deliberation may process information inefficiently (Frederick [2005]). Persons with greater

ability to imagine the future or imagine outcomes reduce the intrinsic uncertainty in their

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[44] See the survey in Starmer [2000].

environments and may be less risk averse, or more risk averse, depending on whether the imagined outcome is more favorable or less favorable. Personality traits affect openness to experience (willingness to learn), risk aversion (anxiety), and imagination about future states not yet experienced (creativity). Persons with higher IQs appear to be more willing to take risks and are more patient (Dohmen, Falk, Huffman et al. [2010]), perhaps because they are better able to envision future consequences.

There are far richer models of decision making under uncertainty in economics than the standard expected utility model or models based on decision making under uncertainty generated from objective distributions. These specifications allow for preferences over the temporal resolution of uncertainty about states of the world (Epstein and Zin [1991]; Kreps and Porteus [1978]), uncertainty about distributions over states of the world (ambiguity) and different types of risk and uncertainty aversion in preferences (see Starmer [2000]). These models enrich conventional economic theory by taking into consideration how agents react to uncertain events and how they process information.[45] These richer theories of decision making under uncertainty expand the scope for introducing personality variables into economics.[46]

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[45] See Hansen [2007] and the references contained therein.

[46] There is some confusion in the literature about the role of additive separability in models of dynamic consistency of decision making under uncertainty. Johnsen and Donaldson [1985] establish that dynamic consistency requires weak separability of intertemporal preferences but not the strong separability used in standard models of consumer decision making. Consider a two period model of agent decision making. X is current consumption. Y_s is future consumption in state s, which occurs with P_s. Under a certain interest rate r, the standard expected utility theory postulates that agents maximize for a three-possible-outcome-second-period-model,

$$U(X) + P_1 U(Y_1) + P_2 U(Y_2) + P_3 U(Y_3)$$

subject to $A = X + \sum_{s=1}^{3} \frac{P_s}{1+r} Y_s$. This produces time consistent preferences for the usual reasons. However, keeping probabilities implicit, the following non-expected model of utility maximization

$$U(X, Y_1, Y_2, Y_3) = [X + \log(X + Y_1) + (X^{\frac{1}{2}} Y_2^{\frac{1}{2}})^{\frac{1}{3}} (XY_3)]^{\frac{1}{2}}$$

also produces time consistent preferences. Note that in this specification even if $P_1 = P_2 = P_3$, discount rates differ for different second period goods.

Personality traits are likely to prove useful in economic models of decision making under ambiguity.[47] Individuals may differ in their capacities to deal with poorly defined situations. Greater intelligence may help define situations, but persons with greater self-control, openness to experience, lower levels of anxiety, and those who seek excitement may also cope better with ambiguity.

Personality traits may also affect the resources available to agents. As emphasized by Bowles, Gintis and Osborne [2001], certain personality and character traits may be more highly valued than others in the labor market (trustworthiness, perseverance, outgoingness, for example). Borghans, ter Weel and Weinberg [2008] show that technological and organizational changes have increased the importance of people skills in the workplace. They present evidence for Germany and the United States that the increased importance of people skills has affected the labor-market outcomes of blacks and women. They find that the relative employment of women is higher in occupations in which people tasks are more important in Britain, Germany and the United States. The reverse is true for racial, ethnic, cultural, and linguistic minorities in the United States. They also show that the rapid increase in the importance of people tasks over this time period helps explain the increase in women's wages relative to men and the stagnation in wages of black workers relative to white workers. Diligent or trustworthy employees require less supervision. More generally, different personality and cognitive traits may be more highly valued in some activities than in others. In any activity, whether it is learning, information processing or performance of a workplace task, those who exert higher levels of effort will be more productive.

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[47] See Epstein and Le Breton [1993], Gilboa and Schmeidler [1993], Siniscalchi [2006], and Hansen and Sargent [2008]for analyses of decision making under ambiguity. Ellsberg [1961] is the classic reference.

Comparative advantage in the labor market is analyzed in the models of Roy [1951],

Mandelbrot [1961], Mandelbrot [1962],Tinbergen [1956], Rosen [1974], Sattinger [1979],

Sattinger [1993], Willis and Rosen [1979], Heckman and Sedlacek [1985], Teulings [1995], and

Teulings [2005. {Borghans, 2008 #7831]develop a model in which personality traits are

included in an assignment model. Write the productivity of a person in occupation (pursuit) j at

time τ as $Y_{j,\tau} = \alpha_{j,\tau}(f_\tau^j, e_\tau^j), j=1,...,J_\tau,$ where we adjoin τ subscripts to the trait and energy

levels. Different occupations or tasks require (or weight) different traits differently. (See Hogan

[2005]; Hogan and Hogan [2007].) Thus, for example, extraversion is an essential trait for a

salesman but not a lighthouse keeper or a truck driver. An individual who tries harder at any

task will typically be more productive, although in certain workplace norms that enforce effort

standards, the loner who makes more effort may be less productive, at least in terms of group

cohesiveness.[48]

In Subsection B, we analyzed specifications of market productivity functions that are

used in the efficiency wage literature (see Weiss [1991]). Market output depends on

psychological traits plus effort and energy. Agents operating under different incentive schemes

will manifest different effort. More generally, as noted in Subsection B and Section 6, the

expression or manifestation of personality traits will depend, in part, on the context in which the

individual is placed. At issue is the situational specificity of personality traits.

If agents choose or are assigned to tasks on the basis of maximal output $Y_{j,\tau}$ and pursuit

of one occupation precludes pursuit of other occupations, the occupation (task) selected at time

τ among the J_τ possible assignments at time τ is j_τ^*, defined as

---

[48] Borghans, ter Weel and Weinberg [2008]provide evidence of assignment based on "people skills" in the labor market using British and German data. Krueger and Schkade [2008]provide similar evidence for gregarious workers in the United States.

(A.9)
$$j_\tau^* = \arg\max_j \left\{ Y_{j,\tau} \right\}_{j=1}^{J_\tau}.$$

In this case, Y_{i,j_τ^*} corresponds to $Z_{J+1,\tau}$ for the period τ as introduced in Subsection C. This

framework captures the notion of comparative advantage in the labor market where agents sort

into sectors based on their comparative productivity. Productivity determined by skills and

personality traits affects the bundle of goods that the agent can buy. The phenomena of

comparative advantage and differential skill requirements in different tasks helps to explain why

some personality traits are predictive in certain activities but not in others (for evidence see

Hogan, Hogan and Roberts [1996]). Hogan [2005] and Hogan and Hogan [2007] show the

predictive power of personality traits in different occupations. Different employers may place

different weights on different characteristics, and they may have different values in different

settings.[49]

Over time, persons may also accumulate assets and skills, and may change their

personality characteristics and cognitive traits. Preference parameters affect asset and skill

accumulation. In Section 8, we presented evidence that cognitive and personality traits can be

changed (see Cunha and Heckman [2007]and Fraley and Roberts [2005]). Both are influenced by

experience and current stocks of the characteristics and other determinants. To formalize these

notions, define C_τ as a capacity vector that includes f_τ and e_τ but encompasses a wider notion

of capacities. Motivation can be affected by intelligence and other capacities of human beings

(see Cunha and Heckman [2008]). Interventions can affect preferences, information, opportunity

sets, and the formation of skills and preferences. Personality and cognitive ability evolve over

---

[49] There is a subliterature in psychology on "g" that pits "g" against personality characteristics in terms of their predictive power (see Gottfredson [2002]). This literature creates a false dichotomy. While "g" is predictive in a much wider variety of settings, in particular settings, as noted in Section 7, certain personality traits are more predictive than "g".

time through investment, through learning by doing or through other life experiences (see Cunha

and Heckman [2007]; Cunha, Heckman and Schennach [2010]). Among the characteristics or

capacities C_τ can be health, motivation, personality traits and ability (Heckman [2007]). Using

the technology of skill formation developed by Cunha and Heckman [2007] and Cunha and

Heckman [2008], capacities evolve via the following recursive technology

(A.10) $$C_{\tau+1} = \varphi(C_\tau, IN_\tau), \quad \tau = 1, \ldots, T-1, \; C_0 = c_0$$

where c_0 is an initial condition for capacities and IN_τ is investment at stage τ and where φ is

concave in IN_τ, and is assumed to be differentiable in C_τ and IN_τ. In one version of this theory,

$f_\tau = C_\tau$ and cognitive and personality skills can evolve over time. Characteristics may be self-

productive $\left(\dfrac{\partial \varphi(C_\tau, IN_\tau)}{\partial C_\tau} > 0 \right)$. Investment, which can include experience and other inputs, may

affect the evolution of abilities and personality, that is, $\left(\dfrac{\partial \varphi(C_\tau, IN_\tau)}{\partial IN_\tau} > 0 \right)$.

A3.D.   *Linking Preference and Constraint Parameters to Psychological Variables*

We previously cited evidence relating IQ to risk preference and time preference. In this

subsection, we speculate about the relationship between personality measures and conventional

preference parameters. It is an area ripe for future research and our comments are designed to

foster it.

The Big Five captures traits that seem relevant but are not exclusive determinants of

economic preference parameters. Moreover, a single agent economic model cannot fully capture

the operation of traits that foster social interactions. Positive social interactions can produce

benefits in terms of learning and information processing. Participation in social groups provides

a form of insurance and may promote risk-taking (through insurance), even if it does not change

risk aversion. Many economic models of contracting emphasize unobserved effort (a component of e), as an important dimension of economic transactions in the presence of imperfect information (Salanié [1997]). Empirical work in contract theory would be facilitated if preference parameters could be extracted from psychological questionnaires that predict effort.

For the same time input, some individuals may put in more effort in a task (a component of T_j, $j=1,...,J+1$) and will be more productive than other individuals at the task whether the task is a job, learning in school or acquiring information. Persons for whom the utility cost of effort is low, and hence exert more effort, will be more productive in a variety of activities. Moreover, effort or energy levels (and other personality traits) can be affected by incentives confronting agents. Thus, behavior is affected by incentives and is not necessarily constant across settings.

In Table 3 of the text, "warmth" (a facet under extraversion) may be a productive trait in some settings, but it may be unproductive in certain settings (for example, an assembly line, on the battlefield or in a seminar). Fantasy (under Openness) can be counterproductive in routine tasks but very productive in creative work, providing that the person is also self-disciplined and open to criticism. There is wisdom in considering traits that have domain-specific productivities. Such productivities are associated with comparative advantage in the labor market. In addition, different incentives and monitoring schemes can produce different behaviors (the measures in equation (A.9) for the same person placed in different settings, for example).

Do the traits discussed by personality psychology cause us to rethink the standard economic model? The evidence on the predictive power of sociability, effort and conscientiousness and the evidence on altruism and other pro-social preferences should lead to a reemphasis of traditional theory. Social interactions tend to be neglected in standard economic

theory, although there is a lot of recent research on this topic (see Durlauf and Young [2001], Brock and Durlauf [2001], and the evidence in Fehr and Schmidt [2006]).

Is it possible that conventional economic preference parameters fully explain all of the personality traits uncovered by psychologists? It seems implausible that conventional leisure preference, risk aversion, and time preference parameters explain all of the personality traits. For one thing, it is likely that these parameters are produced both by cognition and personality as we have previously noted. However, certain traits associated with Big Five conscientiousness might be rationalized by basic preference parameters. A low taste for leisure and a low discount rate would contribute to making persons more conscientious. However, the Big Five traits alone cannot explain diligence unless the person has some goal (or goals) or preferences motivating effort and self-discipline in a particular situation. Conventional economic models do not explain the origin of motives (goals).

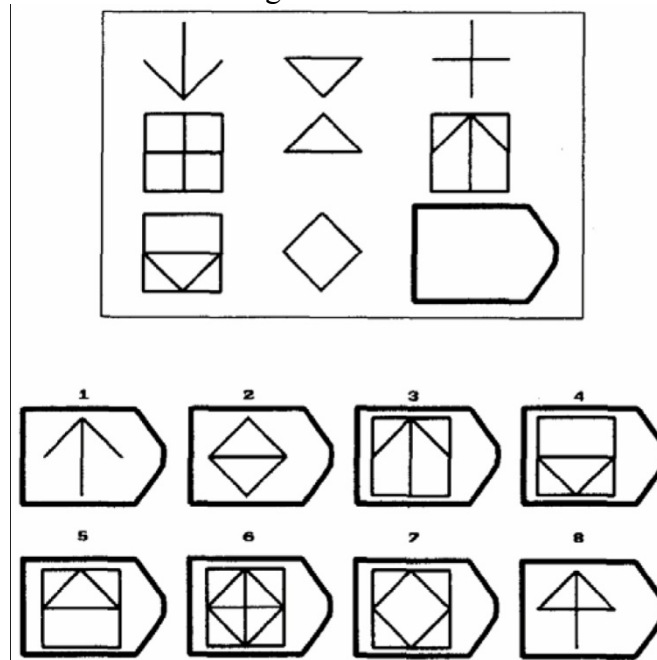# A4. **Measuring Personality**

Section Contents

A5. **Implementing the Measurement Systems**

Section Contents

Figure A1.Problem Similar to Raven's Progressive Matrices Test Item

Note: Note: The bottom right entry of this 3x3 matrix of figures is missing and must be selected from among 8 alternatives. Looking across the rows and down the columns, the test taker attempts to determine the underlying pattern and then pick the appropriate missing piece. The correct answer to this problem is 5.
Source: Figure taken from Carpenter, Just and Shell [1990], used with permission of the publisher, copyright American Psychological Association.

A6. **Personality and Preference Parameters**

Section Contents

Figure A2. Correlations of Personality Traits, Preferences, and Cognitive Skills

Males (N=1135)

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism	Locus of Control	Risk Aversion	Trust	Positive Reciprocity	Negative Reciprocity	Impatience	Cognitive skills Crystallized
Big Five: Openness Factor												
Big Five: Conscientiousness Factor	0.249 (0.00)											
Big Five: Extraversion Factor	0.306 (0.00)	0.452 (0.00)										
Big Five: Agreeableness Factor	0.324 (0.00)	0.156 (0.00)	0.210 (0.00)									
Big Five: Neuroticism	-0.114 (0.00)	-0.039 (0.18)	-0.124 (0.00)	-0.113 (0.00)								
Locus of Control Factor	0.255 (0.00)	0.149 (0.00)	0.221 (0.00)	0.167 (0.00)	-0.288 (0.00)							
Risk Aversion Factor	-0.081 (0.01)	-0.129 (0.00)	-0.188 (0.00)	-0.141 (0.00)	0.049 (0.10)	-0.077 (0.01)						
Trust Factor	-0.060 (0.04)	0.063 (0.03)	0.024 (0.41)	0.008 (0.78)	-0.077 (0.01)	0.128 (0.00)	0.016 (0.58)					
Positive Reciprocity Factor	0.303 (0.00)	0.146 (0.00)	0.185 (0.00)	0.302 (0.00)	-0.009 (0.76)	0.082 (0.01)	-0.137 (0.00)	-0.048 (0.11)				
Negative Reciprocity Factor	-0.086 (0.00)	0.002 (0.94)	-0.060 (0.04)	-0.274 (0.00)	0.196 (0.00)	-0.208 (0.00)	0.074 (0.01)	-0.120 (0.00)	-0.049 (0.10)			
Impatience	-0.129 (0.00)	-0.020 (0.94)	-0.007 (0.82)	-0.195 (0.00)	0.209 (0.00)	-0.103 (0.00)	0.041 (0.17)	-0.060 (0.04)	-0.038 (0.20)	0.179 (0.00)		
Cognitive skills Crystallized	0.007 (0.82)	0.111 (0.00)	0.077 (0.01)	-0.024 (0.41)	-0.032 (0.27)	0.085 (0.00)	-0.020 (0.50)	0.100 (0.00)	-0.020 (0.51)	-0.021 (0.48)	-0.007 (0.82)	
Cognitive Skills, fluid	0.000 (1.00)	0.089 (0.00)	0.057 (0.05)	0.012 (0.69)	-0.085 (0.00)	0.051 (0.08)	-0.039 (0.18)	0.107 (0.00)	-0.028 (0.35)	-0.060 (0.04)	-0.007 (0.80)	0.405 (0.00)

Females (N=1228)

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism	Locus of Control	Risk Aversion	Trust	Positive Reciprocity	Negative Reciprocity	Impatience	Cognitive skills Crystallized
Big Five: Openness Factor												
Big Five: Conscientiousness Factor	0.207 (0.00)											
Big Five: Extraversion Factor	0.245 (0.00)	0.462 (0.00)										
Big Five: Agreeableness Factor	0.378 (0.00)	0.101 (0.00)	0.182 (0.00)									
Big Five: Neuroticism	−0.044 (0.13)	−0.069 (0.02)	−0.142 (0.00)	−0.081 (0.00)								
Locus of Control Factor	0.197 (0.00)	0.124 (0.00)	0.273 (0.00)	0.186 (0.00)	−0.300 (0.00)							
Risk Aversion Factor	−0.084 (0.00)	−0.054 (0.06)	−0.102 (0.00)	−0.143 (0.00)	0.049 (0.08)	−0.067 (0.02)						
Trust Factor	−0.085 (0.00)	0.046 (0.11)	−0.013 (0.65)	0.034 (0.24)	−0.146 (0.00)	0.158 (0.00)	0.054 (0.06)					
Positive Reciprocity Factor	0.270 (0.00)	0.122 (0.00)	0.147 (0.00)	0.315 (0.00)	−0.008 (0.7)	0.057 (0.04)	−0.044 (0.12)	−0.030 (0.29)				
Negative Reciprocity Factor	−0.124 (0.00)	0.008 (0.78)	−0.050 (0.08)	−0.342 (0.00)	0.115 (0.00)	−0.202 (0.00)	0.042 (0.14)	−0.126 (0.00)	−0.031 (0.28)			
Impatience	−0.118 (0.00)	0.022 (0.44)	−0.020 (0.49)	−0.234 (0.00)	0.203 (0.00)	−0.078 (0.01)	0.060 (0.04)	−0.055 (0.05)	−0.114 (0.00)	0.127 (0.00)		
Cognitive skills Crystallized	−0.039 (0.17)	0.101 (0.00)	0.046 (0.11)	−0.068 (0.02)	−0.083 (0.00)	0.054 (0.06)	0.034 (0.24)	0.100 (0.00)	−0.003 (0.93)	−0.032 (0.26)	0.029 (0.31)	
Cognitive Skills, fluid	0.010 (0.72)	0.094 (0.00)	0.041 (0.15)	−0.046 (0.11)	−0.013 (0.64)	0.009 (0.76)	0.041 (0.15)	0.048 (0.09)	−0.027 (0.34)	0.030 (0.29)	0.049 (0.09)	0.435 (0.00)

Notes: In the graph, larger correlations are displayed using a larger font size. Correlations larger than .3 (in absolute terms) are grey. Sample includes all individuals with non-missings for personality measures, preferences measures and cognitive skill measures as well as a battery of control and outcome variables. Factors are predicted using the Bartlett method. Source: GSOEP, waves 2004-2008, authors' calculations.

