

PSYCHOLOGY

Time piece

Hedderik van Rijn weighs up an erudite but idiosyncratic survey of how we perceive life passing.

legacy at Wren once we are gone. In this very library are the Epistles of St Paul, the poems of Milton, Morgan's Bible and, in my estimation as a man of numbers, the *pièce de résistance*, Newton's *Principia Mathematica*." Ramanujan's 'lost notebook' — which contains important mathematical discoveries made in India in 1919–20 and was neglected until 1976 — is, fittingly, in the Wren Library.

Scenes in India are no less ravishing. We see Ramanujan in flowing Indian clothes with Brahminical caste marks, chalking endless equations on the floors of a highly decorated Hindu temple. His dominating mother Komalatammal and wife Janaki provide a glimpse of domestic life. Indian and British colonial figures come and go (with a cameo by Ramanujan admirer Stephen Fry). But the film struggles to shed light on the origins of Ramanujan's prodigious gift. Biographers have had the same problem with Gauss and many other mathematicians. As India's great film director Satyajit Ray put it: "This whole business of creation, of the ideas that come in a flash, cannot be explained by science."

Hardy, too, was dazzled and puzzled. On a 0–100 scale of natural mathematical ability, he gave himself a score of 25 and Trinity colleague John Littlewood (a fellow supporter of Ramanujan) 30, compared with 80 for influential mathematician David Hilbert and 100 for Ramanujan. "The limitations of his knowledge were as startling as its profundity," Hardy wrote after Ramanujan's death. "All his results, new or old, right or wrong, had been arrived at by a process of mingled argument, intuition and induction, of which he was entirely unable to give any coherent account."

Ramanujan has inspired many. Christopher Sykes's pioneering UK television documentary, *Letters from an Indian Clerk*, was screened in 1987. The play *A Disappearing Number*, devised by Théâtre de Complicité, was produced in Britain in 2007 (see *Nature* 449, 25–26; 2007). A biographical novel by David Leavitt, *The Indian Clerk* (Bloomsbury), was published in 2007.

Now, the film has spawned an intriguing, moving autobiography by Ono, *My Search for Ramanujan* (Springer, 2016), written with science writer Amir Aczel, who died before publication. Ono interweaves Ramanujan's life and work with his own fight to become a mathematician — including a suicide attempt — in the shadow of his distinguished mathematician father, Takashi Ono. After years of estrangement, the Onos realized that they were united by admiration and affection for the university drop-out Ramanujan. Here is yet another example of how this enigmatic Indian's unique achievements continue to reverberate nearly a century after his death. ■

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The sense of time passing plays a pivotal part in decision-making — from choosing chicken or pasta on a long-haul flight to deciding whether to propose marriage to a long-term partner. Although the temporal resolution in these scenarios differs by orders of magnitude, *Felt Time* by psychologist Marc Wittmann (first published in German as *Gefühlte Zeit*; C. H. Beck, 2014) argues that the experiences are closely related.

Wittmann marshals a wealth of behavioural and neuroscience results, as well as references to the arts, literature and philosophy, to argue that how we subjectively experience time determines whether we are able to seize the day and live happy and fulfilled lives, or struggle to finish our daily chores. He urges us to strive to slow down subjective time and to live in the here and now. Inspired by the Roman Stoic philosopher Seneca, his suggestion for cultivating presence is to abstain from busywork — to get rid of the "unconditional work ethic" that drives us back to our desks on sunny Sunday afternoons to finish yet another grant proposal instead of relaxing. Another, more pragmatic, proposal for slowing down subjective time is 'mindfulness'. By using meditation



Felt Time: The Psychology of How We Perceive Time

MARC WITTMANN
(TRANSLATED BY ERIK BUTLER)
MIT Press: 2016.

techniques such as a focus on breathing, Wittmann argues, we become more aware of our inner body states, more "mentally present"; this slows down our subjective time, resulting in more fulfilling in-the-moment experiences.

I am not convinced that mindfulness can help in all contexts discussed in *Felt Time*, because Wittmann

defines time very loosely. He links the perception of seconds with perception over months or years. He elides the effects of circadian rhythm and chronotype (whether someone is a 'morning' or 'evening' person), youthful impatience, the observation that years seem to pass faster as we age, and the prospect of dying — the ultimate time limit. Although all of these are associated with our perception of life passing, each has a distinct aetiology: circadian rhythms are driven by well-known biological circuits, for example. But the change in subjective time with age is attributed to experiencing fewer unfamiliar (and therefore memorable) events, something that could be more easily influenced than circadian rhythms.

I do, however, strongly agree with Wittmann's implicit arguments for a more inclusive study of time. Beyond simple laboratory studies of temporal cognition tasks, Wittmann makes the case that science should explore how perceived time affects everyday activities, as well as how everyday activities influence our perception of time. But rather than conducting lab work in which participants must estimate the duration of intervals marked with clear start and end points, we should consider timing as a continuative process: every task we do is timed, irrespective of whether we know at the start that time might become important.

Felt Time is divided into two parts. In the first, Wittmann introduces the important role of time in many aspects of everyday



Perceived and measured time may not always match.

