

Mapping the claustrum to elucidate consciousness

The claustrum is a thin, irregular subcortical nucleus in the brain, surrounded by the external and extreme capsules and located between the putamen and insular cortex. In their seminal 2005 paper, Francis Crick and Christof Koch propose the claustrum as a candidate correlate of conscious experience. The authors base their proposal on the claustrum's central location and its profound connectivity with cortical and subcortical structures.

Crick and Koch argue that the claustrum might serve as a 'hub' with specialized mechanisms to integrate discrete perceptual, cognitive and motor information. They compare the function of the claustrum to an orchestra conductor synchronizing the cacophony of distributed neural activity into a unified harmony of conscious perception.

I first read Crick and Koch's paper in an undergraduate seminar on the philosophy of mind. I had spent a lot of time thinking about consciousness, but I was far better acquainted with thought experiments than empirical ones and had not thought much about the brain. By contrast, rather than getting mired in debates about qualia (the subjective qualities that define the experience of being conscious), Crick and Koch simply accepted consciousness as a given, assumed it must have some neural correlate, and reviewed relevant empirical evidence to offer a mechanistic framework explaining how consciousness might arise.

Crick and Koch's paper persuaded me that empirical investigation of the brain might prove more effective than analytical debate about the mind in solving questions about consciousness. When considering my research focus in graduate school, I specifically recalled Koch's footnote revealing that Crick had been refining the paper on the day of his death. I figured that if the claustrum held such priority for such an eminent scientist, it might be an optimal place to begin my research.

Many scientists seem to have shared my conviction. Crick and Koch's paper catalysed nearly two decades of research on claustral structure and function. Findings from post-mortem human studies and animal experiments implicate the claustrum in various higher-order cognitive processes, including salience processing and attention. These findings are largely consistent with Crick and Koch's speculation that the claustrum might undergird consciousness. Even studies that offer alternative explanations for consciousness or descriptions of claustral function often reference the paper as a foundational touchstone in the field.

The question of what the claustrum does remains a topic of active debate. A major cause of this debate is that some aspects of the claustrum's complex geometry fall beyond the highest resolving power of current *in vivo* neuroimaging tools, including magnetic resonance imaging. However, continuous technological advancements ensure

it is not a question of whether, but when, the claustrum will be fully observed in the living human brain. To this end, my research aims to measure claustral activity by pushing the capacity of ultra-high-field functional magnetic resonance imaging.

“Crick and Koch [...] offer a mechanistic framework explaining how consciousness might arise”

Although it is too early to draw firm conclusions about claustral function, this is no longer a premature topic. With each advance, researchers edge closer to understanding the claustrum and perhaps the nature of consciousness itself.

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Competing interests

The author declares no competing interests.

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