



Cognitive traits are more appropriate for genetic analysis than social outcomes

Franck Ramus

► To cite this version:

Franck Ramus. Cognitive traits are more appropriate for genetic analysis than social outcomes. Behavioral and Brain Sciences, In press. <hal-03776841>

HAL Id: hal-03776841

<https://hal.science/hal-03776841v1>

Submitted on 14 Sep 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

Cognitive traits are more appropriate for genetic analysis than social outcomes

Franck Ramus

CNRS, Ecole Normale Supérieure, PSL University, Paris, France.

franck.ramus@ens.psl.eu

Abstract

The critique of the genetics of complex social outcomes is partly well-founded, insofar as social outcomes sometimes have unreliable relations with cognitive traits. But the correct conclusion is not to dismiss the entire field altogether. Rather, the implication is to redirect geneticists' attention to the stable cognitive phenotypes that are natural candidates for genetic analysis.

Commentary

Burt's point that heritability estimates and polygenic scores are context- and population-dependent is well-taken and widely appreciated. However, it should not be overstated as implying that all genetic analyses are irremediably socially contingent, varying widely depending on period, culture and context, thereby shunning any hope of identifying stable, meaningful genetic associations.

One can of course tell stories about education being something very different in a remote hunter-gather society or in the distant future, but this should not obscure the fact that the notion of educational achievement in the 21st century that is the current focus of genetic analysis is a well-defined and circumscribed concept that is essentially the same all over the world except for some extremely isolated cultures where schools don't exist. Even if it is true that the personality traits that were likely to attract a young woman to higher education in the 1870s and in the 2020s USA may differ to some extent, the cognitive traits (detailed further below) that would have been important for her to succeed at university in 1870 are very likely to be the same as those important in 2020, and they are also the same in the USA, in Saudi Arabia or in Thailand, thus providing a stable basis for the genetic analysis of educational achievement. When some of these factors differ between countries or periods, this should not be cause for despair or rejection of genetic approaches, since the issue is perfectly empirically tractable: this should rather be welcomed as an opportunity to describe interesting gene-environment interactions.

Nevertheless, Burt's critique has the merit of highlighting the potential gaps between the social outcomes that are currently subjected to genetic analysis, and their cognitive basis. One should recall that social outcomes such as educational achievement or income have been genetically studied mainly because they were conveniently available in very large databases. In every genetics project, every participant answers one question about their highest obtained degree, regardless of the initial goal of the research. Thus, pooling across many projects has enabled researchers to gather the millions of

participants required to compute reliable educational achievement polygenic scores (Okbay et al., 2022).

But to the cognitive scientist, this may seem a temporary distraction: these complex social outcomes are not phenotypes that are under direct natural selection and that should naturally be the focus genetic analysis. The phenotypes of interest for genetic analysis are situated at the cognitive level, where stable traits can be defined and can be the target of selection. For educational achievement, these are specific cognitive abilities: not just general intelligence (which is itself a complex emerging property; Ramus, 2017), but its underlying components: verbal ability, abstract reasoning, working memory, and also more specific cognitive skills such as phonological awareness (which contributes to reading acquisition) or number sense. One should not forget the popular but ill-named “noncognitive skills” (Ramus, 2022) such as conscientiousness, self-control, intrinsic motivation, grit, which do explain part of the educational achievement variance and which are also genetically influenced (Demange et al. 2021). These traits reliably underlie educational achievement regardless of time, culture, and gender of the learner, and there is every reason to think that they have a stable neural and genetic basis, which may be to a large extent similar in all populations.

Similarly, the answer to the question “have you ever had sex with someone of the same sex? Yes/No” has never been a valid phenotype for genetic analysis, but it is the one that was available for UK Biobank and 23andMe participants (Ganna et al., 2019). These authors are of course well aware that the stable cognitive trait of interest is sexual orientation, that it is continuous (e.g., as on the Kinsey scale), and that its relationship with actual sexual behaviour is imperfect, subject to social norms, to opportunities and to many life circumstances. Genome-wide research on the genetics of sexual orientation will have to wait until an appropriate scale is rated by a sufficiently large number of participants.

