

► estimates of ultimately recoverable US oil reserves to his eventual winning model: an advanced calculation that incorporated past production, yield per foot of exploration and the tricky variable of reserve growth.

Inman does not, however, cite the work of UK economist William Stanley Jevons, whose 1865 warning about the economy's over-reliance on coal prefigures the Hubbert story. Jevons died in 1882, so never saw his prediction come true: British coal output peaked in 1913. Hubbert, by contrast, was feted with numerous awards, including the Rockefeller Service Award in 1977, and broad coverage in *The New York Times* when his previous reports for the government and the USGS were acknowledged for their accuracy.

Hubbert's forecast was not the end of the US oil story. After his death, production continued to languish, in accordance with his forecast. But with fracking, the United States lifted oil production as recently as last year to levels close to the 1970 peak. Oil production is now falling again owing to a price bust — global supply capabilities were created for demand that failed to materialize. Inman does a fine job of handling this recent history.

*The Oracle of Oil* offers valuable insights beyond energy. In the demand-side bust of the 1930s, it shows Hubbert thinking deeply about the surplus of labour created partly, in his view, by the effects of powerful oil married to the newest machines: cars, construction equipment and aircraft. Hubbert was co-founder of Technocracy, a group of New York intellectuals aiming to prevent future economic dislocations. Two publications by keen observers of the low-growth problem — Thomas Piketty's *Capital in the Twenty-First Century* (Seuil, 2013) and Robert Gordon's 2012 paper 'Is US Economic Growth Over?' (see [go.nature.com/wblxig](http://go.nature.com/wblxig)) — also explore this territory of limits and sustainability.

In Inman's work, the oilman emerges as a restless and prescient figure concerned with the environment. In writing the first biography of Hubbert, Inman has retrieved, if not rescued, the story of a scientist who has much to offer to today's energy conundrum. ■

**Gregor Macdonald** is a journalist based in Portland, Oregon, who covers the energy sector.

e-mail: [gregor@gregor.us](mailto:gregor@gregor.us)

## NEUROSCIENCE

# Listening in on yourself

**Douwe Draaisma** is intrigued by a study examining both 'the voice within' and verbal auditory hallucinations.

Thinking about thinking is a curious exercise. Most of us probably agree that much of our own thought process takes the form of inner speech. But would we also agree that we hear an inner voice? If not, why would we call it talking at all? Can we experience and observe inner speech simultaneously, or would this be like "trying to turn up the gas quickly enough to see how the darkness looks", as US psychologist William James asked himself in 1890? Each of these questions may lead one into a philosophical forest, dense and dark.

Side-stepping such conceptual intricacies, psychologist Charles Fernyhough convincingly explores inner speech from a practical perspective. In *The Voices Within*, he discusses how people with aphasia (a speech and language disorder that stems from brain damage) may lose their sense of inner speech; how deaf people 'talk to themselves' (mostly in sign language, some by lipreading); how more than 60% of children have had silent conversations with imaginary friends; and whether people who stutter experience their inner speech as fluent (they do). Silent self-talk, evasive as it is to introspection, turns out to be a robust and quintessential part of memory, thought and imagination.

Fernyhough's sources are equally wide-ranging. He draws on internal monologues



**The Voices Within: The History and Science of How We Talk to Ourselves**

CHARLES FERNYHOUGH  
Profile: 2016.

in Gustave Flaubert's 1856 novel *Madame Bovary* and reports of self-talk by professional cricketers. He mentions physicist Richard Feynman having an argument with himself, and Joan of Arc insisting that God talked to her in French, not Latin. Today, Fernyhough directs Hearing the

Voice, a research project at Durham University, UK, funded by biomedical charity the Wellcome Trust.

When I'm invited to write a review, I know from experience that it is wise to switch my inner speech from Dutch, my native language, to English, which I routinely use for scientific communi-

cation. Most bilingual people have no trouble identifying the language that they are thinking in. But I would be hard-pressed to say whether I talk to myself at a natural speed or in an abbreviated way, much less whether the stream of my thoughts flows equally fast (or slow) in both languages. Most people say that they have the definite impression that their inner speech unfolds faster than actual speech.

