

10 August 2021

Dear Editors,

I write to submit a manuscript, "Human capital mediates natural selection in contemporary humans", to Nature Human Behaviour. My coauthor is Abdel Abdellaoui. We have blinded the manuscript. Our contact details are:

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- Abdel Abdellaoui, Department of Psychiatry, Amsterdam UMC, University of Amsterdam; [a.abdellaoui@amsterdamumc.nl](mailto:a.abdellaoui@amsterdamumc.nl)

This paper examines natural selection in contemporary humans. A small set of papers have found evidence for contemporary natural selection (e.g. Beauchamp 2016). However, as yet there is no satisfactory theory for the phenomenon. Our contribution is to remedy that, as follows.

- We examine natural selection on 33 polygenic scores – summary measures of DNA which predict heritable phenotypes, such as educational attainment, disease risk, or personality traits – in a sample of about 370,000 UK adults over the age of 45. We measure natural selection by correlating each score with completed fertility (number of children born). We also look at the previous generation, by correlating each polygenic score with respondents' number of siblings.
- Consistently over generations, we find that polygenic scores associated with lower earnings, education and health are selected for, while scores associated with higher earnings, education and health are selected against. Natural selection is concentrated among lower SES groups, younger parents, people with more lifetime sexual partners, and people not living with a partner. Within some subgroups, the direction of selection is actually reversed, so that higher earnings etc. are selected for.
- To explain these patterns, we use the economic theory of fertility, first developed by Becker (1960). This predicts that earnings-increasing human capital, like skills and education, has two opposing effects on fertility. By allowing individuals to afford more children, human capital increases fertility (an "income effect"). By making time out of the labour market more costly, it lowers fertility (a "substitution effect").
- We develop a simple economic model to explain the empirical patterns described above. We test the theory by showing that realized education mediates part of the relationship between polygenic scores and fertility.
- We discuss the implications of our results. Estimated effects of natural selection on population means are small, but they get larger when we correct for sampling bias (UK Biobank oversamples high-income and highly educated people), and may also increase as polygenic scores become more accurate. Because effects are stronger in low-SES subgroups, natural selection also increases genetic inequality. For instance, differences in polygenic scores for

educational attainment between the lowest and highest income groups are increased by about 11% in a single generation. These increases can exacerbate “double disadvantages”, where people with lower income suffer both genetic and environmental disadvantages in education and health.

- To conclude, we argue that geneticists and economists studying fertility can learn from each other. Any model of fertility is implicitly a model of natural selection, but so far, the economic and human genetics literatures have developed in parallel. Putting them together can deepen our understanding of the mechanisms behind natural selection and human capital formation in contemporary societies.

To sum up, we estimate natural selection on a wider range of polygenic scores and a longer timescale than previous work; we find surprising regularities in the data; and we provide a new theory to explain modern natural selection.

About our suggested reviewers:

- Jonathan Beauchamp wrote the major paper on contemporary natural selection on educational attainment. He is an economist with interests in genetics.
- David Laibson is a senior economist with serious interests in genetics.
- Augustine Kong is first author of another paper on contemporary natural selection.
- Aysu Okbay has published several important papers in human genomics. She’s also an economist.

Jonathan Beauchamp, David Laibson and Aysu Okbay would all be helpful in reviewing the economic model as well as the empirics. Other possibilities might be Dan Benjamin or David Cesarini.

Here are our acknowledgements, and other information removed for double-blinding:

AA is supported by the Foundation Volksbond Rotterdam and by ZonMw grant 849200011 from The Netherlands Organisation for Health Research and Development. This study was conducted using UK Biobank resources under application numbers 40310 and 19127.

To compute polygenic scores and PCs, the same procedures were followed as described in “Genetic correlates of social stratification in Great Britain”, Abdellaoui et al. NHB 2019.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'D H Jones', with a stylized flourish at the end.

David Hugh-Jones  
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