An additional difficulty that may be less widely appreciated is that the cognitive functions that are under genetic influence are latent, unobservable variables, that cannot simply be equated with performance in one behavioural test. This is because any test, no matter how elementary it seems, inevitably recruits several cognitive functions. For instance, even the simplest reaction time test involves not only processing speed but also vision (or audition, to perceive the signal), sustained attention, language skills (to understand instructions), and motor skills (to produce a response). Therefore, there never is a one-to-one mapping between cognitive functions and behavioural tests. Any cognitive function can only be inferred by triangulating across several behavioural tests involving it in different ways.

This implies that research into the genetics of cognitive functions is going to be much more difficult than running a GWAS on an answer to a single question or on a single test score. It will require administering well-designed, comprehensive test batteries to very large populations.

The conclusion is that the critique of the genetics of complex social outcomes is partly well-founded, insofar as social outcomes sometimes have unsystematic relations with cognitive traits. But the correct

conclusion is not to dismiss the entire field altogether. Rather, the implication of this critique is to redirect geneticists' attention to the stable cognitive phenotypes that are natural candidates for genetic analysis. Unfortunately, studying the genetics of specific cognitive functions will take greater efforts and a longer time until the necessary test results are collected in sufficiently large genotyped populations.

Author note

I declare no conflict of interest.

This work has received support from grants ANR-17-EURE-0017 and ANR-10-IDEX-0001-02. A CC-BY public copyright license has been applied by the authors to the present document and will be applied to all subsequent versions up to the Author Accepted Manuscript arising from this submission, in accordance with the grant's open access conditions.

References

- Demange, P. A., Malanchini, M., Mallard, T. T., Biroli, P., Cox, S. R., Grotzinger, A. D., Tucker-Drob, E. M., Abdellaoui, A., Arseneault, L., van Bergen, E., Boomsma, D. I., Caspi, A., Corcoran, D. L., Domingue, B. W., Harris, K. M., Ip, H. F., Mitchell, C., Moffitt, T. E., Poulton, R., ... Nivard, M. G. (2021). Investigating the genetic architecture of noncognitive skills using GWAS-by-subtraction. *Nature Genetics*, 53(1), 35-44. <https://doi.org/10.1038/s41588-020-00754-2>
- Ganna, A., Verweij, K. J. H., Nivard, M. G., Maier, R., Wedow, R., Busch, A. S., Abdellaoui, A., Guo, S., Sathirapongsasuti, J. F., Team16, 23andMe Research, Lichtenstein, P., Lundström, S., Långström, N., Auton, A., Harris, K. M., Beecham, G. W., Martin, E. R., Sanders, A. R., Perry, J. R. B., ... Zietsch, B. P. (2019). Large-scale GWAS reveals insights into the genetic architecture of same-sex sexual behavior. *Science*, 365(6456), eaat7693. <https://doi.org/10.1126/science.aat7693>
- Okbay, A., Wu, Y., Wang, N., Jayashankar, H., Bennett, M., Nehzati, S. M., Sidorenko, J., Kweon, H., Goldman, G., Gjorgjieva, T., Jiang, Y., Hicks, B., Tian, C., Hinds, D. A., Ahlskog, R., Magnusson, P. K. E., Oskarsson, S., Hayward, C., Campbell, A., ... Young, A. I. (2022). Polygenic prediction of educational attainment within and between families from genome-wide association analyses in 3 million individuals. *Nature Genetics*, 54(4), 437-449. <https://doi.org/10.1038/s41588-022-01016-z>
- Ramus, F. (2017). General intelligence is an emerging property, not an evolutionary puzzle. *Behavioral and Brain Sciences*, 40, 43-44. <https://doi.org/10.1017/S0140525X1600176X>
- Ramus, F. (2022). *Noncognitive nonsense*. PsyArXiv. <https://doi.org/10.31234/osf.io/xzv4f>