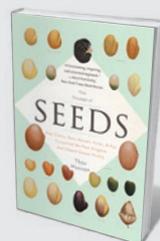
**SILENT SELF-TALK  
TURNS OUT TO BE A  
ROBUST  
PART OF  
MEMORY.**



**Spirals in Time: The Secret Life and Curious Afterlife of Seashells**

Helen Scales (Bloomsbury, 2016)

From beachcombing to shipwreck diving, marine biologist Helen Scales shares her love of molluscs, many of which convert seawater into protective homes. Shells, she reveals, have served as everything from jewellery to calcareous currency.



**The Triumph of Seeds**

Thor Hanson (Basic, 2016)

Biologist Thor Hanson sows the ultimate celebration of seeds and how they conquered Earth. Kernels can be crafty: unripe fruit, for instance, tastes bitter to deter predators from dispersing the seeds too soon (see Sandra Knapp's review: *Nature* **519**, 288–289; 2015).



Referring to the ideas of philosopher Eric Schwitzgebel, Fernyhough points out that this leaves several questions open. Is internal speech faster because it is unhampered by slower motor processes, or because we don't think in full sentences? According to twentieth-century Russian psychologist Lev Vygotsky, inner speech develops as children's conversations 'go underground,' often as a result of social encouragement. In the process, they begin to think in 'pure meanings', causing telegraphic inner speech. This condensation, in turn, could help to explain the paradoxical sensation that inner speech feels faster, but never rushed. Sped up or condensed? To this day, there are no consensual methods or techniques to decide between the two.

Fernyhough also presents several interviews with participants in his Durham research project, itself an offshoot of the Hearing Voices Movement founded in 1987 by Dutch psychiatrist Marius Romme and now expanded to 23 countries. At present, the United Kingdom has 180 support groups for voice-hearers. Some people report hearing intrusive voices, often whispering or

shouting abuse, and seek relief by joining a local group. Most people who experience verbal auditory hallucinations have had a diagnosis of schizophrenia or have experienced childhood abuse — but, as Fernyhough points out, not all. Clinically relevant as they are, these chapters expose a tension in *The Voices Within*: it is still a matter of controversy whether hearing voices has much to do with the quiet self-talk of ordinary thinking.

Fernyhough tries to bridge this gap with a model that he dubs dialogic thinking, which conceptualizes inner speech as an internalized conversation between different voices. He hypothesizes that if a patient fails to identify a particular utterance as a fragment of some inner dispute, he might experience this fragment as coming from an external source — a hallucination. But many voice-hearers also experience inner speech, and can distinguish between the two. It remains to be seen whether the experience of hearing voices will really offer a window on inner speech.

We have come a long way from US psychologist John Watson's behaviourist speculation

that inner speech is simply covert motor action in the speech apparatus. New methods have invited new distinctions. Neuroimaging studies by Fernyhough and his colleagues suggest that speaking internally when instructed activates Broca's area in the brain (associated with producing speech), and deactivates Heschl's gyrus (associated with auditory perception). Spontaneous, free-flowing inner speech, on the other hand, involved the opposite pattern of neural activation. This is but one of many promising avenues of research, and *The Voices Within* is full of them. Profound and eloquent (he is a novelist too), Fernyhough presents an intriguing array of fresh findings and perspectives. He makes a persuasive case that one of the most intimate and private of our mental activities has a social origin. We talk to ourselves because we talked to others first. ■

---

**Douwe Draaisma** is professor of the history of psychology at the University of Groningen in the Netherlands. His latest book is *Forgetting*.  
e-mail: [d.draaisma@rug.nl](mailto:d.draaisma@rug.nl)



**Infested: How the Bed Bug Infiltrated Our Bedrooms and Took Over the World**

Brooke Borel (University of Chicago Press, 2016)  
Bed bugs (*Cimex lectularius*) are perfectly adapted for bloodsucking. Toothed mandibles pierce their victims' skin and inject saliva proteins that widen the blood vessels and prevent clotting, reveals Brooke Borel in her creepy exposé of the household pest.



**Life's Greatest Secret: The Race to Crack the Genetic Code**

Matthew Cobb (Profile, 2016)  
Anecdotes abound in zoologist Matthew Cobb's history of the quest to unravel the genetic code. Cobb updates the story with a look at gene-editing tool CRISPR and its role in gene therapy, agriculture and the control of invasive species.