TITLE: The Genetics of Success: How SNPs associated with educational attainment relate to life course development

A research team led by Dan Belsky, Avshalom Caspi, and Terrie Moffitt at Duke University reports that a genetic signature previously discovered in a genome-wide association study of educational attainment predicts children's social and economic success all the way into midlife. The genetic score also predicts children's upward social mobility, high scorers tended to achieve more prestigious and high-paying occupations than their parents had. The genetic score influenced successful life outcomes by bringing the participants increased intelligence, better self-control, and better interpersonal skill, beginning from the time they were very young children.

PUBLICATION SOURCE: Psychological Science, Published online June 1, 2016.

FINDINGS:

(1) Genetic discoveries for educational attainment are not related to education only. The same genetics predict socioeconomic success long after the completion of schooling.

(2) Genetic discoveries were associated with upward social mobility — children with higher polygenic scores tended to achieve more socioeconomic success even if they were born poor.

(3) Psychological characteristics that accounted for genetic associations with life outcomes included intelligence, but also self-control and interpersonal skills, for example being friendly and outgoing.

(4) The pattern of characteristics and behaviors that connects DNA sequence with life outcomes begins early in life and extends through adulthood. Kids with higher polygenic scores started talking and reading earlier, and they had higher IQ scores, more self-control, and were more skilled interpersonally. As they grew into adolescence and adulthood, they were more ambitious, more willing to move away from home in search of opportunity, able to attract a better-educated and higher-earning spouse, and better at managing their money.

WHY ARE THESE FINDINGS IMPORTANT:

- Genetic discoveries for educational attainment offer clues to the traits and behaviors that produce success across life. The genetics we studied affected our Study members' life choices ranging from whether they moved abroad, to who they partnered with, to how they managed their finances. However, we caution that the degree of genetic influence was small; genes do not provide a formula foolproof enough to make predictions about individual children.
- Genetic discoveries can provide clues to effective intervention targets. For example, we found that children who carried more of the education-associated alleles started talking and reading earlier than their peers, which lends support to efforts to help children acquire language at younger ages. Such efforts could benefit all children, regardless of their genetic background.
- Although existing genetic knowledge is not sufficient for so-called "precision" education, findings suggest such a thing may one day be possible. Policy makers and the public need to engage in an open dialogue to ensure research serves the public interest.

SUPPORTING DETAILS:

PARTICIPANTS: Participants were members of the Dunedin Multidisciplinary Health and Development Study, which tracks the development of a birth cohort of 1,037 children born in 1972-1973 in Dunedin, New Zealand. This birth cohort's families represented the full range of socioeconomic status in the general population. Follow-ups have been carried out at ages 3, 5, 7, 9, 11, 13, 15, 18, 21, 26, 32, and most recently at age 38 years, when 95% of the living cohort members took part. We examined 918 cohort members for whom genetic information was available. Dan put this first bec the rest doesn't make sense unless you first know this was a longitudinal study.

The Genetics of Success – Polygenic Scoring. We took a measurement of the genomes of our Study members using a technique called "polygenic scoring." Polygenic scores combine information from large numbers of genetic variants all across the genome to measure a continuum of genetic influence. We based the polygenic score on a recent genome-wide association study of educational attainment published by the Social Science Genetic Association Consortium (SSGAC).

Measuring Success. We measured Dunedin Study members' socioeconomic success at midlife from several data sources. We used electronic record searches to gather information about their credit scores and their use of social welfare benefits. We used New Zealand Census data to evaluate how prestigious their occupations were. We interviewed the Study members themselves about their income and assets, and about their financial problems.

Measuring Pathways to Success. We tracked Study members' development from birth through midlife using a range of data sources including reports made by their mothers when they were children, direct behavioral observations, reading and standardized testing during the school years, life history calendars tracking where they lived, informant reports, and interviews. A table summarizing measurements is included on the next page.

Genetic Influences on Social Mobility. The children in our study who were born with higher polygenic scores tended to be upwardly socially mobile. We compared the social and economic attainments of our Study members when they were 38 years old with the SES of their parents when the Study members were children. Study members with higher polygenic scores tended to move up in life, even when they were born poor.

Genetic Influences on Early Childhood Development. The genetics we studied were specifically related to children's intellectual and social development, but not to their physical development or health. Children with higher polygenic scores talked and used sentences earlier than their peers. But they didn't walk or potty train any sooner. They scored higher on tests of IQ and assessments of self-control and interpersonal skill (e.g. they were more cooperative), but they weren't any healthier based on measures of lung function, body fat, blood pressure, and balance and motor coordination.

MEDIA CONTACT: Dan Belsky, *Center for the Study of Aging and Human Development, Department of Medicine, Duke University School of Medicine, Duke University Social Science Research Institute.*
dbelsky@duke.edu (t) 919-613-4534 (m) 919-357-8200

UNIVERSITIES INVOLVED: Duke University, Durham, NC, USA; University of Otago, Dunedin, NZ; Institute of Psychiatry, Kings College London, UK; Stanford University, CA, USA.

MAIN FUNDING SOURCES: The research was supported by the US National Institute on Aging (NIH AG032282; AG048895; T32 AG000029; P30 AG028716-08), the UK Medical Research Council (MRC MR/K00381X), and the New Zealand Health Research Council and Ministry of Business, Innovation, and Employment, which supports the Dunedin Multidisciplinary Health and Development Research Unit. Dan Belsky is a Fellow of the Jacobs Foundation.

Table 1. Tracking the Development of Socioeconomic Success

Phenotype	Measure or data source	Age
Success in schooling		
Highest degree	Structured interview	15–38
Success beyond schooling		
Adult-attainment factor	Occupation (prestige score based on NZ Census data), income, assets, credit-problems scale, difficulty-paying-expenses scale, days of social-welfare-benefit use (NZ Social Welfare Administration), credit score (Veda credit bureau)	38
Social mobility	Childhood social class based on parental occupation; adult attainment measured using education, occupation, and the adult-attainment factor	Birth–15, 38
Pathways to success		
Developmental milestones	Interviews with mothers	3
Reading ability	Burt Word Reading Test (Scottish Council for Research in Education, 1976)	7–18
Aspirations	Questionnaire	15
Standardized testing	NZ Ministry of Education test record	18
Geographic mobility	Life-history calendar interview	21–38
Financial planfulness	Structured interview and informant reports	32–38
Mate selection	Structured interview in which Dunedin Study members reported their relationship status and, for those in a serious relationship, their partners' highest educational degree and income	38
Skills and abilities		
Cognitive ability	Peabody Picture Vocabulary Test (Dunn, 1965), Stanford-Binet Intelligence Scale (Terman & Merrill, 1960), Wechsler Intelligence Scales for Children–Revised (Wechsler, 1974)	3–13
Self-control skills	Staff observations, parent and teacher reports, and interviews with Dunedin Study members	3–11
Interpersonal skill	Staff observations	3–9
Physical health	Medical exams, anthropometry, lung function testing, clinical interviews with parents	3–11

Note: NZ = New Zealand.