GENETICS

AND ECONOMIC MOBILITY

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KEY FINDINGS:

• The literature suggests that genetics play a role in intergenerational mobility; however, it is unclear how environmental factors moderate the effects of genetics.

• While evidence suggests a strong genetic link to cognitive skills, these skills appear to explain only a small share of the intergenerational correlation of income.

• Studies document that a large portion of medical conditions have an underlying genetic component, implying that the inheritance of conditions that limit work may reduce intergenerational mobility.

• Some evidence suggests a link between genetics and antisocial behaviors that reduce individuals' academic and labor market successes and economic mobility.

One of the ways that economic status could be transmitted from one generation to the next is if parents pass on to their children the genetic endowments that help them to attain their economic position. Studies comparing siblings with different degrees of genetic similarity and adopted children to biological ones, find that genetics play a substantial role in intergenerational economic mobility. A range of traits—from physical appearance to cognitive skill—are potential targets for this type of genetic transmission. It is important to note, however, that although genes may predispose individuals to certain behaviors, environmental factors can amplify or counteract those influences.

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Jencks and Tach (2006)[1] summarize how parents' and children's economic status could be correlated via genetics: "If genetic variation affects any of the traits that labor markets reward, then genetic variation will affect economic success. If the labor market still rewards the same traits a generation later and genes still affect these traits, then biological children of a successful parent will still tend to have traits that the labor market rewards, even if the children have no social contact with this parent."(p. 33)

A range of traits may be transmitted this way—including **cognitive skills** and personality traits. **Health** and **mental health** have genetic components and could be linked to differences in economic outcomes. Additionally, some physical traits serve as good predictors of income. For example, one study finds wage differentials between individuals judged to be 'below average' and 'above average' in appearance of 14 percent for men and 9 percent for women, after controlling for other factors including health and occupation (Bowles et al. 2001, citing Hamermesh and Biddle 1994). Another study finds that among males, height as a teenager helps predict adult wages (Persico et al. 2004). (See also discussion of **nutrition and obesity** in Kronstadt Health and Economic Mobility review.) Because of the genetic components of these traits, it is possible that a portion of the intergenerational transmission of status could be mediated by these physical characteristics. In almost all cases, these cognitive and noncognitive characteristics are influenced by multiple genes, so the genetic inheritance process is a complex one.

As summarized in the table below, the Role of Genetics in Intergenerational Mobility, there is some evidence (mostly based on international data) that genetics contribute to intergenerational persistence.

Estimates of the Role of Genetics in Intergenerational Mobility	
Study	***Methods and Key Estimates***
Jencks and Tach 2006	Extrapolates from twin and adoption data in Sweden and the United States. ○ About two-fifths of the intergenerational correlation of adult earnings is accounted for by genetic similarities.
Bowles and Gintis 2001	Extrapolates from twin correlations from Ashenfelter and Krueger (1994). ○ Genetics and environment each contribute 0.2 to the intergenerational correlation of earnings (for a total of 0.4). ○ Genetics and environment each contribute 0.14 and assets contribute 0.18 to the intergenerational correlation of income (for a total of 0.46).
Björklund et al. 2005	Compares different types of siblings in Sweden (identical and fraternal twins and singletons). ○ Most conservative estimates suggest that genetics account for 20 percent of earnings inequality for men and more than 10 percent for women.
Björklund et al. 2006	Reviews Swedish adoption data. ○ For the transmission of education from mothers to children, genetics and prenatal conditions contribute more than environment. ○ For the transmission of long-run earnings and income from father to child, environment plays a larger role than genetics. ○ Prenatal conditions play a small role in the intergenerational transmission of status from mother to child.
Björklund et al.	Also uses Swedish adoption data. Compares six different family

[1] The authors are paraphrasing an argument laid out by Herrnstein (1971).

2007	circumstances: raised by both biological parents, raised by the biological mother without a stepfather, raised by the biological mother with a stepfather, raised by the biological father without a stepmother, raised by the biological father with a stepmother, and raised by two adoptive parents. Finds substantial role for both pre- and post-birth factors on socioeconomic status.