Table A3. Personality Traits as Outcomes of Other Variables

	Males						Females					
	O	C	E	A	N	Loc	O	C	E	A	N	Loc
Christalized intelligence	-.018 (.033)	.035 (.033)	.063* (.036)	-.014 (.032)	.027 (.034)	.037 (.035)	-.065** (.03)	.034 (.036)	.001 (.034)	-.065** (.029)	-.039 (.032)	-.008 (.033)
Fluid intelligence	.038 (.039)	.013 (.034)	-.002 (.037)	.028 (.034)	-.029 (.037)	-.03 (.037)	.059* (.033)	.02 (.037)	.031 (.037)	.017 (.03)	.019 (.035)	-.033 (.034)
Age	.044*** (.014)	-.003 (.013)	-.014 (.013)	-.024** (.012)	.002 (.013)	-.016 (.014)	.044*** (.012)	.003 (.012)	.008 (.013)	-.01 (.011)	.033*** (.012)	-.022* (.012)
Age^2	-.0004*** (.0001)	5.15e-06 (.0001)	.00007 (.0001)	.0002** (.0001)	.00004 (.0001)	.0001 (.0001)	-.0004*** (.0001)	-.0001 (.0001)	-.00006 (.0001)	.0001 (.0001)	-.0003*** (.0001)	.0002* (.0001)
Height	.001 (.004)	.012*** (.005)	.005 (.005)	-.005 (.004)	-.002 (.005)	.0001 (.005)	-.003 (.005)	.013** (.005)	.013*** (.005)	-.0009 (.004)	-.003 (.005)	.003 (.005)
Ln(income)	.036** (.018)	.025 (.016)	-.01 (.015)	-.002 (.014)	-.013 (.017)	.025 (.016)	.009 (.017)	.0009 (.016)	.024 (.016)	.006 (.015)	-.041*** (.015)	.051*** (.017)
Ln(income from assets)	-.011 (.014)	-.002 (.014)	-.002 (.015)	-.035*** (.013)	-.025* (.014)	.045*** (.014)	.001 (.014)	.006 (.015)	-.001 (.014)	-.02 (.012)	.018 (.014)	-.005 (.015)
Ln(income from pubtrans)	.008 (.01)	-.011 (.009)	-.007 (.009)	-.005 (.009)	.0005 (.009)	-.006 (.009)	-.019** (.01)	-.0003 (.01)	.014 (.009)	-.014* (.008)	-.012 (.01)	-.005 (.009)
Yrs of Edu	.004 (.012)	.07*** (.012)	.016 (.013)	.005 (.011)	-.009 (.013)	.026** (.012)	.011 (.013)	.045*** (.014)	.031** (.012)	.004 (.011)	-.039*** (.013)	.04*** (.013)
Number of children	-.024 (.048)	-.094** (.042)	-.036 (.045)	.037 (.041)	.06 (.049)	.031 (.046)	.018 (.045)	-.126*** (.042)	-.073 (.045)	.002 (.038)	.067 (.042)	.085** (.04)
Risk aversion (f)	-.036 (.033)	-.088*** (.033)	-.144*** (.034)	-.071** (.028)	.032 (.033)	-.069** (.032)	-.061** (.028)	-.063** (.031)	-.11*** (.03)	-.094*** (.026)	.044 (.03)	-.083*** (.031)
Trust (f)	-.081** (.034)	.023 (.033)	.021 (.034)	.012 (.032)	-.023 (.034)	.055 (.035)	-.086*** (.031)	.008 (.033)	-.056* (.032)	.036 (.028)	-.089*** (.032)	.093*** (.034)
Positive Reciprocity (f)	.296*** (.037)	.148*** (.03)	.181*** (.032)	.287*** (.03)	.003 (.03)	.052* (.031)	.262*** (.036)	.126*** (.033)	.139*** (.035)	.288*** (.03)	.016 (.03)	.046 (.031)
Negative Reciprocity (f)	-.057* (.031)	.038 (.033)	-.056* (.033)	-.223*** (.032)	.156*** (.033)	-.183*** (.033)	-.114*** (.03)	.003 (.032)	-.037 (.031)	-.305*** (.027)	.066** (.033)	-.182*** (.032)
Impatience	-.1*** (.03)	-.013 (.032)	.022 (.033)	-.139*** (.029)	.185*** (.034)	-.063** (.032)	-.067** (.03)	.007 (.031)	-.017 (.03)	-.129*** (.026)	.193*** (.032)	-.056* (.032)
N	1011	1011	1011	1011	1011	1011	1085	1085	1085	1085	1085	1085
R-squared	.123	.097	.069	.193	.074	.096	.112	.055	.044	.251	.076	.087

Notes: O=Openness to Experience, C=Conscientiousness, E=Extraversion, A=Agreeableness, N=Neuroticism. The table displays regression coefficients of factor scores on covariates. Height is a person's body height, Ln(income), Ln(income from assets) and Ln(income from pubtrans) denote total yearly gross household income, total yearly gross household income from assets and total yearly gross household income from public transfers respectively. Source: GSOEP, waves 2004-2008, own calculations.

A6.A. *Leisure, time, risk, and social preferences*

In order to discuss the literature on the links between preferences and traits, we briefly define the aspects of preferences typically measured by economists. We demonstrate that there is nothing fundamental about these parameters, but rather that they represent convenient modeling choices. The behavioral economics literature and the literature on personality traits notes that the conventional parameters may not describe reality.

Measuring preferences boils down to measuring tradeoffs. Consider preferences over K goods for agent n

(10)
$$U_n\left(X_1, X_2, ..., X_K\right)$$

Marginal rates of substitution are given by

$$MRS_{m,l}\left(X_1, ..., X_K\right) = \frac{\partial U_n\left(X_1, X_2, ..., X_K\right) / \partial X_m}{\partial U_n\left(X_1, X_2, ..., X_K\right) / \partial X_l}$$

The marginal rate of substitution is a fundamental concept in economic analysis. If preferences exist and are twice continuously differentiable, we can always define it for any set of choices with no additional assumptions. An important question is which basic choices preferences are defined over, and how stable they are, or rather, which range of choices will allow us to define marginal rates of substitutions as functions of stable parameters. Describing preferences amounts to defining the most fundamental life tradeoffs.

If we are to judge by the amount of interest in the empirical literature, the most important tradeoffs are the tradeoffs between leisure and consumption, between consuming now or later, and between less uncertainty and higher expected returns. In addition, social preferences and altruism have been studied, in particular the tradeoffs between equity, equality, efficiency, and own consumption, in the multiple ways that these may conflict. However, we stress that these

aspects represent a choice by the scholars studying the subject. In a sense, this is not much different from the concept of operationalization and construct validity in the psychology literature. The relevant behaviors are by definition those which we choose to study. We look for our keys under our self-defined street lamps.

Preferences (10) can be general. We can define the preferences typically measured by economists by considering goods $X_1, ..., X_K$ to be consumption and leisure, consumption at K different points in time, consumption in K states, or the consumption of K persons. For example, if X_1 is leisure and X_2 is consumption, we could measure leisure preference by $MRS_{1,2}$. Likewise, if we let the subscripts denote time, and n the preferences of the agent at time n, time discounting is described by $MRS_{m,l}^n$. In our model of personality, subscripts may represent the performance on tasks and the exertion of effort. $MRS_{m,l}^n$ would then represent the tradeoff between better performance on a task and less disutility from effort. Note that the n superscript allows us to think of preferences as dependent on the time period, the current state, or the consumption of person n himself.

We are typically not only interested in how standard bundles of goods are traded off against each other, but in how lower variability in consumption is traded off against higher consumption. Risk preference, preferences for income distribution, and willingness to substitute over time reflect tradeoffs of this type. These preferences all depend on the curvature of the utility function; hence economists use measures such as absolute and relative risk aversion, and certainty equivalence which define curvature. These features are captured by the sensitivity of the MRS to changes in relative consumption:

$$\frac{\partial MRS_{m,l}}{\partial X_m / X_l} \ .$$

A more direct measure of risk aversion is the certainty equivalent of a lottery. We could define social preferences in a similar way; letting the subscripts on goods denote how much an agent values the consumption of other agents, we could define an "inequality equivalent" as a measure of how much an agent is willing to pay to avoid inequality.

The marginal rate of substitution as well as its elasticity might depend on any number of things, and it may not be possible to parameterize it with simple models. A reasonable aim for measuring preferences might be to find relevant tradeoffs that allow analysts to represent these measures in terms of stable parameters. The evidence on personality presented in this section suggests that standard parameters such as the time discount factor in exponential discounting and risk tolerance do not satisfy this requirement.

A6.B. *Measuring preferences*

When measuring preferences, economists are not interested in levels, but in characterizing the tradeoffs between goods over a relevant range, i.e., in measuring $MRS_{m,l}$. Most approaches to measuring preferences, whether observational or experimental, apply some variation of revealed preference theory to observed choices, prices, and incomes. Ideally, we would like to know the marginal rates of substitution between all goods over the entire choice set. Given a price ratio between two goods, we know the marginal rate of substitution at one point. Using observational data, economists typically assume some distribution of agents with identical preferences, facing different prices, and experimental economists ask a series of questions asking subjects to choose between several options, varying the price ratio between questions. Hence if we assume nothing about preferences, we would have to measure choice at all combinations of incomes and price ratios between all goods. However, if we assume that preferences are such that if the MRS is governed by only one parameter, in principle, without any measurement error, an observation at

a single price ratio is enough to identify preferences. Without any restrictions on preferences, identifying parameters over the entire space would be a challenging task, so restrictions on preferences are typically chosen such that the main aspects of choice are captured while ensuring that parameters are identified.

Two types of restrictions are typically made on preference specifications. First, functional separability is often assumed, since this ensures that we can ignore all other goods when measuring marginal rates of substitution between any pairs of goods. Second, the functional form is chosen such that the marginal rate of substitution is described by as few parameters as possible while still capturing main psychological features of choice. Assuming separability is often very restrictive, as we will show in the evidence given below. People are affected by various incentives and influences when choosing between goods. Ignoring these features can lead to large variation in estimated parameters. Likewise, additive separability implies dependencies between aspects of preference such as time and risk, which may not be closely connected from a psychological standpoint (Gorman [1968]). Simple parameterizations hide the fact that some aspects of preferences are multi- rather than uni-dimensional. We will review this evidence below.

Standard preference specifications over time, risk, and income distributions often assume additive separability and simple parameterizations. The parameterization is typically chosen to capture two features of preferences, the *relative importance* of goods and *variability* across goods. To see this more clearly, consider the preferences given by

$$U\left(X_1, X_2, \ldots X_K\right) = w_1 u_1\left(X_1\right) + w_2 u_2\left(X_2\right) + \ldots + w_l u_l\left(X_l\right) + \ldots + w_K u_K\left(X_K\right).$$

The marginal rate of substitution for this case is

$$MRS_{m,l} = \frac{w_m}{w_l} \frac{u'_m\left(X_m\right)}{u'_l\left(X_l\right)}.$$

First, note that the separability ensures that we can disregard the consumption of all other goods when measuring this marginal rate of substitution. Further, the relative importance of goods is captured by the relative weights $\frac{w_m}{w_l}$, and the preference for variation across goods is captured by the curvature in the subutility function (i.e. the u_l). The standard preference specifications for time, risk, and social preferences are special cases of this function. First, expected utility is given by this preference specification $w_l = p_l$ for all l, and $u_l = u_{l'}$ for all l, l'. The weights are the probabilities on each of the states of the world. The curvature represents risk aversion, disutility from variation across states.

Time preferences in the form of standard exponential discounting is given by $n = 1$ and $w_j = \beta^j$. $u_l = u_{l'}$ for all $l \neq l'$. Here, β is the discount factor, and the agent assigns zero weight to all periods in the past. The curvature is his intertemporal elasticity of substitution, how much variability he is willing to accept across time. With CES utility, risk preference and the intertemporal elasticity of substitution are the same parameter. Further, one can think of these preferences as representing social preferences. Take the case $u_l = u_{l'}$ for all l, l'. Each subutility function represents the agent's utility of another person's consumption. The w_l are the weights the agent assigns to his own consumption, as well as to the people around him. If the curvature of u is very high, the agent will not allow for much inequality. Also note that the discount factor β is usually assumed to be subjective, while the weights in the expected utility are usually assumed to be objective probabilities, if these are available.

It is implicitly assumed that preference parameters are constant over any domain, any time period, any social tradeoff or tradeoff between paid work and consumption. Another way of stating this is that we are assuming separability between, e.g., risk tradeoffs and the type of lottery, or between two time periods and the period in which the tradeoff is evaluated. Functional forms are constructed in this way to capture, in the simplest way possible, some desirable features, rather than to give the most complete description of reality. The additively separable model, although convenient, is thus a very restrictive preference specification. We have no inherent reason to believe that preferences are separable, linear, or that the weights are given by probabilities of states, or constant discount factors.

A6.D.   *Integrating traits into economic models*

In standard economic models, it is assumed that preferences are separable across domains, and that time, risk, leisure, and social preferences are fundamentally distinct concepts which do not interact with each other. However, this need not be true. Consider the example of additively separable preferences over risk, time, and distribution with a decreasing marginal utility of wealth function. Suppose in each time period, own income and income of another agent is drawn from a known independent and identical distribution for all agents. Preferences are

$$\sum_{t=0}^{\infty} \beta^t E\left[w_1 u\left(c_1\right) + w_2\left(c_2\right) \right],$$

where w_1, w_2 represent how much he cares about himself and the other agent, respectively. In this case, the intertemporal elasticity of substitution (eis) is the same as the agent's risk preference.[50]

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[50] This result is due to Gorman [1968]. See Browning, Hansen and Heckman [1999] for a definition of eis and a survey of evidence (through 1998) on the magnitude of eis.

However, note that we can use the same argument to show that it is also equal to the agent's inequality aversion as measured by his elasticity of substitution between himself and the other agent. (See Atkinson [1970]). This results relies on the additive separability of preferences, and it is possible to construct preferences where these are distinct concepts. However, Hansen [2005] shows that in many cases, even for more flexible preference specifications, time and risk preferences are observationally equivalent.

A7. **The Predictive Power of Personality Traits**

Section Contents

Table A4. The Predictive Power of Personality for Males (GSOEP)

	Males							
	Married	Divorced	Higher edu	Yrs of edu	Employed	Ln(earnings)	Hospitalized	Poor health
Openness (f)	.048***	.004	.005	.028	.032***	.068***	.01**	-.024***
	(.006)	(.003)	(.005)	(.037)	(.006)	(.017)	(.004)	(.005)
Conscientiousness (f)	-.02***	.007**	.061***	.573***	.023***	.041***	-.0002	-.008
	(.006)	(.003)	(.006)	(.04)	(.006)	(.015)	(.005)	(.005)
Extraversion (f)	-.027***	.014***	-.001	.142***	.031***	.015	-.009**	-.014***
	(.006)	(.003)	(.006)	(.036)	(.006)	(.014)	(.004)	(.005)
Agreeableness (f)	.001	-.002	.003	.016	-.009	-.002	.0007	.001
	(.006)	(.004)	(.006)	(.039)	(.006)	(.017)	(.005)	(.005)
Neuroticism (f)	.003	.00005	-.011*	-.089**	-.013*	-.036**	.003	.012***
	(.007)	(.003)	(.006)	(.041)	(.007)	(.018)	(.005)	(.005)
Locus of control (f)	.002	-.0008	.005	.057***	.007**	.019**	-.002	-.005*
	(.004)	(.002)	(.003)	(.02)	(.003)	(.009)	(.002)	(.002)
Risk Aversion (f)	.005	.001	.001	.004	.0005	.011	-.001	-.0008
	(.003)	(.002)	(.003)	(.021)	(.004)	(.009)	(.002)	(.003)
Trust (f)	-.003	-.005	.047***	.379***	.017***	.068***	-.01**	-.019***
	(.006)	(.003)	(.006)	(.034)	(.006)	(.017)	(.004)	(.005)
Positive reciprocity (f)	.001	.002	.003	.035	.007	-.002	-.004	-.002
	(.006)	(.003)	(.006)	(.033)	(.006)	(.013)	(.004)	(.005)
Negative reciprocity (f)	-.014***	.005	-.04***	-.244***	.014***	-.022*	-.004	.004
	(.005)	(.003)	(.005)	(.032)	(.005)	(.013)	(.004)	(.004)
Impatience (s)	.007	-.01	.012	.06	.005	.044	-.011	.02*
	(.014)	(.007)	(.013)	(.088)	(.013)	(.035)	(.009)	(.011)
Crystalized intelligence (s)	.001	.004	.08***	.741***	.088***	.111***	-.03***	-.041***
	(.014)	(.007)	(.013)	(.083)	(.013)	(.035)	(.009)	(.011)
Fluid intelligence (s)	-.028**	-.007	.045***	.508***	.125***	.097**	-.037***	-.05***
	(.014)	(.008)	(.012)	(.081)	(.013)	(.041)	(.01)	(.011)
N	1153	1153	1153	1153	1153	1153	1153	1153

Note: The table displays regression coefficients from bivariate regressions of outcomes on traits. Coefficients on factor scores (f) are corrected for attenuation bias. Coefficients can be interpreted in terms of standard deviations. Standard errors are bootstrapped using 500 bootstrap replications. Married and Divorced are binary indicators indicating the marital status of an individual, higher edu is binary and indicates post-high school education, employed indicates the current (2008) employment status, Ln(earnings) refers to the logarithm of yearly labor earnings, hospitalized is a binary indicator of whether there was at least one hospital stay in the past year, poor health indicates whether the current self-rated health status is 'bad' or 'poor' (as opposed to 'good' or 'very good'). Source: GSOEP, waves 2004-2008, own calculations.

