Linking environmental influences, genetic research to address concerns of genetic determinism of human behavior

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New genomic research provides strong rationale against genetic determinism for behavior. Credit: Matt Hudson created this image using Midjourney and owns it. They are making it available under CC-BY 4.0 (CC-BY 4.0, https://creativecommons.org/licenses/by/4.0/)

It has long been known that there is a complex interplay between genetic factors and environmental influences in shaping behavior. Recently it has been found that genes governing behavior in the brain operate within flexible and contextually responsive regulatory networks. However, conventional genome-wide association studies (GWAS) often overlook this complexity, particularly in humans where controlling environmental variables poses challenges.

In a new perspective article published on February 27 in the open-access journal *PLOS Biology* by researchers from the University of Illinois Urbana-Champaign and Rutgers University, U.S., the importance of integrating environmental effects into genetic research is underscored. The authors discuss how failure to do so can perpetuate deterministic thinking in genetics, as historically observed in the justification of eugenics movements and, more recently, in cases of racially motivated violence.

The authors propose expanding GWAS by incorporating environmental data, as demonstrated in studies on aggression in fruit flies, in order to get a broader understanding of the intricate nature of gene-environment interactions. Additionally, they advocate for better integration of insights from animal studies into human research. Animal experiments reveal how both genotype and environment shape brain gene regulatory networks and subsequent behavior, and these findings could better inform similar experiments with people.

"Advances in genomic technology have really illustrated how changes in the environment lead to changes not only in behavior, but in the expression of genes, in a way that's not determined just by heredity," said co-author Matthew Hudson, professor of crop sciences at Illinois. "We now understand that even the same genes can function very differently across individuals depending on their expression."

Furthermore, the authors stress the importance of multidisciplinary collaboration to understand the roots of behavior, especially among the animal and human research communities. Co-author Rina Bliss, professor of sociology at Rutgers, added, "We really need these kinds of collaborations among social scientists and biologists to illuminate the complexity of gene-environment interactions, especially as they relate to human behavior."

The article also suggests that emerging technologies such as brain organoids and new forms of brain imaging will be necessary to elucidate the molecular mechanisms linking genetic and environmental influences on behavior.

Ultimately, the authors stress that a paradigm shift is needed in human social and behavioral genomics towards a nuanced comprehension of gene-environment interactions. "Studying the roots of behavior holds great potential for insights that can help better understand brain function, in health and disease. We hope this article helps researchers to make the most of the opportunities while avoiding reductionist pitfalls," said co-author Gene Robinson, Director of the Carl R. Woese Institute for Genomic Biology and professor of entomology and neuroscience at Illinois.

The authors suggest that a holistic perspective and fostering interdisciplinary collaboration could help researchers navigate the complexities of human behavior, while mitigating the risks associated with deterministic thinking in genetics.

More information: The genomic case against genetic determinism, *PLOS Biology* (2024). DOI: 10.1371/journal.pbio.3002510