Because **education** plays an important role in the intergenerational transmission of status, several studies focus on determining how genetics affect the passing on of educational behavior from parent to child. One study finds that a child adopted by a mother with a high level of education is likely to attend school longer (Sacerdote 2007). However, the effect of maternal education for adoptees is only about a quarter of that for biological children. This suggests that a substantial portion of this transmission is likely to be genetic. Another study finds that when accounting for the tendency for highly educated mothers to marry people with similar education—known as **assortative mating**—maternal education no longer has a statistically significant effect on an adopted child's educational outcomes beyond the impact of the father's education (Plug 2004).

It is important to note that most of these estimates of genetics take a broad view and include both the direct effects of genetics and the effects that genes have indirectly by moderating their environment. As Jencks and Tach (2006 p. 34) put it "our genes affect both the way others treat us and the choices we make for ourselves." Therefore, the authors point out, just because they estimate that genetics accounts for two-fifths of the *intergenerational correlation*, it does not mean that the impact of environment is limited to only the remaining three-fifths. A portion of the two-fifths attributed to genetics may actually reflect the different environments people with different genes experience. (Read more about how **estimates of hereditability** are obtained and the implications of those estimates on our understanding of environmental roles.) The case of **antisocial** behavior illustrates the ways in which genetics and **childrearing** can contribute jointly to the passing on of some behaviors.

Furthermore, in almost all cases, genetics increase the probabilities of particular health or behavioral outcomes, they do not determine them. Genetic predispositions often must interact with particular environmental stresses to produce poor outcomes. It is possible for genetic persistence of status to be reinforced if some children are both more likely to experience adverse environments and to have genes that are more susceptible to those environments. Also, some have found that richer parents are better able to moderate the adverse effects of potentially harmful genes and to help enhance more positive genes (d'Addio 2007, citing Turkheimer et al. 2003).

A related point is that a characteristic may have high heritability and still be altered. For example, poor eyesight can be compensated for by eyeglasses. As understanding of the genetic components of both health and other conditions increases, it is possible that researchers will develop treatments that would help alleviate the adverse effects of a greater number of conditions. Harding et al. (2000, p. 136) speculate that this could "somewhat reduce the economic impact of genetic resemblance between parents and children. In due course it may also become easier to control children's actual genetic endowment." Technology currently exists that allows prospective parents to either screen fetuses prenatally for certain conditions or to use in vitro fertilization to only implant zygotes that have been screened for those conditions. It is conceivable that these technologies will increasingly allow parents to select the genetic predispositions they want or do not want their children to possess. (See Robertson 2003 for discussion of this and other possibilities as genetic knowledge increases.) This could serve to reinforce intergenerational socioeconomic transmission if wealthier parents are in a better position to take advantage of these technologies. Currently, some suggest that because of financial and geographic barriers, genetic services are not equally accessible to all (Guttmacher et al. 2001).

COGNITIVE SKILLS

Cognitive skills could contribute to the intergenerational transmission of socioeconomic status if (a) cognitive ability contributes to earnings, either directly or through greater education; and (b) cognitive skills are passed down from one generation to the next. Not only does evidence suggest a strong genetic component to cognitive skill, some researchers speculate that families of higher socioeconomic status may be better able to help their children accomplish their cognitive potential. Despite this, a relatively small portion of the *intergenerational correlation* of income appears to be explained by cognitive skills.

Cognitive ability has a modest influence on socioeconomic status. In a meta-analysis of 65 estimates of the impact of cognitive test scores on earnings in the United States, Bowles et al. (2005) suggest that a standard deviation change in cognitive test score changes the natural logarithm of earnings by approximately one-seventh of a standard deviation, independent of the effect of years of schooling (normalized regression coefficient of 0.15). This effect is somewhat smaller than the independent effect of education (normalized regression coefficient of 0.22).[2] The authors further estimate that because cognitive ability helps explain the number of years of education individuals receive, the total of the direct and indirect effects of IQ on earnings could be more like 0.27—a one standard deviation increase in test scores is associated with more than a quarter of a standard deviation increase in earnings. Cognitive scores have also been shown to affect occupational status (Jencks et al. 1979).