Table A5. The Predictive Power of Personality for Females (GSOEP)

	Married	Divorced	Higher edu	Yrs of edu	Employed	Ln(earnings)	Hospitalized	Poor health
				Females				
Openness (f)	.027***	-.009**	-.018***	-.078**	.011*	.067***	-.0008	-.021***
	(.006)	(.004)	(.005)	(.035)	(.007)	(.019)	(.005)	(.005)
Conscientiousness (f)	-.011*	.014***	.03***	.331***	.03***	.051***	-.013***	-.014***
	(.006)	(.004)	(.005)	(.031)	(.006)	(.017)	(.004)	(.005)
Extraversion (f)	-.023***	.017***	.03***	.261***	.042***	.064***	-.01**	-.015***
	(.006)	(.003)	(.005)	(.03)	(.007)	(.016)	(.005)	(.005)
Agreeableness (f)	-.0005	-.002	-.003	-.034	-.014**	-.003	-.004	-.002
	(.007)	(.004)	(.006)	(.038)	(.007)	(.018)	(.004)	(.005)
Neuroticism (f)	.008	.002	-.012**	-.097***	-.009	-.04**	.004	.016***
	(.006)	(.004)	(.005)	(.036)	(.006)	(.018)	(.004)	(.005)
Locus of control (f)	-.0003	-.002	.006*	.051***	.005	.014	-.001	-.006**
	(.004)	(.002)	(.003)	(.018)	(.004)	(.01)	(.002)	(.003)
Risk Aversion (f)	.003	-8.26e-07	.002	.027*	.013***	.0001	-.003	-.0003
	(.003)	(.002)	(.002)	(.015)	(.003)	(.01)	(.002)	(.003)
Trust (f)	.003	-.011***	.046***	.411***	.028***	.067***	-.014***	-.038***
	(.006)	(.004)	(.005)	(.033)	(.006)	(.018)	(.004)	(.005)
Positive reciprocity (f)	-.006	.004	-.007	-.017	.002	.03*	-.003	-.001
	(.006)	(.004)	(.005)	(.036)	(.006)	(.016)	(.004)	(.005)
Negative reciprocity (f)	-.015**	.007*	-.028***	-.144***	.023***	-.027*	.004	.002
	(.006)	(.004)	(.004)	(.031)	(.006)	(.016)	(.004)	(.005)
Impatience (s)	.019	-.02**	.004	.174**	.024*	.0005	-.009	.011
	(.014)	(.009)	(.012)	(.078)	(.014)	(.04)	(.01)	(.011)
Crystalized intelligence (s)	.002	-.001	.073***	.693***	.104***	.013	-.023**	-.031***
	(.014)	(.009)	(.012)	(.075)	(.013)	(.04)	(.009)	(.011)
Fluid intelligence (s)	-.011	.001	.04***	.552***	.128***	-.023	-.004	-.032***
	(.014)	(.007)	(.011)	(.074)	(.013)	(.042)	(.01)	(.011)
N	1228	1228	1228	1228	1228	1228	1228	1228

Note: The table displays regression coefficients from bivariate regressions of outcomes on traits. Coefficients on factor scores (f) are corrected for attenuation bias. Coefficients can be interpreted in terms of standard deviations. Standard errors are bootstrapped using 500 bootstrap replications. Married and Divorced are binary indicators indicating the marital status of an individual, higher edu is binary and indicates post-high school education, employed indicates the current (2008) employment status, Ln(earnings) refers to the logarithm of yearly labor earnings, hospitalized is a binary indicator of whether there was at least one hospital stay in the past year, poor health indicates whether the current self-rated health status is 'bad' or 'poor' (as opposed to 'good' or 'very good'). Source: GSOEP, waves 2004-2008, own calculations.

Table A6. The Predictive Power of the Big Five and Intelligence for Total Years of Education

| | Years of Education | | | | | |
	Females		Males		All	
Male					.297*** (.109)	.277*** (.106)
Age	.044* (.026)	.026 (.026)	.119*** (.034)	.096*** (.034)	.079*** (.022)	.058*** (.021)
Age^2	-.0007*** (.0002)	-.0005* (.0002)	-.001*** (.0003)	-.0007** (.0003)	-.0009*** (.0002)	-.0006*** (.0002)
Openness (f)	-.102 (.083)	-.086 (.081)	-.098 (.089)	-.076 (.085)	-.103* (.061)	-.085 (.059)
Conscientiousness (f)	.319*** (.083)	.275*** (.081)	.746*** (.089)	.675*** (.086)	.542*** (.062)	.485*** (.061)
Extraversion (f)	.062 (.079)	.057 (.076)	-.128 (.091)	-.154* (.088)	-.044 (.061)	-.058 (.059)
Agreeableness (f)	-.097 (.083)	-.078 (.081)	-.068 (.083)	-.065 (.078)	-.087 (.059)	-.073 (.057)
Neuroticism (f)	-.345*** (.073)	-.299*** (.071)	-.214*** (.081)	-.183** (.079)	-.274** (.056)	-.235*** (.053)
Crystalized intelligence (s)		.48*** (.083)		.555*** (.089)		.526*** (.061)
Fluid intelligence (s)		.176** (.087)		.334*** (.093)		.251*** (.064)
N	1197	1197	1129	1129	2326	2326
R-squared	.078	.12	.068	.132	.06	.115

Note: The table displays regression coefficients of years of education on covariates.
Source: GSOEP, waves 2004-2008, own calculations.

Table A7. The Predictive Power of the Big Five and Intelligence for High School Graduation

| | High School Graduation (Linear Probability Model) | | | | | |
	Females		Males		All	
Male					.064*** (.014)	.062*** (.014)
Age	.017*** (.004)	.015*** (.004)	.017*** (.004)	.016*** (.004)	.017*** (.003)	.015*** (.003)
Age^2	-.0002*** (.00004)	-.0002*** (.00004)	-.0002*** (.00004)	-.0001*** (.00004)	-.0002*** (.00003)	-.0002*** (.00003)
Openness (f)	.007 (.012)	.008 (.012)	.015 (.011)	.016 (.011)	.01 (.008)	.012 (.008)
Conscientiousness (f)	.035*** (.013)	.03** (.012)	.044*** (.011)	.04*** (.01)	.042*** (.008)	.037*** (.008)
Extraversion (f)	.012 (.012)	.012 (.011)	.011 (.011)	.009 (.01)	.01 (.008)	.009 (.008)
Agreeableness (f)	.012 (.012)	.015 (.012)	-.011 (.009)	-.011 (.009)	-.0004 (.007)	.0006 (.007)
Neuroticism (f)	-.033*** (.011)	-.028*** (.01)	-.019** (.009)	-.016* (.009)	-.025*** (.007)	-.021*** (.007)
Crystalized intelligence (s)		.051*** (.011)		.027*** (.008)		.041*** (.007)
Fluid intelligence (s)		.025** (.012)		.035*** (.011)		.028*** (.008)
N	1207	1207	1138	1138	2345	2345
R-squared	.077	.104	.055	.079	.061	.087

Note: The table displays regression coefficients of the probability of graduating from high school on covariates.
Source: GSOEP, waves 2004-2008, own calculations.

Table A8. The Effect of Personality on Educational Attainment and Achievement

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Báron and Cobb-Clark [2010]	Outcome(s): *educational attainment* – secondary school completion, university rank qualification (based on a test), and university ranking Explanatory Variable(s): *locus of control* – factor based on 7 survey questions	Data: Youth in Focus (YIF) Project; 2,065 Australians born in 1987 or 1988 Methods: factor models, probit, parametric censored regression, IV	Controls: welfare receipts, family structure, sex, parental education, parental immigration status, indigenous background, and born early for their grade Timing of Measurements: The measures are contemporaneous. Theory: People with an internal locus of control might perceive they have a higher return to education because they can affect their educational outcomes.	Moving from the 25th to the 75th percentile of the internal locus of control scale is associated with an increased probability of completing secondary school of 6.1 percentage points ($p<0.10$), an increased probability of qualifying for a university ranking at graduation of 7.1 percentage points ($p<0.05$), and an increased university ranking of 1.31 percentiles ($p<0.10$).
Behncke [2009]	Outcome(s): *cognitive ability* – performance on a diagnostic math test for a college economics class Explanatory Variable(s): *noncognitive skill shock* – verbal encouragement before the test	Data: Collected by author; 440 students from a Swiss University Methods: RCT, randomization inference	Controls: n/a (RCT) Timing of Measurements: The noncognitive skill shock directly proceeded test. Theory: Verbal encouragement boosts self-esteem.	Verbal encouragement raised test scores by 2.5% amongst all students ($p<0.05$) and by 8.0% amongst students who reported difficulties with math ($p<0.01$).

Borghans, Meijers and ter Weel [2008]	Outcome(s): *cognitive ability* – number of correct answers on an IQ test; *effort* – time spent on each question Explanatory Variable(s): *risk aversion* – survey response to lotteries; *time preference* – survey response to time trade – offs ; *leisure preference* – survey response; *experiment incentives* – payment for correct answers; *personality* – self-reported Big Five and others	Data: Collected by authors; 128 university students from a Dutch University Methods: probit model	Controls: type of cognitive test, the amount of incentive pay, and time constraints Timing of Measurements: They measured IQ both before and after providing incentives. Theory: People with different personalities and preferences might be willing to expend different amounts of mental effort during a test.	Performance motivation, fear of failure, internal locus of control, curiosity, low discount rates, and risk aversion are positively associated with more correct answers (p<0.05). Extroversion, openness, and agreeableness are negatively associated with answering the question correctly (p<0.05). Performance motivation, positive fear of failure, resilience, enjoyment of success, lower risk-aversion and higher discount rates are positively associated with time spent on questions (p<0.05). Preference for leisure is negatively associated with time spent on questions (p<0.05). Incentives did not affect the number of questions answered. Intrinsic motivation, curiosity, internal locus of control, emotional stability, and conscientiousness are associated with low responsiveness to incentives (p<0.05). Low discount rates and low risk aversion are associated with high responsiveness to incentives (p<0.05).
Goldberg, Sweeney, Merenda et al. [1998]	Outcome(s): *educational attainment*– years of education Explanatory Variable(s): *personality* – self-reported Big Five	Data: 3,629 adults aged 18-75 in year 2000 Methods: OLS	Controls: gender, age, and ethnicity Timing of Measurements: The measures are contemporaneous. Theory: People with different personalities and preferences might be willing to expend different amounts of mental effort during a test.	Openness to Experience ($r = .31$) was most strongly associated with years of education. Associations with Conscientiousness ($r = .12$), Agreeableness ($r = .08$), Extraversion ($r = -.04$), and Emotional Stability ($r = .03$) were more modest.

Holmlund and Silva [2009]	Outcome(s): *academic performance* – average of standardized test scores in English, Math, and Science Explanatory Variable(s): *non-cognitive skill intervention* – participation in the "xl programme"	Data: "xl club programme," National Pupil Database (NPD), Pupil Level Annual Schools Census (PLASC) ; 2,333 and 259,189 treated and control students aged 14 in England (2004) Methods: logit, propensity score matching, OLS, difference-in-difference, double differences, "random-growth" model	Controls: sex, language, eligibility for school meals, special needs status, and race Timing of Measurements: The data contains test scores from age 11, age 14 (both before the program), and age 16 (after the program). Theory: People who participated in the program designed to boost noncognitive skills might perform better at school.	Unconditional on observables, the performance of the students in the xl club is 1.2 to 1.4 standard deviations lower than the control subjects (p<0.01). Using OLS , the effect is -0.17. The propensity score estimates are -.13 and -.15. For the difference-in-difference models estimated using OLS and propensity score matching, there is no longer a significant effect of the program in either direction.
Koning, Webbink, Vujić et al. [2010]	Outcome(s): *academic performance* – high school grades (below average, average, above average) , years of schooling, high school graduation; *negative human capital* – physically attacking others, being arrested since 18, spent time in jail Explanatory Variable(s): *conduct disorder* – meeting the requirements for the APA definition based on survey questions before the age of 18	Data: Australian Twins Register (ATR), Alcohol Cohort 2, TWIN89; 2,220 twins born in Australia between 1964 and 1971 Methods: OLS	Controls: (1) age, age squared, gender, birth weight, and parental education (2) controls in (1), and fixed effects for all twins (3) controls in (1), and fixed effects for identical twins Timing of Measurements: The conduct disorder measures are based on interviews when the twins were 24-39 years old that asked them to reflect on their behavior before age 18. Some of the questions pertain to earlier ages, such as the first onset of conduct disorder. The outcome variables potentially span many ages, some of them before age 18 and some of them after. Theory: Early-life behavior predicts later life behavior.	APA classified conduct disorder reduces the marks in high school (p<0.01;(1)), (p<0.01;(2)); years of education by 0.82 (p<0.01;(1)) ,0.34 (p<0.01;(2)) ; the probability of graduating high school by 13.6 (p<0.01;(1)) and 5.4 (p<0.01;(2)) percentage points. APA classified conduct disorder increases the probability of attacking others by 17.9 (p<0.01;(1)), 14.6 (p<0.01;(2)), 16.2 (p<0.01;(3)); being arrested since age 18 by 12.4 (p<0.01;(1)), 7.6 (p<0.01;(2)), and 6.7 (p<0.01;(3)) percentage points; and the probability of spending time in jail by 4.8 (p<0.01;(1)), 2.0 (p<0.05;(2)) and 2.2 (p<0.10;(3)). Conduct disorder most affects high school graduation rates when the disorder beings between ages 13 and 16 and arrests between ages 10 and 16.

Rodríguez-Planas [2010]	Outcome(s): *educational attainment* – high-school completion and post-secondary eduction; *academic achievement* – math test score percentile, reading test score percentile , GPA; *labor market success* – earnings during the last year of the program, three years after the program, and five years after the program Explanatory Variable(s): *mentoring, educational services, and incentives* – participation in the Quantum Opportunity Program (QOP)	Data: Quantum Opportunity Program (QOP); 1,069 students from seven large US cities Methods: RCT	Controls: n/a (RCT) Timing of Measurements: The program was offered for a cohort of ninth graders and was available for five years. Follow-up interviews were conducted during the last year of the program, three years after the program, and five years after the program. Theory: Mentoring can boost non-cognitive skills that would help in academic achievement. Educational services can boost cognitive ability. Incentives can increase study effort.	During last year of the program: Participation in the program was associated with a 7 percentage point increase in the probability of graduating high school (p<0.10) and 6 percentage point increase in the probability of attending college (p<0.10). There were no differences in academic achievement. Three years after the program: Participation in the program was associated with a 7 percentage point increase in the probability of ever attending college (p<0.10), 9 percentage point increase in the probability of attending college (p<0.05), and a 7 percentage point decrease in the probability of having a job (p<0.10). Five years after the program: There are no significant differences five years after the program. Findings for sub-populations: The program benefited people who were 14 or less upon entering high school significantly more than older students. It also tended to benefit girls more than boys.
van Eijck and de Graaf [2004]	Outcome(s): *educational attainment* – years of education Explanatory Variable(s): *personality* – self-reported Big Five	Data: 1998 Family Survey Dutch Population; 2,029 adults aged 18 to 70 living in Holland in 1998 Methods: OLS	Controls: n/a (RCT) Timing of Measurements: The program was offered for a cohort of ninth graders and was available for five years. Follow-up interviews were conducted during the last year of the program, three years after the program, and five years after the program. Theory: Mentoring can boost non-cognitive skills that would help in academic achievement. Educational services can boost cognitive ability. Incentives can increase study effort.	Openness to Experience (β = .14). Associations with Emotional Stability (β = .09), Extraversion (β = -.07), Agreeableness (β = -.07) and Conscientiousness (β = .05) were more modest.

Table A9. The Effect of Personality and Preferences on Labor Market Outcomes

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Antecol and Cobb-Clark [2010]	Outcome(s): *vertical integration in field of study* – percent of males in field of study; male dominance in occupation – percent of males in occupation; percent of Explanatory Variable(s): *personality* – seven factors based on survey response that load on male traits, self-esteem, analytical problem solving approach, willingness to work hard, impulsiveness, problem avoidance, and self-assessed intelligence	Data: National Longitudinal Study of Adolescent Health, *Integrated Public Use Microdata Series* (IPUMS), Integrated Postsecondary Education Data System (IPEDS); 8,594 respondents Methods: OLS	Controls: age, sex, race, immigrant, Add Health Picture Vocabulary Test Score, marital status, children Timing of Measurements: The non-cognitive skills were measured in high school and the outcomes were measured after high school (18-28 years old) Theory: People pick occupations based on expectations of future income and employers accept people above a particular threshold.	Percent male in field of study: a one standard deviation increase in "male traits" for men is associated with choosing an occupation with 3.3% more males ($p<0.05$), a one standard deviation increase in self-perceived intelligence for men is associated with choosing an occupation with 3.0% fewer males.
Barrick and Mount [1991]	Outcome(s): *job proficiency* – performance ratings, productivity; *training proficiency* - training performance rating, productivity; *personnel data* – salary level, turnover, status change, tenure Explanatory Variable(s): *personality* -- Big Five classifications based on professional rater's assessment of other personality questionnaires	Data: 162 samples from 117 studies; 23,994 combined participants Methods: meta-analysis, corrections for artifactual variance, range restriction, and measurement error	Controls: n/a Timing of Measurements: The measures were contemporaneous. Theory: n/a	Conscientiousness is correlated with job proficiency ($r=0.23$, $p<0.10$), training proficiency ($r=0.23$, $p<0.10$), and personnel data ($r=0.20$, $p<0.10$). Extraversion is correlated with training proficiency ($r=0.26$, $p<0.10$). Openness to experience is associated with training proficiency ($r=0.25$, $p<0.10$). All other correlations were less than 0.20. They also found some evidence that conscientiousness predicted choice of occupation.