► life, from speech perception and production to experiencing and memorizing what he terms the “best moments of life”. Here he presents an elegant selection of the often confusing, sometimes contradictory academic literature, with a clear emphasis on his own work and that of collaborators and mentors such

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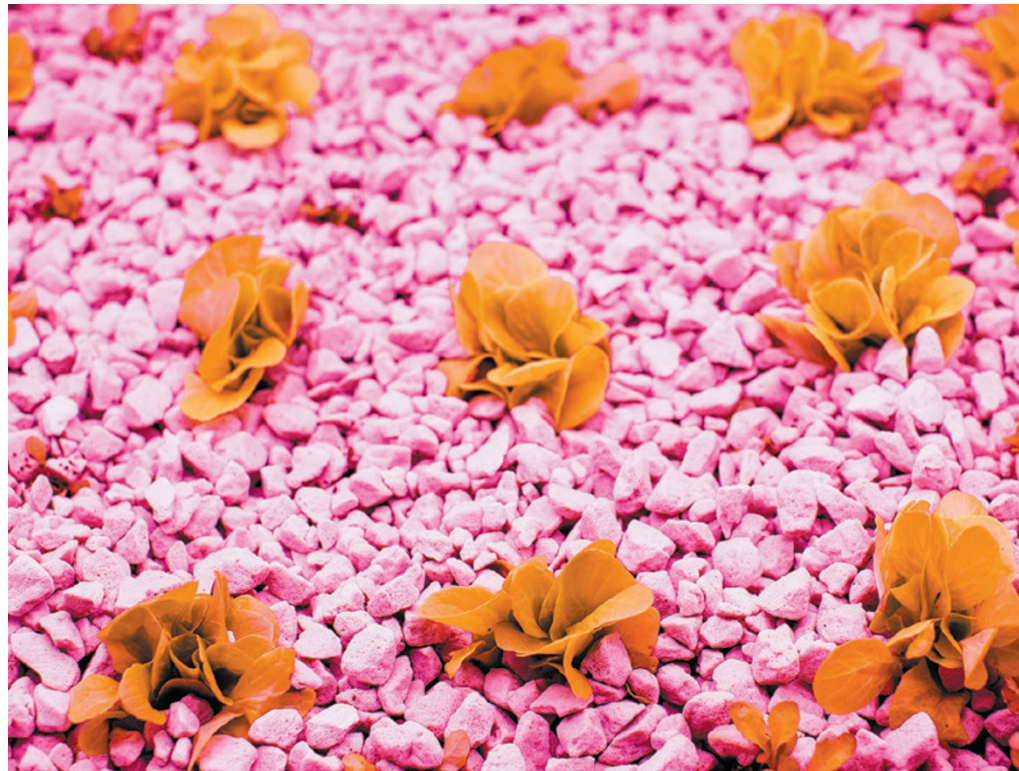
as functional neuroanatomist Bud Craig and psychologist and neuroscientist Ernst Pöppel. In the last two chapters, Wittmann advances a theory of how temporal perception is directly linked to the self-consciousness of bodily states. His idea is grounded in the observation that during timing tasks, the brain’s insular cortex (a part of the cerebral cortex associated with the integration of physiological input such as heartbeat) is active. Wittmann suggests that the heart might act as an ‘internal clock’, because accuracy in counting heartbeats correlates with how accurately someone can estimate the duration of an interval. Although there are correlational studies that link sensing heartbeat with timing accuracy, Wittmann unfortunately ignores prominent alternative proposals for the brain mechanisms that underlie the internal clock. For example, there is ample evidence that corticostriatal circuits — neural pathways that link the basal ganglia with the neo-cortex — are key to the accurate timing of duration in the range of seconds to minutes. Such work is better covered in other books or special journal issues on the neurobiology of timing (for example, H. Merchant and V. de Lafuente (eds) *Neurobiology of Interval Timing* (Springer, 2014) and R. B. Ivry and W. H. Meck *Curr. Op. Behav. Sci.* 8; 2016) — but these are aimed at experts.

Although idiosyncratic at times, *Felt Time* eloquently sketches out the importance of time, both in the darkness of the lab and in the full light of everyday behaviour. ■

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In the installation *AQUA*lab, plants purify water for fish, which provide fertilizer for the plants.

AGRICULTURE

Future farming

Anthony King views video games for pigs and urban ‘aquaponics’ at Science Gallery Dublin’s latest show.

The visible face of intensive agriculture is supermarkets bulging with vegetables, meat and milk. Yet behind the scenes, as Science Gallery Dublin’s latest exhibition reveals, factory farming’s reliance on energy-intensive fertilizer manufacture and vast amounts of water raises big questions about sustainability. No one solution is on offer in *Field Test*, which is curated by the Center for Genomic Gastronomy, an artist-led global think tank devoted to imagining a more just, biodiverse food system. But visitors can feast on prototypes, research, revolutionary agronomy manifestos, innovative and imagined farm technologies and speculative cuisines. “We’re asking how we can get more from less,” explains acting gallery director Lynn Scarff.

Meat, for instance, is a Western penchant now spreading around the world. The Food and Agriculture Organization of the United Nations estimates that demand will increase by more than two-thirds over the next 40 years, despite sky-high costs — it takes 15,000 litres of water to produce a kilogram of beef. The curators’ *Farmstand Forecast*

Field Test: Radical Adventures in Future Farming
Science Gallery Dublin
Until 5 June 2016.

looks at alternatives: attractively packaged insect-based foods, and historical ‘miracle’ crops such as breadfruit and *Chlorella* algae. An exhibition strand dubbed ‘Farm Cyborgs’ features animal-husbandry innovations including *Silent Herdsman*, a smart collar for tracking data on bovine health. *Playing With Pigs: Pig Chase* is a video game for alleviating porcine boredom, designed by researchers at the HKU University of the Arts Utrecht and the Wageningen University and Research Centre, both in the Netherlands. A pig uses its snout to manipulate a virtual ball on a touch-sensitive display, while a person uses a finger to do the same on a tablet computer. The reward for moving the ball in harmony is colourful ‘fireworks’.

Imagination-tickling as this is, it does not probe the central issue — demand and supply. That dilemma is framed in ‘Grow House’. Does the plastinated leftover of physician Mark Post’s 2013 *in vitro* burger, made by culturing beef cells, represent a viable solution?