The cognitive abilities of children and parents are highly associated. One analysis of more than 200 studies found average correlations in IQ of 0.5 between both parents and their biological children, and 0.4 between single parents and their children (D'addio 2007, citing Daniels et al. 1997). There is also a strong genetic component to IQ. In a recent meta-analysis, Devlin et al. (1997) suggest that the broad-sense heritability, which includes both the direct genetic transmission and the additional effects which occur when a genetic predisposition interacts with the environment, may be around 48 percent, and the narrow-sense heritability 34 percent.[3] This estimate is much lower than earlier estimates. In 1970, researchers thought that genetics could account for 80 percent of the variation in IQ, but more sophisticated analyses since then shift the estimate down. (See Goldberger 1979 for overview of the history of estimates.)

Even though a large portion of IQ is inherited via genetics, it is possible that the environment can influence an individual's cognitive abilities. For example, increased levels of simulation in the home environment have been correlated with higher cognitive scores. (Read more in the discussion of the impacts of **childrearing**.) Additionally, experimental studies that have evaluated the impacts of high-quality early childhood interventions have shown some increases in IQ, although those fade over time (Heckman and Masterov 2007).[4]

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[2] Some suggest that estimates of the impact of cognitive skills on earnings are overstated, because they are based on test scores which not only measure cognitive ability but also performance on the test itself. Therefore, test scores may also capture factors such as ability to follow test directions and work ethic—skills that may, themselves, affect earnings (Bowles and Gintis 2001).

[3] The authors explain that their estimates are lower than past ones, in part because they find that the environments siblings share in their mother's womb contribute to similarity in IQ. Other studies assume that there are no effects of prenatal environment and consequently overstate the impact of genetic transmission.

[4] Interpreting these temporary increases in IQ is complicated by the fact that some researchers suggest that the genetic transmission of cognitive skills becomes more pronounced as children age (Bouchard et al. 1990, Plomin et al. 1997). This suggests that environmental factors may be better able to alter the rate of acquisition of cognitive skills rather than adult cognitive ability. On the other hand, Devlin et al. (1997) do not find support for the notion that age alters the heritability of IQ.

In general, **estimations of heritability** are unable to make definitive statements about the role that the environment can play. Jencks and Tach (2006) illustrate this point with an example about how a child who has difficulty in math classes at an early age, in part because of a genetic predisposition, may take fewer math classes than a child who excels early on. In this way, differences in innate skill will be exacerbated.

Researchers suggest a link between a child's socioeconomic status and his IQ (Brooks-Gunn et al. 1997). These links may not be limited to genetics. Adoption studies find that the correlation between a child's IQ and her adoptive parents' socioeconomic status is only modestly smaller than the links between children and their biological parents' status (Shonkoff and Phillips 2000).[5] Another study finds that among children adopted between the ages of 4 and 6 with very low IQ scores prior to adoption, those adopted by higher socioeconomic status experience greater gains in cognitive ability than those adopted by less well-off families (Shonkoff and Phillips 2000, citing Duyme et al. 1999). Others suggest that individuals with low socioeconomic backgrounds may have more difficulty realizing their cognitive potential given a particular genetic endowment (Duncan et al. 2005, citing Guo and Stearns 1999). Thus, it is possible that the environment can reinforce the effects of genetics in transmitting cognitive ability.

Although the above discussion explains pathways through which cognitive skills may be a mechanisms for transmitting status from one generation to the next, researchers find that it only plays a rather modest role in that transmission. Unless some elements of cognitive skills that are heritable but not well captured by IQ and other cognitive tests, Bowles and Gintis (2001) suggest that IQ may account for only one twentieth of the observed intergenerational transmission of status.

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[5] See discussion of potential limitation of **adoption studies**.

GENETIC TRANSMISSION OF HEALTH

To the extent that **health** plays a causal role in affecting economic status, the transmission of health from parent to child through genetics could explain some portion of the intergenerational persistence of socioeconomic status. As the scientific community gains a better understanding of the human genome, it has become clear that a large portion of medical conditions have an underlying genetic component. For example, one study that examined nearly all patients at a children's hospital in Ohio during 1996 finds that 71 percent of admitted pediatric patients had an underlying disorder with a significant genetic component (McCandless et al. 2004).