Caliendo, Fossen and Kritikos [2008]	Outcome(s): *entrepreneurial survival* – leaving self-employment as reported in a longitudinal survey Explanatory Variable(s): *risk preference* – a self-reported measure of willingness to take occupational risks on an 11-point scale, choices over a hypothetical lotteries on a survey	Data: German Socio-Economic Panel (SOEP);7,325 person-year observations of self-employed people aged 18-65 and living in Germany (2000-2005) Methods: logistic hazard rate model with duration dependence	Controls: sex, education, age, age squared, work experience, work experience squared, past unemployment experience, unemployment experience squared, living in East Germany, disability, German, children, marital status, capital income, and father's self-employment status Timing of Measurements: They use risk measurements from 2004, but self-employment status from 2000-2005 Theory: Assuming that the marginal return to risk-taking decreases after some point, there will be a u-shaped pattern in leaving self-employment versus risk-taking.	There is a u-shaped pattern of the probability of leaving self-employment and risk aversion. People who report a value of 5 or 6 on an 11-point occupational risk scale are less likely to leave self-employment by 5 percentage points relative to those who report a value of 0 ($p<0.01$; adjusted analysis).
Caliendo, Cobb-Clark and Uhlendorff [2010]	Outcome(s): *search effort* – number of applications submitted; *subjective belief of gaining employment*– self-reported belief of finding a "very good" job; *reservation wage*– log of self-reported reservation wage Explanatory Variable(s): *locus of control* – an average of two factors based on survey questions	Data: IZA Evaluation Data Set; 7,900 people aged 16 to 54 living in Germany who became unemployed between 2007 and 2008. Methods: probit, OLS, propensity score matching	Controls: openness to experience, conscientiousness, extraversion, neuroticism, sex, age, origin, marital status, children, schooling, employment history, log of wage, father's , living situation, and means of communication Timing of Measurements: All respondents were interviewed near when they became unemployed, diminishing the role of reverse-causality. Theory: People with an internal locus of control believe that they their search effort has a bigger effect, leading them to expend more effort, have a higher subjective probability of employment, and have a higher reservation wage.	A one standard deviation increase in internal locus of control is associated with a 0.2 percentage point increase in the perceived marginal effect of submitting one additional application ($p<0.01$, conditioning on personality, not conditioning on personality), 1.3-1.9 percentage point increase in the reservation wage ($p<0.01$ conditioning on personality, not conditioning on personality) and with submitting 0.8 additional job applications ($p<0.01$; not conditioning on personality). The last result is not significant when conditioning on personality.

Cobb-Clark and Tan [2009]	Outcome(s): *occupation* – survey reports of 18 aggregated occupational categories; *wage* – survey report Explanatory Variable(s): *personality* – survey responses to 36 questions measuring the Big Five and 7 questions measuring locus of control	Data: Household Income and Labour Dynamics in Australia (HILDA); 5397 people aged 25-65 living in Australia (2001-2006) Methods: multinomial logit	Controls: years in paid employment, educational attainment, marital status, the presence of children under the age of 14 years, and measures of parental occupation Timing of Measurements: Locus of control was measured in the 3rd and 4th waves of the survey and the Big Five were measured in the 5th (of 6 total waves). Theory: Different personality traits might predispose people to select into different occupations and might be able to explain some of the male-female wage gap.	Men: A standard deviation increase in agreeableness is associated with a 2.8 percentage point decrease in being a manager (p<0.01) and 2.9 percentage point decrease in being a business professional (p<0.01). A standard deviation increase in internal locus of control is associated with a 2.8 percentage point increase in being a manager (p<0.01). Women: A standard deviation increase in openness to experience is associated with a 2.5 percentage point increase in the probability of being a manager (p<0.01). Occupational attainment is not linked to their locus of control. Wage Gap: 96.5% of the wage gap stems from differences in wages for men and women in the same occupations. Nearly 3/4 of the wage gap stem from differences in the return to human capital, demographic characteristics, and noncognitive skills of the within occupations.
Dohmen and Falk [2010]	Outcome(s): *baseline productivity* – the number of multiplication exercises a participant completes facing piece rate incentive in five minutes; *compensation scheme* – how the participant chooses to be compensated for future multiplication exercises (fixed payment, piece rate, tournament or revenue-sharing), has a performance evaluation at their job (survey data only) Explanatory Variable(s): risk *aversion* – elicited through a real-stakes experiment, survey questions matching the GSOEP; *trust* – elicited through a real-stakes, two-player trust game	Data: Experiment conducted by the authors, German Socio-Economic Panel (SOEP) ; 360 students from the University of Bonn, 8,159 people living in Germany Methods: Wilcoxon rank-sum tests, probit, Spearman rank correlations	Controls: (1) Big-Five, and gender (2) years of schooling, experience, experience squared, part-time experience, part-time experience squared, tenure, age, risk attitude, trust in strangers, reciprocity, and sex (3) controls in (2), employed in public sector, living in East Germany, firm size, occupation, and industry Timing of Measurements: The measures are contemporaneous. Theory: More productive people will select into variable compensation schemes. People in variable schemes will work at least as much as those in fixed schemes. People with higher willingness to take risks will sort into variable pay jobs more. Social preferences could be linked to selection.	Experimental Results: Participants in a piece-rate contract solved an average of 60.59 problems compared to 29.51 in the fixed rate payment (p<0.0001). Selection into the piece rate scheme was positively associated with productivity and willingness to take risks(p<0.01). Trust, reciprocity and relative self-assessment had little significant effect on sorting. Survey Results: Risk preference is associated with having a job with a performance evaluation (p<0.01, (1), (2)). Reciprocity is negative associated with having a performance evaluation (p<0.01; (1)).

| Dohmen, Falk, Huffman et al. [2009a] | Outcome(s): *long-term unemployment* – unemployed for over a year; *overdrawn account* – account overdrawn at the time of the interview

Explanatory Variable(s): *education* – self-reported years of schooling; *processing speed* – perceptual speed test; *gambler's fallacy* – belief that a streak of coin tosses will be more likely to end; *hot hand fallacy* – belief that a streak of coin tosses will persist | Data: Collected by TNS Infratest; 1,012 nationally representative adults in Germany (2005)

Methods: probit | Controls: (1) age, sex, word fluency, and symbol-digit score (2) age, sex, years of schooling, and wealth

Timing of Measurements: The measures are contemporaneous.

Theory: People who subscribe to the gambler's fallacy will be more likely to overdraw their bank account because they believe negative income shocks will not persist. People who subscribe to the hot hand fallacy are likely to face long-term unemployment because they will give up more easily in the face of rejections. | (1)An additional year of schooling is associated with a 4.2–4.6 pp higher chance of correctly answering the probability questions (p<0.01).
(2) Subscribing to the "hot hand" fallacy increases the probability of long-term unemployment by 8.9 pp. (p<0.01). Significance falls to 10% when conditioning on education and wealth. Subscribing to the "hot hand" fallacy increases the probability of long-term unemployment by 8.8 pp. (p<0.01). Significance falls to 5% when conditioning on education and wealth. |

Dohmen, Falk, Huffman et al. [2009b]	Outcome(s): *worker effort* – worked over time during the last month; labor market success – monthly income, employment status; overall welfare – overall self-reported life satisfaction, number of friends Explanatory Variable(s): *positive reciprocity (the tendency to reward kindness)* – factor based on 3 survey questions; *negative reciprocity (the tendency to punish unkindness)* – factor based on 3 survey questions	Data: German Socio-Economic Panel Study (SOEP), 20,744 individuals living in Germany Methods: probit, interval regression	Controls: (1) sex, education, experience, tenure, part-time status, age, firm size, sector, and occupational status (2) sex, education, experience, tenure, part-time status, age, firm size, sector, and occupational status (3) sex, age, residence in 1989, German nationality, region dummies, marital status, children, and religion (4) education, sex, age, residence in 1989, subjective health, income, employment status, trust, parental education, marital status, children, enrollment in school, religious background, social and national background, and month of interview Timing of Measurements: They have three years of outcome variables relative to the explanatory variables: contemporaneous, one year later, and two years later. Theory: Positively reciprocal workers will tend to work overtime more, even if they cannot be monitored.	Positive reciprocity is positively associated with the following: (1) overtime in the present, one year later and two years later (p<0.01;); (2) higher present monthly income (p<0.05), higher monthly income the next year (p<0.01), higher monthly income in two years (p<0.10); (3) being currently employed (p<0.01), being employed in the subsequent year (p<0.10), and being employed in two years (p<0.10); (4) the number of current friends (p<0.01), current overall life satisfaction (p<0.01), overall life satisfaction in the subsequent year (p<0.01) and overall life satisfaction in two years (p<0.01). Negative reciprocity is negatively associated with the following: (3) being currently employed (p<0.01), being employed in the subsequent year (p<0.05), and being employed in two years (p<0.05); (4) the number of current friends (p<0.05), current overall life satisfaction (p<0.01), overall life satisfaction in the subsequent year (p<0.01) and overall life satisfaction in two years (p<0.01).
Drago [2008]	Outcome(s): *wages* – log earnings based on a survey measure Explanatory Variable(s): *self-esteem* – index based on ten survey questions; *ability* – AFQT score	Data: National Longitudinal Survey of Youth (NLSY), 2250 white males living in the US Methods: IV	Controls: age, own education, parental education, and AFQT score Timing of Measurements: 1980 self-esteem serves as an instrument for 1987 self-esteem. Theory: If ability and effort are complements, then having higher self-esteem should lead to more effort and therefore higher wages.	The correlation between 1980 self-esteem and 1987 self-esteem is 0.42. A two standard deviation increase in self-esteem leads to a 18% (p<0.10; all controls) to 26% (p<0.05; just age) increase in log earnings.

Dur, Non and Roelfsema [2010]	Outcome(s): *bonus incentives* – whether employer offers bonuses based on appraisal; *promotional incentives* – whether employer offers promotions based on appraisal Explanatory Variable(s): *reciprocity* – average of 3, 7-point questions about willingness to return favors	Data: German Socio-Economic Panel Study (SOEP), 20,744 individuals living in Germany Methods: probit	Controls: sex, age, education, tenure, part-time status, lives in East-Germany, firm size, occupation, and industry Timing of Measurements: The measures are contemporaneous Theory: Firms with reciprocal workers should be more likely to offer promotional incentives and reciprocal workers should be less likely to receive bonuses.	Reciprocity is positively associated with receiving promotional incentives ($p<0.01$). Reciprocity is not associated with bonus pay.
Ham, Junankar and Wells [2009]	Outcome(s): *occupation* – whether an employee works in "blue collar" job that requires manual labor or a "white collar" job Explanatory Variable(s): *personality* – self-reported measures of the Big Five on a 7-point scale	Data: Household Income and Labour Dynamics in Australia (HILDA), 25,638 observations of people living in Australia Methods: probit	Controls: age, age squared, and the parent's ANU4 index Timing of Measurements: The Big Five were measured in the 5th of 6 waves. Theory: Personality could have different effects on occupational choice based on gender.	People with the highest levels of conscientiousness (on the seven point scale) are 10.8% more likely to have a white collar profession ($p<0.01$). Open-minded men are 14.6% more likely to have a white-collar job, whereas open-minded women are not ($p<0.01$). Emotional stability (the opposite of neuroticism) is also associated with having a white-collar job ($p<0.01$) .

Störmer and Fahr [2010]	Outcome(s): *absenteeism* – annual absent days Explanatory Variable(s): *cognitive ability* – performance on a test similar to AFQT measured on a 9-point scale; *noncognitive ability* – result of an interview with a psychologist measured on a 9-point scale; *physical capacity* – maximum resistance on stationary bike	Data: German Socio-Economic Panel Study (SOEP), 4,901 people living in Germany Methods: linear exponential specification with a Negbin II model, logit	Controls: health, education, firm size, industry, measures of job satisfaction, age, age squared, marital status, children, wage, white collar worker, contractual working hours, tenure, tenure squared, and job history Timing of Measurements: Personality and absenteeism are measured contemporaneously. Theory: Extroverts value leisure more so will be absent more. Neurotic employees might be overly anxious or depressed so will be absent more. Conscientious workers are more responsible so will be absent less. Agreeable employees will be absent less out of a sense of loyalty.	A one standard deviation increase in neuroticism is associated with an 11.9% more absent days for men (p<0.01). A one standard deviation increase in agreeableness is associated with 9.0% fewer days absent for men (p<0.01). A one standard deviation increase in openness for women is associated with 13.4% more absent days for women.

A7.A.   *Personality and Health by Pietro Biroli*

The idea of ties between personality and health has received particular attention in the last decades but it dates back thousands of years: Hippocrates is believed to be among the first to connect medicine and Humoralism, the doctrine of the four temperaments, whose imbalance would affect both personality and physical health[51]. In this section, we review some evidence on the interconnections between personality and well being, considered not only as longevity and absence of chronic conditions but also as healthy behaviors and lifestyles[52]. Tables A10-A13 complement the discussion and provides further details.

Initially researchers focused on the direct connections between longevity and cognitive and non-cognitive abilities; Roberts, Kuncel, Shiner et al. [2007]provides an extensive and organized review of this literature: typically studies would collect information on personality, socio economic and health status of a particular population and, controlling for those initial characteristics, follow their survival throughout old-age. Although the magnitude and the significance of the relation varied widely across different studies and not all results were replicable[53], the long-term association between personality traits and longevity has been convincingly demonstrated. Friedman, Tucker, Tomlinson-Keasey et al. [1993]analyze a cohort of mentally gifted children and find that conscientious people tend to lived longer, especially men, while women's longevity is negatively associated to their cheerfulness at young ages (one of the measures of Agreeableness). Later studies (Martin, Friedman and Schwartz [2007]and Kern and Friedman [2008]) find corroborating evidence of a positive relation between longevity and conscientiousness, even after controlling for mid-life health and economic outcomes and

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[51] See Hampson and Friedman [2008] and Friedman [2007] for a brief literature.
[52] See Friedman, Kern and Reynolds [2010] for a more thorough definition of healthy living an aging
[53] See Weiss and Costa [2005] for a discussion

examining evidence from various countries. Among others, Weiss and Costa Jr [2005]as well as

Mroczek and Spiro [2007] find that high Agreeableness and Neuroticism have a negative impact

on longevity: individuals who are, or become more neurotic over time tend to die sooner. A

similar impact can be attributed to high Hostility (Boyle, Williams, Mark et al. [2005]) and

Pessimism (Schulz, Bookwala, Knapp et al. [1996]), while Kubzansky, Sparrow, Vokonas et al.

[2001] evaluate mortality from coronary heart disease and find that Optimism decreases the

probability of death. Results about Openness are more controversial: while many studies don't

find a significant correlation with mortality, Taylor, L., Davey Smith et al. [2003] find that men

who died before the follow-up study had lower Openness and Conscientiousness scores and

higher Neuroticism; however they did not control for participants cognitive ability, which tends

to be highly correlated with Openness and whose relationship with mortality has been

extensively documented[54]. Aware of the potential composite effects of cognitive and

noncognitive abilities on longevity, Wilson, Mendes de Leon, Bienias et al. [2004] control for

participants IQ as well as initial medical conditions in their analysis and find that high

Neuroticism and low Extraversion are associated with lower survival probability; following a

similar approach, Weiss, Gale, Batty et al. [2009] find that high Neuroticism and low Cognitive

ability are independent mortality risk factors, and particularly fatal once interacted with each

other.

A significant shortcoming of this literature is that some of these studies, although

controlling for possible cofounding socioeconomic and health factors associated with mortality,

focus mostly on a particular facet of personality and fail to control for the correlation among

different individual traits; furthermore they often neglect the possible indirect effects that

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[54] See Roberts, Kuncel, Shiner et al. [2007] and Batty, Deary and Gottfredson [2007]for systematic reviews

personality has on longevity via education[55] or healthier life-style. Moreover, most do not directly address the causal mechanism through which personality influences longevity: they simply document that individuals living longer have different traits than the original sample group. A more recent strand of psychological and economic literature addresses these problems and evaluates the effect that initial endowment of individual skills and physical conditions have on mid-life outcomes, which in turn can influence health and longevity in the long run. Looking at the genetic endowment of individuals as possible explanation for differences in personality and health, Luciano, Houlihan, Harris et al. [2010] confirm the existing finding that certain Single-Nucleotide Polymorphisms (SNPs) of the human DNA are associated with Extraversion, Emotional stability, Agreeableness, Conscientiousness and Intellect, which in turn are related to anxiety and depression of people in their 80s; however they fail to find a direct strong connection between the selected SNPs and old age health outcomes. Taking a different approach, Hampson, Tildesley, Andrews et al. [2010] follow a cohort of young children while in school and find that both the initial level and the growth in hostility over the years of elementary school are associated to substance abuse[56] in high school; furthermore their level of sociability is correlated with drinking but not smoking. Using data from the National Longitudinal Study of Youth-1979, Kaestner [2009] finds that adolescent measures of cognitive ability and self-esteem are positively associated with self-reported measures of physical and mental health at age 41, even after controlling for education and socioeconomic outcomes. Focusing on Locus of Control and IQ, Gale, Batty and Deary [2008] find strong correlations between these two personality traits measured in children and better health outcomes at age 30, such as low BMI, blood-pressure or psychological distress and higher self-rated health status; furthermore they show that these

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[55] For a more thorough discussion of the education and health gradient, see Cutler and Lleras-Muney [2008; [2010] or Conti, Heckman and Urzua [2010b]
[56] Cigarette, alcohol and marijuana consumption

associations vary by gender and are attenuated once taking into account educational attainment and social class. A similar comprehensive approach is pursued by Friedman, Kern and Reynolds [2010]who assess the life-time evolution of personality and health traits of a cohort of intellectually gifted students born in the 1910s; they find that low Neuroticism and high scores of Agreeableness, Conscientiousness and Extraversion are connected to better physical health and social interactions when 70 years old, as well as longevity, with sizeable gender differences.

