World view

By Emily G. Jacobs

Bridging the neuroscience gender divide

Women's brain health has been severely neglected — our initiative aims to change that.

Neuroscientists now have unprecedented access to the living brain, thanks to magnetic resonance imaging (MRI). More than 50,000 human-brain-imaging articles have been published since MRI came on the scene in the 1990s. But of those, less than 0.5% consider health factors specific to women.

Women's health is both understudied and underfunded. This oversight is especially troubling given that 70% of people with Alzheimer's and 65% of those with depression are women. Some neurological conditions are experienced only by people who have menstrual periods: postpartum depression, perimenopausal 'brain fog', endometriosis and menstrual migraines, to name a few. Globally, around 400 million women take hormonal contraception. Some of those people experience depression as a side effect, yet there has been no comprehensive neuroimaging study to understand how long-term hormone suppression influences the brain.

Representation is not the problem: about 50% of people enrolled in neuroimaging studies listed on OpenNeuro.org are women. Researchers are simply not choosing to study (and funders to invest in the study of) health factors specific to women, which is perhaps not surprising when 80% of tenured neuroscientists are men.

The scientific community is only now starting to wake up to how stark the imbalance is. Assigning equal value to the health of men and women will require "a global shift in science culture" (R. M. Shansky & A. Z. Murphy *Nature Neurosci.* **24**, 457–464; 2021).

That's why, on 16 November, the University of California (UC) launched the Ann S. Bowers Women's Brain Health Initiative, of which I am the director. It is a brain-imaging consortium whose mission is to close the gender data gap and make neuroscience inclusive — in terms of both who asks the questions and who is served by the answers.

Our initiative was also born out of a second observation: the current siloed model of neuroscience is a dead end. Small-scale neuroimaging studies lead to underpowered data sets and serious questions about reproducibility.

The UC system is in a unique position to offer an alternative path forwards. Its campuses span a geographically and demographically diverse state.

The initiative includes seven members of the UC system, with more to come. Together, these campuses generate data from thousands of MRI participants every year. MRI data and health metrics are pooled across sites, while our data coordinating centre at Stanford University oversees the automation of data storage, quality control, standardization and open-access data sharing on the OpenNeuro platform.

> "Precision imaging could be the key to discovering early indicators of, for example, risk of depression during pregnancy."

This consortium approach and the embrace of big data has ushered in major discoveries in fields such as genomics and particle physics, and we can do the same for women's brain health.

We've built the infrastructure to collect MRI data from tens of thousands of women across the UC system. Analysing this information using machine-learning tools will help us to establish population-level tendencies, linking health factors such as hormonal contraceptive use, perinatal birth complications, menstrual migraines and menopausal symptoms with MRI data.

In addition, the project will collect a huge amount of MRI data on individuals. Precision-imaging studies that track people intensely over time are already transforming what we know about the dynamic properties of the brain (C. Gratton & R. M. Braga *Curr. Opin. Behav. Sci.* **40**, iii–vi; 2021). In women's brain health, these techniques are starting to yield insights into the brain's capacity to change in both structure and function across the menstrual cycle (E. G. Jacobs *Nature Mental Health* **1**, 700–701; 2023). Applying a precision-imaging lens to other major hormonal transitions, especially pregnancy and menopause, holds great promise. Besides shedding light on basic neurobiology, it could be the key to discovering early indicators of, for example, risk of depression during pregnancy, postpartum and during menopause.

With this unprecedented trove of data, we aim to make strides in understanding depression and its ties to hormones, and make material improvements to clinical care. Before puberty, rates of depression are about equal in boys and girls, hinting that depression is often tied to hormonal transitions. We hope to use the tools of neuroscience to develop predictive models so that clinicians can prepare therapeutic interventions early and give people appropriate support. We also hope to grasp why some people on hormonal contraceptives experience depression, whereas others experience benign or positive mental-health outcomes. Answers to these questions, and others, are long overdue.

The Ann S. Bowers Women's Brain Health Initiative includes trans and non-binary people, because quality data on this population are even more impoverished than are data on women. By understanding how, for example, hormone replacement therapy and other forms of gender-affirming care affect brain function and subjective experience, we hope to improve clinical care and people's lives.

In all this, we are driven by a radically simple idea: that progress in neuroscience will flourish when the health of people of all genders is valued equally.

Emily G. Jacobs is associate professor of psychological and brain sciences at University of California, Santa Barbara, and director of the Ann S. Bowers Women's Brain Health Initiative.
e-mail: egjacobs@ucsb.edu

ARIELLE DONESON