With few exceptions, genetic mutations elevate the likelihood that an individual will have a condition. Penetrance is the measure used to describe the proportion of individuals who have the gene composition (genotype) who end up with the condition (phenotype). Some conditions, including hemophilia and Huntington disease, are nearly a 100 percent penetrant, meaning that if individuals have the genetic mutation they will have the condition. In addition to penetrance, the prevalence of a genetic mutation—or the frequency with which it shows up in the population—is also an important factor in understanding the genetic component of that disease's burden on society. Some mutations can have high penetrance, but relatively low prevalence. For example, mutations in two genes known as BRCA 1 and 2 are associated with lifetime breast cancer risks for women that range from around 40 percent to more than 85 percent (Petrucelli et al. 2007), compared to a general population risk of around 13 percent (Ries et al. 2006). However, because relatively few people carry these mutations, the majority of breast cancer cases are not considered hereditary. In one study, only a little more than 5 percent of breast cancer patients carried one of these mutations (Malone et al. 2006).[6]

In addition to cancers, researchers are continuing to discover genetic mutations that may help to explain why relatives of individuals with chronic conditions including asthma, cardiovascular disease, and diabetes are more likely to have those same conditions (World Health Organization 2008).

Because most conditions are not 100 percent penetrant, it is sometimes possible to make environmental changes to reduce the risk, for example, by changing one's diet. However, not everyone has equal access to **medical care and health insurance** leading to differences in early screenings and preventive treatments. High status families may have an advantage if they can alleviate adverse health consequences of genetic predispositions. Economic mobility may also be implicated if some individuals have more exposure to environmental stresses and a genetic predisposition to the negative effects. The field of toxicogenomics studies the genetic compositions that may make people more susceptible to pollutants and other toxins. Some research suggests, for example, that poorer children may both be more likely to be exposed to air pollution and more likely to develop **asthma** as a result.

[6] A somewhat higher percentage of breast cancer cases are likely to be hereditary due to mutations in other genes, some of which have yet to be discovered.

GENETIC TRANSMISSION OF MENTAL HEALTH

The literature shows that **mental illness** is related to **socioeconomic status**. Since evidence suggests that mental health can both be influenced by and influence educational and labor market performance, it may play a role in understanding economic mobility. Many mental conditions also have a large genetic component.

In their review of the literature, Rutter et al. (1999) find evidence of a strong genetic role in transmitting bipolar disorder (heritability estimated at approximately 80 percent), autism (heritability estimated to be as high as 90 percent) and hyperactivity (heritability estimates range from 54 to 98 percent).

Rutter et al. (1999) also find that schizophrenia has a substantial genetic component, with estimates of heritability often at 75 percent or above. Others note that dysfunctional family patterns may contribute to the development of the condition. For example, a study of adopted children finds that children with a genetic predisposition to schizophrenia are more likely to exhibit psychiatric problems if they are raised in dysfunctional adoptive families (Maccoby 2000, citing Tienari et al. 1994). Austin and Homer (2004) show that immigration is a risk factor for schizophrenia.

The genetic component of unipolar depression is more modest, with estimates typically around 20 to 45 percent (Rutter et al. 1999). The authors find support for the theory that genes may make individuals more sensitive to environmental stressors. They also note that children of depressed parents have an elevated risk for anxiety disorders, and drug or alcohol dependence, in addition to depression. Additionally, parental depression is associated with poorer **parent-child interactions**, greater family discord and marital break-up, and other forms of social disadvantage for the child.