An approach more attentive to causality and the presence of indirect effects is pursued by Hampson, Goldberg, Vogt et al. [2007] who, using a structural model, find that high scores of Extraversion, Agreeableness and Conscientiousness are associated with an overall better health status when middle age (less smoking, more exercise, better self-rated health) and also have significant indirect effects via educational attainment and improved eating habits. Using a structural dynamic model of skill formation, Conti, Heckman and Urzua [2010a]estimate the causal relationship between personality traits, initial health endowments and endogenous choices about schooling and post-schooling outcomes; they find a strong sorting into secondary education based on higher cognitive and noncognitive skills (both men and women) and initial health endowment (only women); on top of it, more than half of the difference in poor health, depression and obesity at age 30 can be explained by variation in personality and health traits when young, with health returns to education varying strongly with unobserved skills even after controlling for standard socioeconomic conditions. Using an analogous technique but looking at a life-long time span, Savelyev [2010] finds that both child Conscientiousness and higher education causally increase survival through age 80, but these traits tend to substitute each other so that effects of education are only strong at low levels of Conscientiousness and vice versa.

Finally, a different branch of research focuses on the effects of physical health on personal traits. A fairly popular biological approach analyses the consequences of hindered development of the brain in utero and early life: Shenkin, Starr and Deary [2004]systematically review a strand of the literature that highlights small but consistent, positive associations between birth weight and childhood cognitive ability; a steep rise in IQ is associated to increases from severely low birth-weights but possibly a downward sloping relationship can exists at high weights. Similarly Pesonen, Räikkönen, Heinonen et al. [2008]find that very low birth weight (below 1500gr) was linked to higher Conscientiousness and Agreeableness scores during childhood and lower Openness to experience, Hostility and Impulsivity.

Besides initial health conditions, also current physical conditions like appearance or the level of hormones in the body have been associated to certain facets of personality: Sapienza, Zingales and Maestripieri [2009] find an overall negative correlation between salivary testosterone concentrations and risk aversion, even if the effect is strongly gender specific and primarily driven by the fact that females tend to be less prone to risk and also have lower testosterone in circulation. Ryden, Sullivan, Torgerson et al. [2003]focus on physical appearance and study a sample of obese subjects who underwent surgical or conventional dietary treatment: they find that considerable weight-loss ameliorates patients' anxiety, extraversion and aggressiveness, with effects varying with gender and the amount of kilos lost. Concentrating on height, Hoffman, Fessler, Gneezy et al. [2010] find that taller individuals tend to be more competitive and estimate that each additional centimeter of height increases the probability of competing in a controlled experiment by 0.6%. Sell, Tooby and Cosmides [2009]corroborate this finding and put it in the perspective of evolutionary theory, reporting that taller and stronger men are more prone to anger in a controlled experiment and also reported a higher frequency of fights

since the age of 14; on the other side, they find that women's anger and success in conflicts is

more associated with self-rated attractiveness.

Table A10. The Effect of Personality on Health Outcomes[57]

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Taylor, Whiteman, Fowkes et al. [2009]	Outcome(s): *health* – longevity Explanatory Variable(s): *personality* – Big Five (NEO Five-Factor Inventory) *Health* – systolic blood pressure, BMI, smoking history (packs per year)	Data: Edinburgh Artery Study (N=1322) Methods: differences in mean; Cox proportional hazards model; EQS structural equation modeling program	Controls: sex (separate analysis); age, social class, systolic blood pressure, BMI, smoking (square root of packs per year) Timing of Measurements: Contemporaneous (aged 55 to 74) Theory: personality traits might spur healthy behaviors that reduce mortality	Men who died during follow-up had significantly lower **openness** and **conscientiousness** scores (-1/3 of a standard deviation, p<.01) as well as higher **neuroticism** (-0.3 of a sd, p=0.3); no significant difference in women. Results about openness and conscientiousness were confirmed by a Cox regression (p<.05). EQS structural equation model showed that both conscientiousness and openness were significantly (p<.01) affected by age and negatively (p<.01) influenced both blood pressure and all-cause mortality. **Openness** was also correlated with lower social status
Mroczek and Spiro [2007]	Outcome(s): *health* – longevity Explanatory Variable(s): *personality* – growth-curve parameters of neuroticism and extraversion (EPI-Q scale) *health* – self-reported subjective and objective health (Seriousness of Illness Rating Scale) and depression (from the Symptom Check List-90);	Data: Normative Aging Study (Department of Veterans Affairs) 2,280 initially health men Methods: Cox proportional hazard model	Controls: neuroticism and extraversion separately; (1) Age (2) Age + health controls + interaction of level and growth of personality traits. (No gender, only men) Timing of Measurements: Health status and personality traits were assessed in 1987-88 (age 43 to 91); death certificates through 2005 Theory: neuroticism and its growth influence depression and poorer health	**Extraversion**: no significant impact on mortality (p>.05) **Neuroticism** level had no significant effect; neuroticism **growth**: (1) increase of 1/2 a standard deviation over a decade increased the risk of dying by 40% (p<.01) (2) controlling for health, effect grew to 67% (p<.01); significant (p<.01) effect of the interaction between level and growth: men with higher initial levels and greater increases in neuroticism over time died sooner

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[57] Tables A10 – Table A13 were created by Pietro Biroli.

Friedman, Tucker, Tomlinson-Keasey et al. [1993]	Outcome(s): *health* – longevity Explanatory Variable(s): *personality* – six personality dimensions (Conscientiousness, Motivation, Cheerfulness, Sociability, Energy, Moods; parents and teacher assessment on 25 dimensions) *cognitive* – IQ (Rated general intelligence)	Data: Terman Life-Cycle study of Children (n=1,178) Methods: factor analysis; Cox proportional hazard models; logistic regression	Controls: (1) sex, year of birth and IQ (2) sex and all personal traits (3) sex; conscientiousness and cheerfulness squared (4) separate regression by gender Timing of Measurements: personal traits in 1922 (around age 11); survival up to 1986 Theory: biological (genetic / early environmental joint determinants); personal traits influence health behaviors or ability of coping with stress	(1) No effect of IQ or year of birth; only sex mattered (females live longer, p<.0001) (2) **conscientious** people tend to live longer (Relative Hazard $75^{th}/25^{th}$ percentile=.77; p<.01); **cheerful** ones tend to die earlier (RH = 1.23, p<.05); no effect of anything else than gender (3) concave effect of conscientiousness on mortality (square term has a RH=.15, p<.05) (4) conscientiousness has a significant effect for men (p<.01) but not women; women's longevity (but not men's) is influenced by cheerfulness
Kern and Friedman [2008]	Outcome(s): *health* – longevity Explanatory Variable(s): *personality* – Conscientiousness (various measures: MMPI, NEO-Five factor; childhood/ parents/ teacher/ hospital ratings)	Data: several medical dataset about patients with different diseases (see results); Changing Lives of Older Couples Study; Terman Life Cycle Study; Cardiovascular Disease Project; Kansas high School Graduates (n=108); U.S. presidents (32); Medicare Demonstration study; Religious Orders Study; graduates from State University (155) Methods: literature review; Raw correlations and Random Effect moderator analysis	Controls: none Timing of Measurements: various. Some data assessed traits before onset of disease, some were contemporaneous Theory: conscientiousness induce better coping with stress, healthier behaviors; possible biological joint determinant of longevity and conscientiousness	Correlation coefficients ranged from 0.00 to 0.41: **conscientiousness** was never associated with higher mortality. Overall weighted and unweighted means and medians calculated following a random-effects approach showed a significant (p<.05) association between conscientiousness and longevity. Six different countries: the United States, Canada, Germany, Norway, Japan, and Sweden. Medical Datasets included patients with: coronary heart disease (n=40) angina pectoris patients (74) Stage 1 malignant melanoma patients (60) chronic renal insufficiency (174) anorexic (103) older community members (380 and 392) adolescent psychiatric patients (1095); cancer (819) leukemia (35); institutionalized elderly chronically ill patients (193)

Weiss and Costa [2005]	Outcome(s): *health* – longevity Explanatory Variable(s): *personality* – Big Five (NEO-Five Factor Inventory 60-item questionnaire) *initial health*—presence of diabetes or cardiovascular disease (Health of Seniors Survey) or major depressive episode (dummies); functional limitations (Activities of Daily Living and Instrumental Activities of Daily Living scale); self-rated health; smoking (current, former, never)	Data: Medicare Primary and Consumer-Directed Care Demonstration (n=1076) Methods: Cox proportional hazard regression	Controls: sample: old age with no severe cognitive impairment; always control for gender, age, education, initial health variables. (1) continuous personality scores (2) trichotomized personality score (low-middle-high) Timing of Measurements: personality assessed at baseline and 23-year follow-up (age 65 to 100); mortality followed up to 5 years after baseline Theory: personal traits influence healthy behaviors/survival probability	(1) a SD increase in Neuroticism or **Agreeableness** related to 15.76% and 12.27% reduction in mortality risk (p<.05); other personal traits were non-significantly related to mortality (2) moving from average to high **conscientiousness** scores reduced mortality more than twice (p<.05); no other significant results
Christensen, Ehlers, Wiebe et al. [2002]	Outcome(s): *health* – longevity Explanatory Variable(s): *personality* – Big Five (NEO-Five Factor Inventory 60-item questionnaire) *Initial health* – clinical variables (dummy for presence of diabetes mellitus, comorbid cardiovascular disease; serum creatinine, blood urea nitrogen (BUN), albumin, potassium, and hemoglobin levels; blood pressure)	Data: Patients at the renal medicine clinic at the University of Iowa Hospitals and Clinics (n=174) Methods: Cox proportional hazard regression	Controls: sample selection: no severe cognitive impairment; chronic and progressive form of renal disease with a serum creatinine level above 3.0 mg/dl; no renal replacement intervention Controlling for age, gender, years of education, marital status and initial health Timing of Measurements: personality and initial health at baseline (average age 54.4) and follow-up; mortality followed for 4 years Theory: personal traits influence healthy behaviors/survival probability	High **neuroticism** scores and low conscientiousness decreased survival probability (37.5% and 36.4% respectively, p<.05)

| Kubzansky, Sparrow, Vokonas et al. [2001], | Outcome(s): *health* – longevity (mortality from coronary heart disease)

Explanatory Variable(s): *personality* – Optimism (revised Optimism-Pessimism Scale derived from Minnesota Multiphasic Personality Inventory)
health – BMI, smoking status (never, former, or current), alcohol use (dummy for two or more drinks of alcohol per day) systolic and diastolic blood pressure (mm Hg), serum cholesterol (mg/dl), family history of heart disease (dummy) | Data: Veterans Affairs Normative Aging Study (n=1306)

Methods: Cox proportional hazard regression | Controls: sample: men with no known chronic medical condition (1) Controlled for age, education (dummy for beyond high school studies) and health status; (2) also control for anxiety, anger/hostility, and depression (SCL-90 scale).

Timing of Measurements: personality and health status checked at baseline (age 21 to 80); mortality followed for 10 year

Theory: an optimistic explanatory style may protect against risk of coronary heart disease in older men | **Optimistic** men have few probabilities of dying from Coronary Heart Disease). Compared to pessimistic men, optimistic have a relative risk of death of .44 (p<.05); (2) controlling for negative emotions the relative risk increases to around .70 |
| Chiteji [2010] | Outcome(s): *health behavior* -- Drinking and Exercising (dummies)

Explanatory Variable(s): *personality* -- future oriented (question about length of individual's time horizon), self-efficacy (index in the 1972 PSID) | Data: PSID (2911 household heads in 1972 and 525 in 1999)

Methods: logistic regression | Controls: current wage, future earnings, health insurance, education. No gender difference

Timing of Measurements: contemporaneous

Theory: psychological traits influence behavior that influences health outcomes | **Future oriented** people have roughly 7% (p<.01) lower probability of drinking and 15% (p<.01) higher probability of exercising; **self-efficacy** reduces by 20% (p<.01) the probability of drinking and increases by 7% (p<.05) the probability of exercising (p<.01). |

Hampson, Tildesley, Andrews et al. [2010]	Outcome(s): *unhealthy behavior* – self-reported substance abuse, levels and growth (cigarettes, alcohol, and marijuana; 0 = Never, to 5 = "Some each day" in the past year) Explanatory Variable(s): *personality* – growth-curve parameters of hostility and sociability (annual teacher assessments of levels; growth over 4 years of childhood; questions taken from Walker-McConnell Test of Children's Social Skills, the Harter Social Acceptance subscale of the Perceived Competence Scale for Children, the Teacher Report Form and the pro-social subscales of the Children's Social Behavior Scale Teacher Form)	Data: Oregon Youth Substance Use Project (OYSUP); 1074 children from 15 elementary schools Methods: cohort sequential latent growth modeling; directed acyclic graphs	Controls: n/a. Separate analysis by gender Timing of Measurements: hostility and sociability assessed from 1st to 8th grade; unhealthy behaviors assessed from 9th to 12th grade Theory: Previous studies showed stable relations between sociability/hostility *levels* and substance abuse. Since children self-select into peer-groups with similar personality traits, *growth* of certain traits over time can predict involvement in risky behaviors	Initial level of **hostility** was significantly (p<.01) associated with initial level of cigarette, alcohol and marijuana use (effect stronger for girls (p < .01) than boys); hostility level also predicted (p<.01) growth in the use of cigarettes and marijuana (effect stronger for boys). Growth in hostility was associated (p<.01) with initial abuse of all 3 substances. Initial level of **sociability** was positively associated (p<.01) with initial level of alcohol abuse (no gender difference). Growth in sociability was never associated with substance use
Hampson, Goldberg, Vogt et al. [2007]	Outcome(s): *health status* -- Self-rated general health, functional status, BMI Explanatory Variable(s): *personality* – teacher assessment of Big Five (36 to 63 personality attributes from Cattell and Coan) *health behaviors* – eating habits (22-item version of the Food Habits Questionnaire) , smoking history (0 ="never smoked," to 3= "smokes half a pack a day or more."), physical activity (Godin Exercise Questionnaire)	Data: 1,054 members of the Hawaii Personality and Health cohort (40 years, childhood to mid-life) Methods: factor score; directed acyclic graphs	Controls: education, health behaviors. Pooled by gender and then separately Timing of Measurements: Childhood personality traits were obtained between 1959 and 1967 (1st to 6th grade); all other variables were obtained between 1999 and 2000 (age 41 to 50) Theory: Personality influences on health status are mediated by patterns of health-enhancing and health-damaging behaviors over the life course as well as educational attainment	**Extraversion** positively affected (p<.10) physical activity (.06) and smoking (.07), **Agreeableness** decreased smoking (-.10, p<.01) and increased educational attainment (.07; p<.10); **Conscientiousness** positively influenced both education (.16; p<.01) and final health status (.12; p<.05); **intellect/imagination** only influenced education (.17; p<.01). In turn, educational attainment improved eating habits (.38;p<.01) and smoking (-.32; p<.01) but decreased physical activity (-.15; p<.01). Physical activity and eating habits were positively associated with overall health status (.22; p<.01) while smoking decreased it (-.10; p<.01) Only gender difference was that women who were less **agreeable** as children were more likely to smoke (–.21, *p*< .001)

Luciano, Houlihan, Harris et al. [2010]	Outcome(s): *stress* – anxiety and depression (7 items each, Hospital Anxiety Depression Scale (HADS)) Explanatory Variable(s): *Personality* –Big-Five (IPIP 50-item inventory and NEO five-factor inventory) *genetic* -- Genomic DNA (single-nucleotide polymorphisms (SNPs) selected based on previous associations with personality, anxiety or depression)	Data: Lothian Birth Cohort 1936 (age 70, N = 1,091) and 1921 (age 80, N=550; age 87, N=229) Methods: regression with Bonferroni correction (association tests performed in PLINK)	Controls: sex and age Timing of Measurements: contemporaneous Theory: The genes influence personality traits and inflammatory markers, which in turn can induce depression	None of the selected SNPs in candidate genes for anxiety, depression and personality traits were significantly associated to negative health outcomes after a correction for multiple testing. Significant (p<.01) associations were found between NOS1 and **Extraversion**, and between PSEN1 and **depression/neuroticism**. Of the inflammatory marker genes, Transferrin (TF) was positively associated (p<.05) with **emotional stability**, **agreeableness** and **conscientiousness**; Glutathione peroxidase (GPX) with **extraversion**, **intellect**, **conscientiousness**
Friedman, Kern and Reynolds [2010]	Outcome(s): *healthy aging*– 5 measures of healthy aging (physical health, Subjective well being, Cognitive functioning, Social competence, Productivity); Explanatory Variable(s): *personality* – six personality dimensions (Conscientiousness, Motivation, Cheerfulness, Sociability, Energy, Moods; parents and teacher assessment on 25 dimensions) *cognitive* – IQ (Rated general intelligence)	Data: Terman Life-Cycle study of Children (n=1,312) Methods: factor analysis; hierarchical linear regression for the health aging;	Controls: sample selection: high ability children; Healthy aging: (1) only neuroticism, separate by sex (2) all personality traits separated by sex Timing of Measurements: personal traits in 1940 (age 29); health information in 1986 (age 75); death certificated throughout 2007 Theory: starting from a homogenous healthy sample, compare the health and personality evolution over the life-cycle	(1) Worse physical health and subjective well being were significantly (p<.05) associated with higher **neuroticism**, even more so for women (p<.001). Female scoring high on neuroticism in adulthood also were less social competent in later life. (2) **Agreeableness** was associated with higher subjective well being (men and women, p<.05) better physical health and social competence (men). **Extraversion** was associated with higher social competence (men and women) **Conscientious** men were more productive and social competent

Table A11. The Effect of Cognitive Ability on Health Outcomes

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Jokela, Batty, Deary et al. [2009]	Outcome(s): *health* – longevity Explanatory Variable(s): *cognitive* – IQ (40 verbal and 40 non verbal items) *health* -- psychosomatic symptoms (30-item Malaise Inventory), smoking (dummy), alcohol use (units of alcohol per week), BMI	Data: 1958 British Birth Cohort Study (N=10,620) Methods: discrete-time survival analysis	Controls: (1) sex interacted with IQ, childhood measures (father's occupation, family size, family difficulties, problematic behavior, height, mother's and father's investment); (2) add also adult measures (education, occupation, marital status, psychosomatic symptoms, smoking, alcohol use, BMI) Timing of Measurements: IQ, height and childhood risk factors at age 11; adult risk factors at age 23,33 and 42; mortality followed up to age 46 Theory: Not fully established. Possibly environmental (higher IQ, higher social status) possibly biological (higher IQ, better care oneself)	(1) 1sd increase in **IQ** decreased mortality probability (odds-ratio=.73, p<.05); (2) still significant but lower association between mortality and IQ (OR=.80, p<.05); Gender-IQ interaction never significant (p>.80); controlling for parents' investment in child reduced the association by 15% to 20%; education and psychosomatic symptoms attenuated association by 25%

Batty, Deary and Gottfredson [2007]	Outcome(s): *health* – longevity Explanatory Variable(s): *cognitive* – IQ (various measures)	Data: Swedish prospective cohort study (1938–1979); Australian retrospective cohort study (1965–1982); American retrospective cohort study (1931–1998); Scottish retrospective cohort study (1932–2001); Danish retrospective cohort study (1965–2002); UK prospective cohort study (1955–2001) Methods: literature review	Controls: (not all in same study) age, sex, birth date, birth weight, childhood illness, education, paternal socio-economic position, adult socio-economic position, smoking Timing of Measurements: Pre-morbid IQ, later life outcomes and mortality Theory: IQ might affect disease and psychiatric and injury prevention or management, increase socio-economic position	Positive relation between higher **IQ** and longevity; comparing groups from lowest to highest IQ, mortality risk decreased from 50% to 100%; some studies found a stepwise increase in mortality risk in successively lower quartiles of IQ; possible threshold effects; possible differences by sex (not common across all studies)
Batty, Deary, Schoon et al. [2007a]	Outcome(s): *healthy behavior* – eating habits (how often they ate a range of food); exercise (how often, how intense) Explanatory Variable(s): *cognitive* – IQ test (modified version of the British Ability Scales)	Data: 1970 British Cohort Study (N=8282) Methods: analysis of variance, logistic regression, Chi-square test	Controls: sex, childhood and current social class, education, annual earnings Timing of Measurements: Personal traits were measured at age 10, while health outcomes at age 30 Theory: not discussed	A sd increase in childhood **verbal mental ability** significantly ($p<.05$) increased the probability of eating fresh fruit (Odds Ratio = 1.09), cooked (OR=1.18) and raw (OR=1.09) vegetables; fish (OR=1.16); fewer French fries (OR=0.91); food fried in vegetable oil (vs hard fat; OR=1.11). Also increased the probability of getting out of breath/sweaty more frequently (OR=1.15), but had no significant impact on taking regular exercise or exercising more frequently (significant effect present when controlling only for sex)

Taylor, Whiteman, Fowkes et al. [2009]	Outcome(s): *healthy behavior* – smoking (never, past, current. Age of beginning) Explanatory Variable(s): *cognitive* – IQ (Moray House Test (MHT))	Data: Link of Scottish Mental Survey and Midspan prospective cohort studies (N=938) Methods: logistic regression; Cox's proportional hazards regression	Controls: (1) sex (2) sex and social class Timing of Measurements: Mental ability at age 11, smoking status at midlife Theory: not discussed	**IQ** and risk of ever smoking were not significantly correlated (p>.05) The relative rate of stopping smoking associated with one standard deviation increase in childhood IQ was 1.25 (p<.05) but not significant anymore once controlling for social class
Batty, Deary, Schoon et al. [2008]	Outcome(s): *health* – alcohol abuse (frequency, alcohol units consumed per week, problems drinking indexed by CAGE score) Explanatory Variable(s): *cognitive* -- IQ test (modified version of the British Ability Scales)	Data: British Cohort Study 1970 (n=8170) Methods: ANOVA, Chi-square test, ordinal logistic regression	Controls: Sex, current social class, adult alcohol outcomes Timing of Measurements: Personal traits were measured at age 10, while health outcomes at age 30 Theory: higher IQ induces a more responsible drinking behavior	Higher **mental ability** (childhood) linked with alcohol problems during adulthood (P for interaction term=.004) or drinking alcohol more frequently (0.043); for women, significant association between current social class and alcohol problems (P for interaction term=.44)
Batty, Deary, Schoon et al. [2007b]	Outcome(s): *health risk factor* – accidents (at work, at or around home, sports, others) Explanatory Variable(s): *cognitive* -- IQ test (modified version of the British Ability Scales at age 10; mental test abilities for 5 year olds: Human Figure Drawing Test, Copying Designs Test, English Picture Vocabulary Test, Profile Test)	Data: British Cohort Study 1970 (n=8203) Methods: ANOVA, logistic regression, odds ratios	Controls: Sex, childhood social class, current social class, academic/ vocational qualifications, annual net earnings, Timing of Measurements: mental test scores at age 5 and 10; risk factors at age 30 Theory: higher IQ induces a more responsible behavior	**IQ** scores positively related to level of educational qualifications (Spearman: 0.31); accident at work decreased with increasing IQ scores in unadjusted analysis (OR: 0.81; weakened when adjusted for parental social class or educational attainment; not significant for current social class), for sports (OR: 1.25), around the home (OR: 1.12), other circumstances (OR:1.15); in multivariate analysis, one SD increase in IQ score at age 10 years risk of accident in home rose by 19%, 29% in other locations (results weaker for women); results differed on sex and location; for women, positive relationship between IQ score and accidents and backwards for men

Gale, Batty, Cooper et al. [2009]	Outcome(s): *health risk*– self-reported health, obesity Explanatory Variable(s): *cognitive* -- IQ test (modified version of the British Ability Scales at age 10) *health* -- Psychomotor Coordination (Rutter Parental 'A' Scale of Behavior Disorder and Malaise Inventory)	Data: 1958 National Child Development Study and the British Cohort Study 1970 (N=6147) Methods: Correlation coefficients, logistic regression, odds ratios	Controls: Sex, educational attainment, earnings, parental social class, and current socioeconomic position Timing of Measurements: psychomotor coordination and intelligence at age 11 years and health outcomes at age 33 years Theory: higher IQ induces a more responsible behavior	Psychomotor coordination scores were higher in individuals with a higher **IQ** in both cohorts (r=-0.18 for 1958 cohort and r=-0.17 for 1970 cohorts); **nonverbal intelligence** strongly correlated with psychomotor coordination, more than **verbal intelligence** (r=0.20 and r=0.11, respectively); higher IQ and better coordination associated with lower risk of fair/poor health (OR=0.63 for 1958 cohort and OR=0.79 for 1970 cohort) and with lower risk of obesity (0.75 in 1958 cohort and 0.85 in 1970 cohort
Gale, Hatch, Batty et al. [2009]	Outcome(s): *health risk*– psychological distress (Malaise Inventory/BMI, and Rutter's Malaise Inventory) Explanatory Variable(s): *cognitive* -- IQ test (modified version of the British Ability Scales at age 10) *health* -- Psychomotor Coordination (Rutter Parental 'A' Scale of Behavior Disorder and Malaise Inventory)	Data: 1958 National Child Development Study and the British Cohort Study 1970 (N=6147) Methods: Spearman correlations, point bi-serial correlations, binary logistic regression, odds ratio	Controls: Sex, educational attainment, earnings, parental social class, and current socioeconomic position Timing of Measurements: psychomotor coordination and intelligence at age 11 years and health outcomes at age 33 years Theory: higher IQ induces a more responsible behavior	Higher **IQ** scores associated with lower total scores on Malaise Inventory in both cohorts (correlation coefficients: -0.18 for 1958 cohort and -0.11 for 1970 cohort); risk of psychological distress was greater in women for both cohorts; 1 SD increase in childhood IQ for psychological distress OR=0.61 for 1958 cohort and OR-0.77 for 1970 cohort; higher intelligence in childhood associated with reduced risk of psychological distress in both cohorts

Table A12. The Effect of Health on Personality

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Pesonen, Räikkönen, Heinonen et al. [2008]	Outcome(s): *personality* – Big Five (NEO-Personality inventory) Explanatory Variable(s): *health* – very low birth weight (VLBW < 1500g)	Data: Helsinki Study of Very Low Birth Weight Adults (n=326) Methods: Univariate analyses of covariance (ANCOVA); matching and Bonferroni correction (next available singleton infant, same sex, born at term, not small for gestational age);	Controls: sex, age at assessment, parental educational attainment, individual school grade average; maternal preeclampsia and prenatal smoking; Timing of Measurements: weight at birth, maternal and gestational variables (1978-85); child age and education at follow up (2004) Theory: biological mechanism associated with prematurity; parents take better care of VLBW children;	VLBW adults scored significantly higher in **conscientiousness** (mean difference=1/5 of a standard deviation, p < .03), **agreeableness** (MD=1/2 of 1sd, p < .001), and lower in **openness** to experience (MD= –1/4 of 1sd, p < .02). They also showed lower **hostility** (-1/3 of 1sd, p<.02) and **impulsivity** (1/2 of 1sd, p<.001) however **neuroticism** overall was not significantly different; also displayed less **assertiveness** (1/2 of 1sd, p < .05) but no overall difference in **extraversion**. No significant interaction with gender No significant impact of excluding chronic disability (cerebral palsy (n = 12) or other developmental impairment (n = 5))
Ryden, Sullivan, Torgerson et al. [2003]	Outcome(s): *personality* -- Karolinska Scales of Personality (Somatic Anxiety, Muscular Tension, Psychasthenia, Psychic Anxiety, Monotony Avoidance, Impulsiveness, and Irritability) Explanatory Variable(s): *health* – obesity (2-year weight change due to surgery or diet)	Data: Swedish Obese Subjects reference study (1380 surgical treatment, 1241 conventional treatment) Methods: Matching (non-randomized controlled trial); Wilcoxon signed-ranks test; ANOVA with Bonferroni correction; effects sizes (ES) using Cohen's d	Controls: matching on 18 variables, 6 of which psychological. Analysis performed also separated by gender Timing of Measurements: BMI and personality trait assessed before treatment and 2 years after (age 37 to 60) Theory: obesity affects the way people relate to others	Due to non-randomization, personality traits significantly differed among the three groups (surgical treatment, conventional treatment, control). After treatment **anxiety**, **extraversion** and **aggression** significantly improved (p<.01) for both surgical and conventional treatment patients. Qualitatively, the greater the weight-loss the bigger the change in personality scores. Compared to the reference group, changes in traits were small or trivial: differences in Somatic Anxiety, Muscular Tension and Impulsiveness were significant and more than ½ a standard deviation for patients who loss <10kg. Also Psychic Anxiety and Irritability differed by roughly 1/4 of a standard deviation. Changes in all other psychological traits were less than 1/5 of a standard deviation Men and women differed significantly (p<.01) in personal traits (women scored higher in anxiety and lower in Monotony Avoidance); treatment effect significantly different across gender only regarding **Impulsiveness** (women=0.4 of a sd; men=0.6 of a sd)

Sapienza, Zingales and Maestripieri [2009]	Outcome(s): *personality* – financial risk aversion (willing to pay to avoid a 50/50 lottery $0/$200) Explanatory Variable(s): *health* – testosterone (salivary concentration and markers of prenatal exposure)	Data: 460 MBA students at Uchicago Methods: OLS (robust s.e.)	Controls: (1) none (2) sex (3) only low levels of testosterone Timing of Measurements: contemporaneous Theory: testosterone can affect brain formation (pre- and postnatal exposure) or its functioning (puberty)	(1) Overall negative correlation between salivary testosterone concentrations and **risk aversion** (r=-0.1793; p=.01); (2) effect goes away once controlling for sex (female are significantly more risk averse p<.05). (3)Focusing only on people with low levels of testosterone (n=225) higher levels of circulating testosterone were associated with lower risk aversion even after controlling for gender. Possible nonlinear effect of testosterone on risk aversion regardless of gender. Markers of prenatal exposure to testosterone had no significant effect on risk aversion
Shenkin, Starr and Deary [2004]	Outcome(s): *cognitive* – IQ measurement Explanatory Variable(s): *health* – birth weight	Data: 1946 and 1958 British birth cohort; 1950–1954 Birmingham study; National Collaborative Perinatal Project; Scottish Mental Survey; Newcastle Growth and Development Study and Performance Indicators in Primary Schools Method: Literature review	Controls: (not all in the same study) sex, gestational age, birth rank; maternal age; parental education; social class (parental occupation); deprivation; weight in infancy; race; Postnatal height and weight; breast fed Theory: Biological development of brain hinders IQ;	Small, consistent, positive association between birth weight and childhood **cognitive ability**, even after controlling for other variables. Possible concavity of the relation (steeper at low birth weights and possibly downward sloping at high weights) which varies across gender and as children age. However **IQ** variance was more related to parental social class than birth weight.
Hoffman, Fessler, Gneezy et al. [2010]	Outcome(s): *personality* – competitiveness (ball throwing task) Explanatory Variable(s): *physical health* – height	Data: 1296 residents of 8 villages in Meghalaya (India) Methods: randomized controlled experiment, matching on gender and village	Controls: (matching) gender and village Timing of Measurements: contemporaneous Theory: bigger individuals are more aggressive by nature since they are more likely to win a fight (especially men)	When asked to play a particular game either alone or against a randomly assigned partner, 38.1% of the men and 23.8% of women chose to compete. Each additional centimeter of height increased the probability of competing by 0.6% (p=.004). the tallest quartile is 1.5 times as likely to compete as the shortest quartile

Sell, Tooby and Cosmides [2009]	Outcome(s): *personality* – anger and aggression (proneness to anger, history of fighting, utility of personal and political aggression) entitlement (expectation of better treatment, e.g. "I deserve more than the average person") Explanatory Variable(s): *physical health* – height and strength (weight lifting machines, self-perception, chest/arm circumference); attractiveness (self-perception)	Data: (study 1) 62 men from UCSB gym; (study 2) 125 men and 156 women from UCSB study center Methods: Correlation (Pearson r)	Controls: (study 1) simple correlation (study 2) control for both strength and attractiveness Timing of Measurements: contemporaneous Theory: evolutionary biology	(1) In men, both lifting strength and self-perception of strength were positively (p<.009) correlated with **anger** and **aggression** measures (0.27 < r < 0.47) (2) The effect of strength on **aggressiveness** was significantly lower for women; attractiveness was positively (p<.04) correlated with all measures of anger and entitlement but not aggression; in men, strength and attractiveness are highly correlated with each other and with measures of anger and aggression

Table A13. The Effect of Personality on Cognitive Ability and Health

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Gale, Batty and Deary [2008]	Outcome(s): *health* -- BMI, blood pressure, self-rated health, psychological distress (Rutter's 24-item Malaise Inventory), smoking, exercising Explanatory Variable(s): *personality* -- locus of control (16-item CAROLOC scale) *cognitive* -- IQ test (modified version of the British Ability Scales)	Data: 1970 British Cohort Study; 10 year follow-up (14,875 children) and 30 year follow-up (7,551 children) Methods: logistic regression	Controls: (1) sex, locus of control and IQ (2) sequentially add parental social class, current social class, academic/vocational qualifications, annual earnings Timing of Measurements: Personal traits were measured at age 10, while health outcomes at age 30 Theory: Locus of control might affect health spurring healthy behaviors or via psychological influences (maintain homeostatic internal environment, lower stress responsiveness)	(1) **IQ** and **locus of control** are correlated among themselves (r=0.48) are positively (p<.01) correlated to health outcomes; adjusting for locus of control weakened the associations between IQ and lower health risk by 20% to 60%; (2) A standard deviation increase in the **locus of control** decreased significantly (p<.05) the risk of being overweight (BMI≥25) or obese (BMI≥30; stronger effect for women), the risk of fair or poor self-rated health and the risk of psychological distress. It had no significant impact (p≥.05) on blood pressure, smoking or exercising. Adjusting for childhood IQ attenuated the health risk estimates due to higher locus of control by 17% to 30% percent. Adjusting for education attainment further attenuated them by 25%-80%
Weiss, Gale, Batty et al. [2009]	Outcome(s): *health* -- longevity Explanatory Variable(s): *personality* – Neuroticism (Minnesota Multiphasic Personality Inventory) *cognitive* – IQ (Army General Technical Test) *health – physical*: hypertension, cancer, diabetes, or coronary heart disease; serum glucose levels, systolic (SBP) and diastolic blood pressure (DBP), physical activity (resting pulse rate), lung function, BMI; *behavioral*: use of cigarettes (never, current, former) or alcohol (never, seldom, or number of binge per month); *mental*: depression or anxiety	Data: Vietnam Experience Study (4200 Vietnam-era war veterans) Methods: differences in mean; Cox proportional hazards model; covariance structure modeling (MLE)	Controls: men only; (1) age, ethnicity, and marital status; (2) add education, income, 7 physical health measures, 2 mental health measures, drinking, and smoking to (1) Timing of Measurements: Explanatory variables assessed in 1985-1986 (age 30 to 48); death records censored in 2001 Theory: not discussed	(1) Independent mortality risk factors were high **neuroticism** (Hazard Ratio 1.296, p<.01) and low **cognitive ability** (HR 0.797, p=.006); there was significant interaction between the two (p<.01). (2) SES, physical and mental health variables attenuated the effect of cognitive ability but not that of neuroticism Covariance structure models allowing for correlation between factors showed that mortality is directly affected (p<.01) by **neuroticism**, lower income, and poor health as well as indirectly predicted by **cognitive ability** (paths from cognitive ability to higher income, more education, better health, and less neuroticism)