HOW HERITABILITY IS ESTIMATED AND WHAT IT TELLS US ABOUT ENVIRONMENTAL EFFECTS

Heritability (h^2) is the statistic that researchers use to capture the degree to which a trait is passed on from parent to child. It measures the percentage of the variability in phenotype—observable characteristics in the population—that is accounted for by variation in genotype—genetic composition (Shonkoff and Phillips 2000). These numbers are often derived by looking at the ways the resemblance between parent and child differs among identical (monozygotic or MZ) twins, fraternal (dyzgotic or DZ) twins, and other siblings; or between adopted and nonadopted children. **(See box below on the Potential Limitations of Adoption and Twin Studies for a brief discussion of these methodologies.)**

Population geneticists[7] often assume that the effects of genes and environment are additive. They suggest that the proportion of the resemblance between parents and offspring not accounted for by genetic variation is the proportion of that resemblance explained by environmental variation. (In other words, the percentage of the variation that is attributed to the environment is 100 percent minus the percentage attributed to genetics.) This captures only the part of the environment that cannot be traced to genetic inheritance in any way.

Population geneticists further break down the environmental share of the variance into the shared and unshared environment. They estimate shared environment by looking at similarities among siblings. Any variation that is still unaccounted for after estimating the genetic and shared environment components is considered to be part of the unshared environment or measurement error. Many population geneticists have argued that the nonshared environment has a larger effect than the shared environment. (See Maccoby 2000 for an overview.)

Maccoby (2000) summarizes the conclusions of some researchers (Rowe 2004 and Harris 1998) who have used these types of methodologies to suggest that the effects of **childrearing** have been greatly exaggerated. They argue that studies that have found correlations between parenting styles and children's behavior make a faulty assumption that the parenting causes the child's behavior and suggest, based on the small magnitude of the estimates of the shared environment, that children's peers may have a greater influence.

Maccoby responds that in recent years better methods can now capture the impact of **childrearing** on child development. Additionally, the fact that shared environment estimates are low does not necessarily mean that the home environment is not important, because nonshared environment includes cases in which the same event or parental trait affects two siblings differently. Similarly, if the same parent treats two children differently, it is considered a reflection of non-shared environment. Consequently, a small shared environment estimate cannot rule out a prominent role for childrearing.[8]

Perhaps the most important criticism to the standard population genetics approach is the additive assumption, which implies that if the measure of heritability is large then environment must play

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[7] Population geneticists, also referred to as behavior or quantitative geneticists, rely on statistical methods studying data from twins, adoptions, and the population as a whole to understand genetic transmission, rather than studying genes on a molecular level.

[8] Heritability estimates can also be misleading because it is possible for a broad change to improve childrearing across a sample while maintaining the same rank order among individuals. For example, if every child's IQ was improved by five points, the correlations would still remain the same. This could mask the positive impact of an environmental change (Maccoby 2000).

only a modest role. Even if particular outcomes can be traced backed to genes, it is possible that genes play a role by influencing a child's environment. Jencks (1980) stresses the importance of identifying the proximate cause for an outcome, rather than simply assuming that if genetics plays a role it must be some type of physical process. Because of the dynamic role that genetics play in shaping environments, Jencks argues that measurements of the heritability do not set a limit on the role that environment can play.

Maccoby (2000) also points out that parents naturally react differently to children with different genetic temperaments. Although it makes sense to attribute the child's role in this evocative correlation to the child, she argues that the parent's response should be counted as part of the environment. To assign the whole dynamic to the genes would overstate their role. In addition to these gene-environment correlations, gene-environment interactions in which genetic predispositions alter people's responses to the environment, are also incompatible with the additive assumption.

For these reasons it is important to understand that even if a particular trait is considered to be transmitted from one generation to the next primarily through genetics, it is still possible that the genetic effect will operate through the environment or that the genetics will make individuals respond differently to the stimulus. In either case, environment plays an important role.

Potential Limitations of Adoption and Twin Studies

Researchers who use samples of twins or adopted children often make several assumptions that can cause them to overstate the role of genetics in transmitting traits from parent to child.

Adoption studies typically assume that there is no systematic similarity between adoptive parents and biological parents. In cases in which relatives adopt children this assumption is clearly violated. It is also likely violated if a parent adopts the child of a spouse after remarriage, because people typically marry individuals who resemble them—a phenomenon known as **assortative mating**. Some evidence suggests that adoption agencies may engage in selective placement, in which children are placed in adoptive homes that are similar to the homes of their biological parents (Plug 2004). A further problem with adoption studies is that typically parents are screened carefully before they are allowed to adopt and as a result they tend to be of higher socioeconomic status than parents as a whole. Therefore, adoption studies focus on a population that has less environmental variance than the population as a whole (Goldberger 1979). This can also make it difficult to generalize heritability estimates to family situations that are in the lower extremes of socioeconomic status or are abusive.