Savelyev [2010]	Outcome(s): *health* – longevity (survival through ages 40-80 conditional on survival through age 30); *education* – the highest degree obtained in life. Explanatory Variable(s): *personality* – Conscientiousness, Openness, and Extraversion (averaged parents' and teachers' ratings from 1922), *cognitive* – IQ in 1922 (Stanford Binet and Terman Group Test), *initial health* – birth weight, whether birth was normal without complications, breastfeeding dummy	Data: Terman Life-Cycle study of Children (n=1180) Methods: factor analysis; matching (observables and unobservables); Discrete time proportional odds model of longevity with time-dependent effects, personality-education interactions; MLE; bootstrap inference	Controls: (1) separate analysis by gender; highest education level, IQ, father's and mother's education and occupation, parental origin, private tutoring by age 12, number of siblings, deceased mother, deceased father, divorced parents, World War II participation, World War II combat experience, cohort dummies (2) conscientiousness interacted with education Timing of Measurements: personality items and IQ, 1922 (around age 12); survival up to 1991; highest education level 1922-1986; private tutoring 1922-1928; World War participation information, 1945; all other variables, 1922. Theory: education creates skills that substitute Conscientiousness in producing health, since those skills act through the same mediators as Conscientiousness (healthy lifestyle)	Male results: **Conscientiousness** and education increase survival and they substitute for each other (Education has stronger effects at low levels of Conscientiousness and vice-versa). **IQ**, **Openness**, **Extraversion** and other traits are not strong predictors of longer survival. The indirect effect of Conscientiousness on longevity acting through enhancing education is small. Females: effects of education and traits are generally not precisely determined. Doctorate degree is slightly associated to higher mortality, which is possibly related to poor family outcomes. The result is likely specific to females born in the beginning on the 20th century

Conti, Heckman and Urzua [2010a]	Outcome(s): *healthy behavior* – ever used cannabis, daily smoking and regular exercise *health* -- BMI, self-rated health, psychological distress (Rutter's 24-item Malaise Inventory) Also: *schooling* and *labor market* outcomes Explanatory Variable(s): *personality* – locus of control (16-item CAROLOC scale) perseverance, cooperativeness, completeness, attentiveness and persistence (teachers' assessment) *cognitive* – IQ test (modified version of the British Ability Scales) *initial health* – height and head circumference conditional on weight (age 10); father's and mother's height	Data: 1970 British Cohort Study; (3,777 men and 3620 women) Methods: factor model (mixture of multivariate normals); matching (observable and unobservable); estimation of distribution of treatment effect conditional on endogenous schooling behavior using Bayesian Markov Chain Monte Carlo methods to compute likelihood	Controls: separate analysis for gender; mother's age at birth, mother's education at birth, father's high social class at birth, total gross family income at age 10, living with both parents since birth until age 10 (dummy), parity, number of children in the family at age 10. Timing of Measurements: Personal traits were measured at age 10, while health outcomes at age 30 Theory: technology of skill formation: personality and health traits grow and reinforce themselves over the life-cycle	Strong sorting into post-compulsory levels based on high **cognitive** and **personality skills** (p<.01) and also high health endowment (significant for females only) Conditional on education attained, cognitive ability matters for labor market outcomes and increases probability of cannabis use (both genders). Personality traits reduce probability of unhealthy outcome s (behaviors and overall health status at age 30). Initial health condition have a significant direct effect on health outcomes (both genders) but influence higher education only for women

Wilson, Mendes de Leon, Bienias et al. [2004]	Outcome(s): *health* – longevity (Annual clinical evaluation and brain autopsy) Explanatory Variable(s): *personality* – NEO Five-Factor Inventory (60 self-evaluated statements on a 5-point scale) *cognitive* – 19 individual tests (episodic memory, semantic memory, working memory, perceptual speed, visuospatial ability) *initial health* – clinical evaluation (medical history, complete neurological examination, assessment of motor abilities) ever smoker, alcohol (number of alcoholic drinks consumed in the past year), BMI	Data: Religious Orders Study (n=883) Methods: factor analysis; Cox proportional hazards models	Controls: Dementia patients were excluded; separate regression for each personal trait; (1) age, gender and education; (2) as (1) controlling also for global cognition and lower limb function; (3) add to (2) the number of medical conditions at baseline, alcohol use, smoker dummy, BMI; (4) interact personal traits with gender Timing of Measurements: Annual clinical evaluation from 1994 (75.1 years-old on average) to present Theory: personality influences healthy behaviors that increase longevity	(1) **Neuroticism** significantly (p<.05) decreases longevity (person at 90th percentile is 95% less likely to survive than person at the 10th percentile) while longevity increases with **extraversion** (90/10 percentile comparison: 75% increase in probability of survival) and **conscientiousness** (48%); when all traits are included in the regression, only neuroticism remains significant (2) controlling for **IQ** doesn't change substantially the results (same significance, similar levels) (3) only neuroticism and extraversion significantly affect longevity, in opposite direction and similar magnitudes as in (1) (4) Gender did not interact with any trait (all p>.30)

A7.B. *The Effects of Personality and Cognitive Measures on Crime and Deviance by Amanda Agan*

There is a large literature in criminology focusing on the effects of self-control on crime due to Gottfredson and Hirschi's seminal work in *A General Theory of Crime* (1990). In it they posit that a uni-dimensional factor they label as "self-control" is responsible for much of the variance in crime and deviance across individuals – although opportunity to commit crime interacts with self-control in important ways. If one has both opportunity and low self-control then crime is very likely, but without opportunity no crime occurs. They also argue that self-control is a stable trait that is unchanging over time, and thus advocate for cross-sectional tests of the theory, since longitudinal tests would be unnecessary (and more costly).

People with low self-control, as characterized by Gottfredson and Hirschi [1990], are "impulsive, insensitive, physical (as opposed to mental), risk-taking, short-sighted, and non-verbal" (1990:90). Criminal acts, they argue, are "likely to be engaged in by individuals unusually sensitive to immediate pleasure and insensitive to long-term consequences" (1990:2). Thus parts of Gottfredson and Hirshi's definition of self-control resembles the economists measure of the discount rate as well as the psychologists measure of impulsivity. There have been many studies in criminology and psychology that look at the correlations between self-control or impulsivity and criminal outcomes and deviance. However, there have been no studies linking common economic experimental measures of discount rates (or risk aversion) to criminal outcomes. This seems surprising particularly given that proliferation of research recently using these measures to predict outcomes such as education and migration (i.e. Jaeger, Dohmen, Falk et al. [2010]).

Two empirical measures of self-control have emerged in the literature. The first is a series of Likert-scale questions devised by Grasmick, Tittle, Bursik et al. [1993] – their original factor analysis on these questions determined that, as Gottfredson and Hirschi posited, this trait is unidimensional. The other empirical measure asks behavioral questions (Tittle, Ward and Grasmick [2003]) – these consists of questions about 10 forms of problem behavior such as smoking, drinking, overeating, using seatbelts etc..), and Benda [2005] includes questions like have you skipped school, have you had sex with more than one person without a condom, have you harassed someone in the past year, have you received a ticket for reckless driving, etc… The behavioral measures have been criticized as verging on tautological due to the fact that they essentially ask about participation in deviant behavior then use those responses to predict deviant behavior.

Given that the "analytic" self-control scales consist of Likert-type personality questions it is interesting to ask how it overlaps with the Big Five Personality traits. O'Gorman and Baxter [2002] test how the Grasmick, Tittle, Bursik et al. [1993] index correlates with the Conscientiousness scale of the NEO – which contains six subscales: dutifulness, self-discipline, deliberation, competence, achievement striving, and order. They find that low self-control is significantly negatively correlated with each of these subscales, with correlation coefficients ranging between 0.38 (competence) to 0.57 (order). Interestingly, when they regress self-reported deviant behavior on self-control and conscientiousness they find that self-control does not significantly add to the prediction once conscientiousness was entered.

Both the "analytic" and "behavioral" measures, and measures like them, have proven over and over again to consistently predict crime and deviance. Pratt and Cullen [2000] performed a meta-analysis of 21 empirical studies that consider the effects of self-control on

crime. They find consistently positive and significant standardized correlation coefficients between self-control measures and crime or deviance, though the correlations sizes are higher when a behavioral measure is used. Benda [2005] finds similarly that in an OLS regression of person or property offenses committed on low self-control that self-control significantly predicts offenses and this effect is higher when a behavioral rather than Grasmick, Tittle, Bursik et al. [1993] scale is used. Vazsonyi, Pickering, Junger et al. [2001], using the International Study of Adolescent Development (ISAD) finds that the Grasmick, Tittle, Bursik et al. [1993] scale explains a positive and significant amount of the variance in deviant acts (ranging from 10-16% depending on the type of act) across the four countries in the study (Hungary, the Netherlands, Switzerland, and the United States).

However, that is not to say that Gottfredson and Hirschi's theory is completely accepted. Although the main thrust of the theory is that self-control predicts much of the variance in criminal acts among people there are other facets of the theory that have not held up as robustly to empirical study. One is that once self-control is accounted for very little else should help predict crime differences. However, Pratt and Cullen [2000] find that across several studies that add in social learning variables the mean effect size of self-control on crime was unchanged but the social learning variables also had significant effects on crime. Gottfredson and Hirschi also argue that the self-control factor is uni-dimensional, however Tittle, Ward and Grasmick [2003] among others find evidence of multi-dimensionality in the scales measuring self-control.

In addition to self control other realms of personality or non-cognitive skills have been measured and analyzed in an attempt to determine their effects on crime. The studies mostly analyze deviance in children/adolescents and crime outcomes of undergraduates. Two of the studies use personality measures that load onto three main factors – constraint, positive

emotionality and negative emotionality. Across two studies – the Pittsburgh Youth Survey and the Dunedin Multidisciplinary Health and Development study – constraint was negatively correlated with self-reported delinquency while negative emotionality was positively correlated. Neither study found an effect of positive emotionality on delinquency. (Caspi, Moffit, Silva et al. [1994]). Similarly, Agnew, Brezina, Wright et al. [2002] found that their single factor measure of negative emotionality/constraint was significantly, positively associated with self-reports of delinquency amongst 12-16 year olds in the 2nd wave of the National Survey of Children. Sensation seeking and impulsivity have also been found to be positively associated with crime (Horvarth and Zuckerman [1993]), although one may argue that these traits are a subset of self-control and thus may also offer evidence in favor of Gottfredson and Hirschi's theory.

These studies in criminology and psychology, for the most part, use either correlations or OLS regression to talk about "effects" of various personality measures on crime. There has been little attempt to rigorously deal with causation in these studies.

In addition there is an emerging literature on the effects of education on crime. Lochner and Moretti [2004]using US data and Machin, Marie and Vujić [2010] using UK data find that increasing years of schooling is negatively associated with crime participation. Both papers use compulsory schooling laws as an instrument and find that these results hold up in a two stage least squares (2SLS) analysis. Lochner and Moretti [2004] posited several mechanisms through which education could causally impact criminal activity, including that education may change traits such as patience or risk aversion. Though neither paper attempts to differentiate amongst the various mechanism through which education could effect crime, that education changes ones non-cognitive skills seems like a particularly plausible argument. This is especially true in light

of findings by Cunha, Heckman and Schennach [2010]that criminal participation is more heavily

loaded on noncognitive skills, thus any intervention that can change these (in a "positive" way) is

likely to have effects on crime.

Table A14. The Effect of Personality on Crime[58]

	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Caspi, Moffit, Silva et al. [1994]	Outcome(s): *Delinquency* -- self-reports, teacher and parental reports, and official records Explanatory Variable(s): *personality* -- "Common language" version of California Child Q-sort (CCQ) for United States and Multidimensional Personality Questionnaire (MPQ) for New Zealand	Data: US: 430 12- and 13- year old boys from the Pittsburgh Youth Survey (PYS) NZ: Dunedin Multidisciplinary Health and Development Study (New Zealand) -862 18 year olds who took the MPQ Methods: correlations	Controls: US: Separate correlations computed for blacks and white, no controls NZ: separate correlations for men and women, but no controls Timing of Measurements: US: Reports were contemporaneous with test and were about delinquency at age 12 and 13. NZ: Self-reports are contemporaneous with MPQ test at age 18, though may have occurred in any of the previous years Theory: Personality can affect delinquent behavior	Both personality inventories were used to construct three "superfactors" – constraint (combines traditionalism, harm avoidance and control), negative emotionality (combines aggression, alienation, and stress reaction), and positive emotionality (combines achievement, social potency, well-being and social closeness) . US: *Constraint* is negatively correlated with self-reported delinquency for blacks and white (-0.17 and -.022 , $p<0.05$). *Negative emotionality* is positively correlated with self-reported delinquency for blacks and white (0.13 and 0.20, $p<0.05$). Positive emotionality is not significantly correlated with self-reported delinquency. Similar signs and significant for teacher- and parent-reported delinquency, except for positive emotionality which is negatively correlated with parent-reported delinquency for blacks and whites (-0.26 and -0.21 ($p<0.05$) NZ: *Constraint* is negatively correlated with self-reported crime for men and women (-0.44 ($p<.05$)), *negative emotionality* is positively correlated with self reported crime for men and women (0.48 and 0.34 ($p<.05$)), *positive emotionality* is not significantly correlated with self-reported crime. Signs of correlations were consistent across informant reports, police contact and court convictions, and for the most part similarly significant. Overall MPQ profile can explain 34% (25%) of variance in self-reported criminal activity for men (women).

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[58] Tables A14 - Table A16 were created by Amanda Agan.

Horvarth and Zuckerman [1993]	Outcome(s): *Crime* -- self reports of arrests for drugs, shoplifting, DUI, perjury, forgery, or vandalism Explanatory Variable(s): *Sensation Seeking* -- form V of the Sensation Seeking Scale (SSS). *Impulsivity* -- Narrow Impulsivity Scale of Eysenck and Eysenck (1978)	Data: Collected by authors; 447 undergraduates from an Introduction to Psychology course at the University of Delaware Methods: Correlations and multiple regression	Controls: Perceived proportion of peers participating in the specific criminal behavior, perceived risk of negative consequence from the specific criminal behavior Timing of Measurements: Personality measures and questions about crime were contemporaneous, though crime questions asked about criminal activity ever Theory: Sensation seeking, impulsivity and peer behaviors are likely important influences on criminal (and other risky) behavior	Sensation seeking and impulsivity are positively correlated with self-reported crime risk factor (0.53 and 0.36 respectively (p<0.01). In a multiple regression analysis with both sensation seeking and impulsivity included as well as the other controls, both sensation seeking and impulsivity are still positively associated with self-reported crime (with "Beta weights" of 0.27 and 0.13 - no p-values given but stated significant in the text). Note that perceived behavior by peers was the strongest predictor of criminal behavior.

Agnew, Brezina, Wright et al. [2002]	Outcome(s): *Juvenile Delinquency* -- self-reported five-item scale of how many times they had committed 5 acts of delinquency (hurt someone, stolen from store, damaged school property, skipped school, gotten drunk) Explanatory Variable(s): *Negative emotionality/constraint* -- factor derived from questions from teachers and parents about the child's behavior and personality	Data: 2nd wave of the National Survey of Children - 1423 children who completed the interviews, age 12-16 in 1981. Methods: Correlations and OLS	Controls: sociodemographic characteristics: total family income (8 categories), education of primary parent, family status (divorced, married), age of child, sex of child, race of child; measures of "strain" - including conflict with parents, school hatred, picked on by kids, family strain and neighborhood strain; measures of social control and social learning such - attachment to parents, parental firmness, school commitment, educational goals, time spend on homework, school attachment, troublesome friends Timing of Measurements: Contemporaneous self-reports of crime with questions to parents/teachers about behavior, although both could describe actions in the past Theory: Experiencing strain can increase an individuals likelihood of experiencing negative emotions which in turn create pressure to take action which may take the form of delinquency/crime. Personality traits, such as negative emotionality, may have a significant impact on this link.	Negative emotionality/low constraint is positively correlated with delinquency (0.22, p<0.01). In a regression of delinquency on all controls and negative emotionality/low constraint, an increase in the negative emotionality/low constraint scale increases delinquency (p<0.01). It is unclear how to interpret this magnitude. When negative emotionality/low constraint is interacted with strain, the main effect of negative emotionality/low constraint on delinquency remains positive and significant (p<0.01) and the coefficient on the interaction effect is positive and significant (p<0.01) – individuals are score higher on the negative emotionality/low constraint scale are more likely to react to strain with increased delinquency.

Table A15. The Effect of Self-Control on Crime

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Pratt and Cullen [2000]	Outcome(s): *crime and analogous behaviors* – measured in various ways in different studies Explanatory Variable(s): *self control* -- using Grasmick et al. (1993) inventory, other inventories, or behavioral questions	Data: Meta-analysis of 21 empirical studies testing the effects of self-control on crime Methods: Meta-analysis (mean effect sizes calculated)	Controls: Varies by study Timing of Measurements: Majority are contemporaneous, only two studies are longitudinal and thus have measures at different times Theory: Gottfredson and Hirschi (1990) *General Theory of Crime. A uni-dimensional factor they label as "self-control" is responsible for much of the variance in crime and deviance across individuals*	Mean effect size (standardized correlation coefficient) of self control on crime is 0.20 across the studies. When "behavioral" rather than "cognitive" or "attidunal" measures (i.e. Grasmick at al scale) are used the effect sizes are slightly higher. The effect of low self-control is significantly weaker in longitudinal studies as compared to cross-sectional studies. Self control has consistently large effects (minimum of 0.155) across different types of samples (juveniles vs. adults, racially homogenous or diverse, etc...). Variables that measure other criminal theories (i.e. social learning) do not effect the size of the effect of self-control but do tend to enter significantly in regressions on crime.
Nagin and Paternoster [1993]	Outcome(s): *criminal proclivity* -- students presented with crime scenarios were asked about whether they would participate and their probability of being caught if they do Explanatory Variable(s): *self control* -- using Grasmick et al. (1993) inventory	Data: Collected by authors; 699 undergraduates from the University of Maryland Methods: Tobit	Controls: gender, prior criminal behavior, sanctions present in the scenario, perceived utility from crime Timing of Measurements: The measures are contemporaneous Theory: Gottfredson and Hirschi (1990) *General Theory of Crime. A uni-dimensional factor they label as "self-control" is responsible for much of the variance in crime and deviance across individuals*	"Lack of self-control" as measured by the Grasmick et al. (1993) inventory is positively associated with the choice to commit crimes in all three scenarios (theft, drunk driving and sexual assault). Tobit regression was used because the modal response category for the dependent variables was 0 (i.e. no chance they would commit the crime). The lack of self-control measure was created by summing across 24 responses. An increase in 1 additional response associated with lack of self-control increases probability of intending to commit theft by 0.08 ($p<0.01$), drunk driving by 0.06 ($p<0.01$) and sexual assault by 0.11 ($p<0.01$).

Benda [2005]	Outcome(s): *Crime* -- self-reported property and person and offenses Explanatory Variable(s): *self control* -- using Grasmick et al. (1993) inventory and behavioral self-control scale where yes-no answers to questions about behavior (i.e. I regularly drive without a seatbelt) were combined to form an index	Data: Collected by authors; 3395 adolescents from a Midwestern state Methods: OLS	Controls: age, gender, race, rural/urban, family structure (two caregivers or not), caregiver years of education, annual family income, caregiver monitoring, Inventory of Parent and Peer Attachment (IPPA), Self-Efficacy Scale, 3 subscales from Childhood Trauma Questionnaire (CTQ), subscales from Multiple Problem Screening Inventory (MPSI) Timing of Measurements: Self-reports contemporaneous with personality measures but pertaining to offenses in the past Theory: Gottfredson and Hirschi (1990) *General Theory of Crime. A uni-dimensional factor they label as "self-control" is responsible for much of the variance in crime and deviance across individuals*	In an OLS regression of person and property offenses low behavioral self control is positively associated with both measures (p<0.01). These associations remain positive but shrink when the "cognitive" (Grasmick et al. (1993)) measure of self control is used instead.
Vazsonyi, Pickering, Junger et al. [2001]	Outcome(s): *Deviance* -- 55-item Normative Deviance Scale (NDS) - which contains 7 subscales relating to self-reported: vandalism, alcohol, drugs, school misconduct, general deviance, theft, and assault) Explanatory Variable(s): *self control* -- Grasmick et al. (1993) low self control scale	Data: International Study of Adolescent Development (ISAD), ~8500 subjects from Hungary, the Netherlands, Switzerland, and the United States. 6,085 15-19 year olds with no missing data were used in this present study Methods: Correlations, Hierarchical Regression Analysis	Controls: Sex, age, country Timing of Measurements: Contemporaneous self-repots about past deviance and self-control test. Reports given at ages 15-19 Theory: Gottfredson and Hirschi (1990) *General Theory of Crime. A uni-dimensional factor they label as "self-control" is responsible for much of the variance in crime and deviance across individuals*	All six sub-factors of self-control: impulsiveness, simple tasks, risk seeking, physical activity, self-centeredness, and temper were all positively correlated with deviance across all 7 deviance subscales. Risk seeking had the highest correlation with an average correlation of 0.320 across the 7 deviance subscales. Hierarchical regression was then used with each sub-factor of self-control entered in reverse order of correlation with deviance (age, sex, and country were entered first). Self control accounted for 18-24% of the variance in deviance across the 5 age groups (15-, 16-, 17-, 18-,19- year olds).Low self-control explains 10% of variance in theft, 12% in assault, 13% in alcohol use, 13% in drug use, 14% in school misbehavior, 15% in vandalism, and 16% in general deviance.

Table A16. The Effect of Education on Crime

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Fergusson, John Horwood and Ridder [2005]	Outcome(s): *crime* -- self reported criminal activity, self-reported arrests and convictions, and self-reported incarcerations Explanatory Variable(s): *IQ* -- Revised Wechsler Intelligence Scale for Chidren (WISC-R)	Data: Christchurch Health and Development (CHDS) study - 1,265 children in a birth cohort in New Zealand Methods: OLS	Controls: Conduct problems age 7-9, attentional problems age 7-9, anxiety/withdrawal score (age 7-9), socioeconomic disadvantage score, family instability score, parental adjustment problems score, child abuse score, and gender Timing: IQ test at age 8-9, crime outcomes from ages 17-25 Theory: Though some have found a relationship between IQ and crime, IQ is also linked to childhood behavioral and conduct problems which may explain the link.	IQ was measured in 5 categories ranging from <85 to >115, with 10 IQ point contained within each of the intervening categories. An increase from 1 category to the next is associated with -.28 self-reported offenses committed (p<0.001) and -0.23 self reported arrests/convictions. However, once covariates are added to the regression this relationship goes away almost completely, with a coefficient of 0.00(p=0.87) on self-reported offenses and -0.11(p=0.11) on arrests/convictions.
Lynam, Moffitt and Stouthamer-Loeber [1993]	Outcome(s): *Delinquency* -- self-reports, teacher and parental reports Explanatory Variable(s): *IQ* - Short form WISC-R	Data: 430 12- and 13-year old boys from the Pittsburgh Youth Survey (PYS) Methods: ANOVA, mean differences	Controls: Analysis separately by age and race, social class as a covariate, effort during test Timing of Measurements: Reports were contemporaneous with test and were about delinquency at age 12 and 13. Theory:	The authors find a significant main effect of delinquency on IQ (p<0.001). Adding in social class does not change the differences in mean IQ scores of delinquents and nondelinquents.

| Lochner and Moretti [2004] | Outcome(s): *Imprisonment* -- reported as institutionalized in the US census Crime (census) self-reported criminal acts (NLSY)

Explanatory Variable(s): *Education*--years of schooling | Data: 1960, 1970 and 1980 US Census Data on males age 20-60. National Longitudnal Survey of Youth (NLSY) 1979 cohort.

Methods: OLS, IV | Controls: **Census** - separate regressions for race, cohort birth effects, state of residents x year effects, age, year, state of birth, state of residence

NLSY - Age/cohort, area of residence, dummy for school enrollment, family background, AFQT score, SMSA status, local unemployment rate.

Timing of Measurements:

Theory: Education may have an important impact on criminal outcomes through several mechanisms: education increases wage which increases opportunity cost of crime, education may change non-cognitive skills which may in turn impact criminal activity. | **Census Data** - Using compulsory schooling laws as an instrument in a 2SLS estimate they find that one additional year of schooling reduces the probability of being in prison at the time of the census by 0.1 ($p<0.01$) percentage points for whites and 0.3-0.5 ($p<0.01$) percentage points for blacks (depending on controls included). OLS estimates were remarkably similar.

NLSY data - Self-reported crime participation is reduced by around 1-3 percentage points for each additional year of schooling for white males.. For black males the effect is not significant (the purport this to be due to underreporting of criminal activity by black males. |

Machin, Marie and Vujić [2010]	Outcome(s): *Crime* -- apprehended or charged for a crime; self-reports of crime *Imprisonment* -- individuals in a prison service establishment during the British Census Explanatory Variable(s): *Education*--years of schooling	Data: UK Census 2001; British Crime Survey (BCS) from 2001/2 to 2007/8. Offender Index Database aggregated and combined with education information from Labour Force Survey and wages from New Earnings Survey 1984-2002. Methods: OLS, IV	Controls: Age dummies, county of brith dummies, gender dummies, non-white dummy, marital status, dummy for never worked, current country of residence Timing of Measurements: Theory: Education may have an important impact on criminal outcomes through several mechanisms: education increases wage which increases opportunity cost of crime, education may change non-cognitive skills which may in turn impact criminal activity.	**Census Data** - From an OLS regression - individuals with no qualifications are four times more likely to be in prison at the time of the census as those with some qualifications ($p<0.01$). **BCS data** - From an OLS regression - Individuals with no qualifications report significantly more self-reported crimes than those with qualifications. **OID Cohort Data** - Using changes in compulsory schooling laws as an IV- these 2SLS results are larger in magnitude than the OLS results but cannot be rejected as significantly different from OLS.

Table A17. The Effect of Personality and Preferences on Other Outcomes

Author(s)	Main Variable(s)	Data and Methods	Causal Evidence	Main Result(s)
Jaeger, Dohmen, Falk et al. [2010]	Outcome(s): *migration* – whether a person ever moved between regions in German between 2000 and 2006 Explanatory Variable(s): *risk preference* – the response to a survey question about general willingness to take risks, measured on a 10-point scale	Data: German Socio-Economic Panel (SOEP); 10,115 people aged 18-65 living in Germany (2000-2006) Methods: probit	Controls: (1) none (2) age and sex (3) age, sex, marital status, education, and place of origin Timing of Measurements: The risk question was asked in 2004 and 2006. A comparison of people who moved before and after 2004 suggested that migration did not affect risk preference. Theory: Migration is associated with uncertainty, so risk-preference should partially determine the propensity to move.	A one standard deviation increase in willingness to take risks is associated with a (1) 1.7 (p<0.01), (2) 1.1 (p<0.01), (3) 0.7 (p<0.01) percentage point increase in the probability of migrating, depending on specification (see controls). The average unconditional propensity was 5.8 percent.
Lundberg [2010]	Outcome(s): *marital status* – ever married by age 35, whether the first marriage ended in a divorce Explanatory Variable(s): *personality* – survey measures of The Big Five	Data: German Socio-Economic Panel (SOEP); 7,106 household heads, spouses, and partners aged 35-59 in Germany (2005) Methods: probit, Cox proportional hazard model	Controls: (1)education, German ethnicity, and living in East Germany (2) controls in (1), trust, risk aversion, locus of control, positive and negative reciprocity Timing of Measurements: The measures are contemporaneous. Theory: People match both positively and negatively on personality traits depending on whether they reflect preferences or specialization in production. Matching based on specialization will change as the labor market evolves.	Born before 1960: Extraversion increases the probability of marriage for both men and women (p<0.05); conscientiousness increases the probability for men (p<0.05); neuroticism increases the probability for women (p<0.05, (1) only); and agreeableness increases the probability for women (p<0.05; (1) only) but decreases the probability for men (p<0.05). Born after 1960: Openness to experience has a negative effect on marriage probabilities for men (p<0.05;(1)) and (p<0.10,(2)) and women (p<0.05;(2)) and conscientiousness has a strong positive effect for men and women (p<0.05;(2)).

As an example of the findings in the literature, Table A18 shows that adolescent measures of personality (locus of control and self-esteem) are associated with a diverse set of meaningful outcomes.[59] The fourth column shows that personality measures have incremental validity beyond IQ for many outcomes. As is the case in the literature as a whole, the associations vary in strength across outcomes. In this section we explore the evidence on the link between personality measures and meaningful later life outcomes, discussing separately education, labor market success, health, and crime. The review is not comprehensive, but the selected studies highlight the trends in the literature and explore a range of methods used. Tables A9 – A17 supplement the discussion in the text and provide more details about the literature.

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[59] Tables A4 and A5 present correlations of the outcomes with the Big Five.

Table A18. Correlations, Partial Correlations, and Explained Variance of IQ and Personality with Later-life Outcomes

Outcome/Variables Included	Correlations and Partial Correlations			Explained Variance (R^2)		
		Locus of Control/			Locus of Control/	
	IQ	Self-Esteem	All	IQ	Self-Esteem	All
High School Diploma	0.037***		0.017	0.001	0.005	0.005
		0.049***	0.045***			
		0.044***	0.039***			
Highest Grade Completed	0.390***		0.358***	0.151	0.042	0.165
		0.013	-0.049***			
		0.199***	0.118***			
12th Grade GPA	0.486***		0.464***	0.236	0.035	0.242
		0.018	-0.065***			
		0.180***	0.075***			
Hourly Wage at 35	0.198***		0.179***	0.039	0.001	0.041
		0.063***	0.033**			
		0.058***	0.013			
Weeks Unemployed at 35	-0.137***		-0.137***	0.019	0.002	0.021
		0.023*	0.046***			
		-0.043***	-0.009			
Any Welfare at 35	-0.235***		-0.211***	0.055	0.014	0.058
		-0.038***	-0.003			
		-0.103***	-0.051***			
Depression at 40	-0.097***		-0.070***	0.009	0.011	0.016
		-0.024*	-0.012			
		-0.098***	-0.079***			
Physical Health at 40	-0.040***	-0.143***	-0.019	0.002	0.020	0.021
		0.024*	-0.138***			
			0.027**			
Mental Health at 40	0.023*		0.007	0.001	0.004	0.004
		0.056***	0.054***			
		0.021	0.019			

Note: The first column shows the later life outcome. The second column shows the correlation of the outcome with IQ. The third column shows the partial correlations of the outcome with locus of control (Rotter) and self-esteem (Rosenberg) entered jointly. The fourth column shows the partial correlation with IQ, self-esteem, and locus of control entered jointly. The fifth, sixth, and seventh columns show R^2 for the models associated with the second, third, and fourth columns, respectively. IQ is a percentile score obtained by equating IQ across different IQ tests from NLSY79 transcript data following the procedure in Borghans, Golsteyn, Heckman et al. [2010]. The sample excludes military personnel.
*statistically significant at the10 percent level; **statistically significant at the 5 percent level; ***statistically significant at the 1 percent level
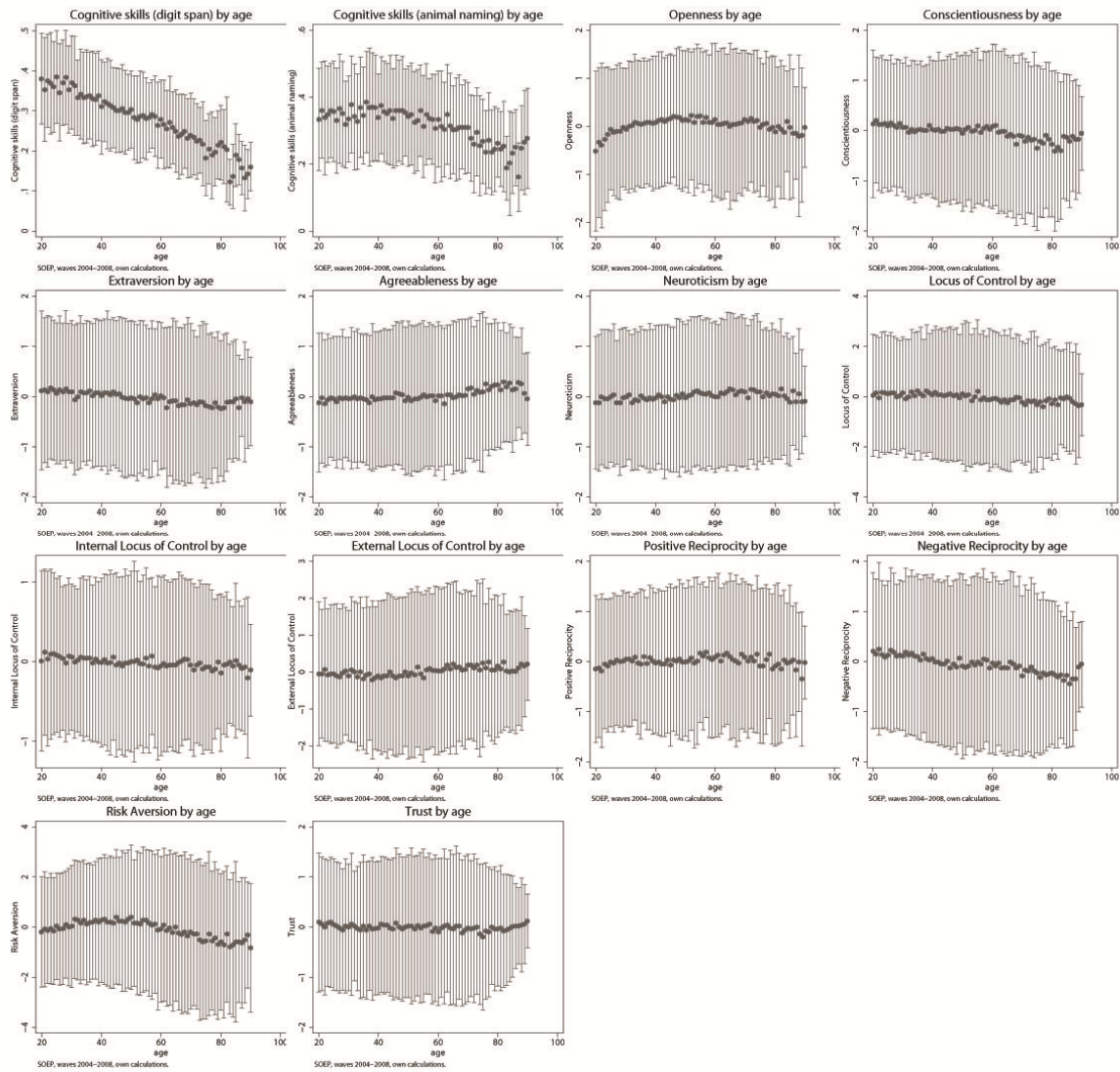Source: Authors own calculations using the NLSY79.

A8. **Stability and Change in Personality Traits and Preference**

Section Contents

Figure A3. Cognitive Ability, Personality and Preferences by Age (GSOEP)

Note: The table displays means of traits by age in a cross-sectional data set. The bars represent standard errors. Source: GSOEP, waves 2004-2008, own calculations.

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