Twin studies also rely on the assumption that parents do not engage in assortative mating. Furthermore, they assume that the similarity in the environment for identical twins is the same as the similarity in the environment for fraternal twins, even though it is possible that parents treat identical twins more similarly. If these assumptions are relaxed, estimates of heritability are lower (Bowles et al. 2005). Perhaps because of these assumptions, estimates of the heritability of earnings that are derived using twin studies tend to be larger than those using adoptions (Jencks and Tach 2006).

Either method may fail to separate out the effect of prenatal environment from the effect of genetics—a factor that Devlin et al. (1997) say is largely responsible for overly stated estimates of the genetic component of IQ.

GENETIC AND ENVIRONMENTAL IMPACTS ON ANTISOCIAL BEHAVIOR

Antisocial behavior demonstrates many of the ways in which genetics, environment, and the intersection of the two can contribute to the transmission of traits from parents to children. Because antisocial behavior, particularly in the form of criminality, can have an impact on an individuals' academic and labor market successes, it is possible that it can drive intergenerational transmission of economic status in some cases.

Evidence suggests that antisocial behavior is often found in multiple members of the same family. For example, one study found that inner-city London boys whose parents demonstrated delinquency or criminality were three to four times as likely to show similar problems (Rutter et al. 1999, Case and Katz 1991). There is also evidence of a large amount of **assortative mating** along this trait, with one study finding that antisocial individuals are nine times as likely to marry someone who is antisocial than are individuals who are not antisocial (Rutter et al. 1999, citing Farrington et al. 1996).

Rutter et al. (1999) note that the transmission of antisocial behavior may occur through the following mechanisms:

- Passive gene-environment correlations. Antisocial parents may be more likely to create environments that influence their children to adopt similar behaviors. Research suggests that exposure to physical abuse, hostile or inconsistent parenting, and single-parent homes predict conduct problems (McLanahan 1997, Shonkoff and Phillips 2000). (Read more about **childrearing** and **family structure in Kronstadt and Favreault on Families and Economic Mobility**.) One study finds that an intervention that reduced parents' coercive behavior reduced antisocial behavior among aggressive children (Maccoby 2000, citing Dishion et al. 1992).

- Evocative and active gene-environment correlations. Antisocial children may act in ways that prompt their parents to engage in more negative childrearing behavior. Several studies find that adoptive parents treat antisocial children more harshly and with less nurturing apparently in response to the child's genetic predisposition for antisocial behavior. (See Maccoby 2000 and Shonkoff and Phillips 2000 for overview.) Rutter et al. (1999) also note that when antisocial children grow up they may be more likely to experience marital discord, fight with others, or experience unemployment.

- Gene-environment interactions. Some children may have genetic predispositions to be more sensitive to environmental risks. A study of adopted children in Scandinavia finds that children with neither genetic risk (biological parents who show signs of criminality) nor environmental risk (adoptive parents who show signs of criminality or alcoholism or exhibit adverse childrearing behavior) have a 3 percent rate of criminality in adulthood. Children with either a genetic or an environmental risk have a 6 to 12 percent criminality rate. By contrast, children who experience both have a 40 percent rate of criminality (Shonkoff and Phillips 2000 citing Bohman 1996). Similarly, some research identifies an alteration in a particular gene that, when combined with maltreatment as a child, significantly increases the risk of antisocial behavior among grown men (Caspi et al. 2002).

Antisocial behavior may influence socioeconomic status in several ways. For one, aggression has been linked to lower levels of academic competence and less schooling (Cairns et al. 1998). Jencks and Tach (2006) also note that incarceration leads to lower future earnings and therefore it may help to explain some of the intergenerational correlation of income. However the authors did not find studies that estimated this effect.

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