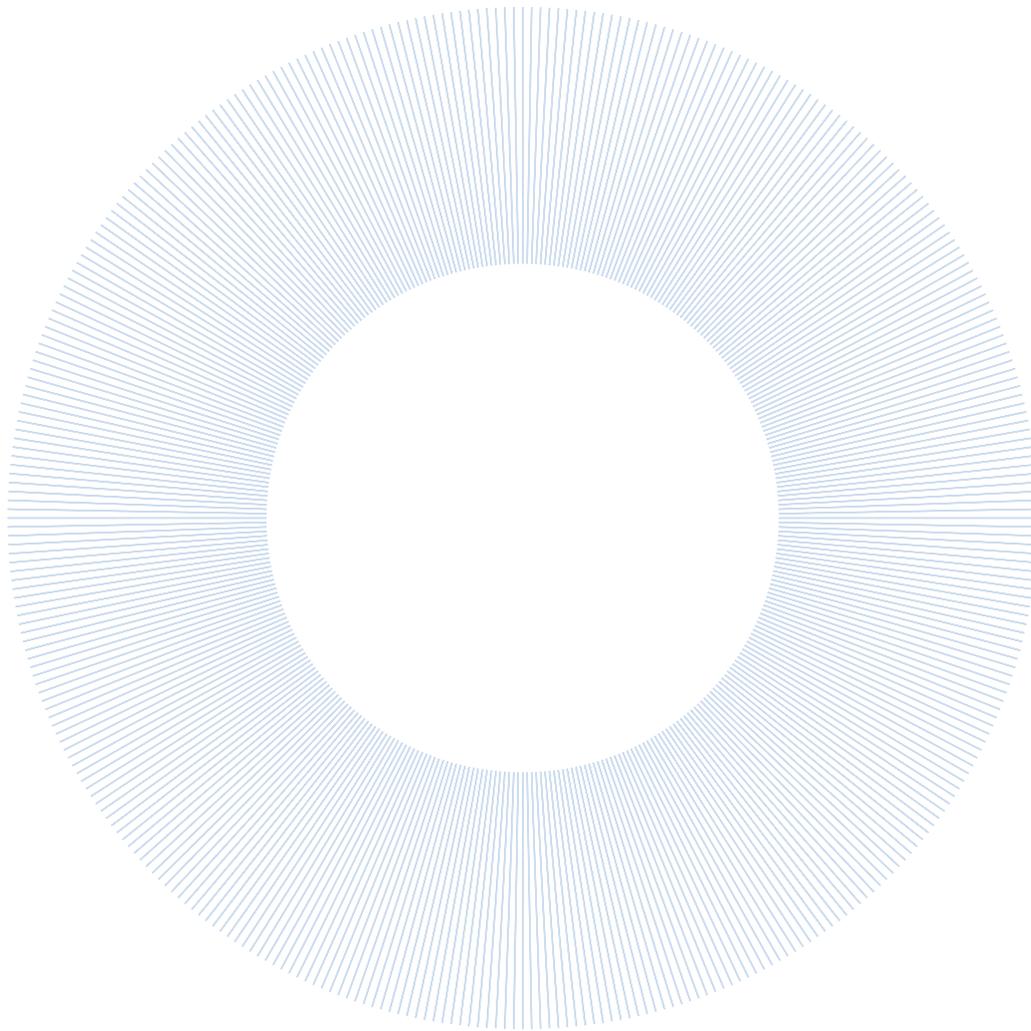


Waves



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WAVES

This piece presents preliminary, exploratory thinking toward a cultural – perhaps ethnographic – study of how people in a variety of domains use watery metaphors and symbols to think about wave phenomena, from physics to biology to social theory. To be sure, ricochets of analogical thinking about waves have been tracked before. Historians of science have provided documentary accounts of how models of electromagnetism congealed around water wave comparisons. And literary theorists such as Gillian Beer have examined the calibration of wave theory to the rise of early twentieth-century modernism and some of its epistemological accompaniments, including relativist attitudes toward the relation of the real to the represented (are waves real or an artifact of how we frame questions?) as well as scientifically inflected apperceptions of worlds unseen, from the unconscious to the realm of wireless radio imagined as an etheric ocean. Today, scientific and popular visions of reality as constituted by waves endure – with watery imagery never far behind – and often underwrite universalizing claims about the world, from quantum mechanics up to descriptions of the rise and fall of social movements (e.g. waves of feminism). Such visions – which often refer to ripples on ponds, breakers on the shore – signal a tendency to construe waves as ordinary, even canonically natural phenomena. But more self-conscious deployments of waves have lately come into view, ones that call attention to waves' varied cultural and, indeed, natural weight – as, for example, with research into the military-industrial production of shock waves, the aftermath of the 2004 Indian Ocean tsunami and the politics of surfing in post-colonial Hawaii. Inspired by such reflexive deployments, this essay is a thought experiment that plays with ways to think, today, about the matter and meaning of water and waves. It is meant to be impressionistic and suggestive rather than authoritative.



In the 1990s, when I was conducting ethnographic research about how computer simulation might change biologists' notions of vitality, a theoretical biologist I interviewed had this to say to me when I asked him how he might define *life*:

It is not important to focus on a formal definition of 'life.' But it is important to understand and agree that the word 'life' refers to organization and process, not to substance and substrate. In this respect it is like the word wave, which is a description of the dynamics of a process, not of the medium in which it propagates (in Helmreich, 1998, p. 210).

Three aspects of this claim fascinate me. First, there is the simile itself, which posits that processes can be separated from substances. Second, there is the distinction between definition and description, with the unstated argument that wave phenomena have a stable description. Third, there is the way the statement as put suggests a question: whether 'life' as a process may be analogous to a 'wave' or be constitutively entangled with wave dynamics.

But what are waves? Certainly there are many kinds, and not only at different scales. At a first approximation, scientists describe mechanical waves, in which energy and pattern propagate

through a medium (e.g. sound waves), standing waves, which send energy in two directions at once (e.g. a vibrating violin string), and electromagnetic waves, which do not require a medium (...to say nothing of gravity waves, which remain a mystery (see Collins, 2004)). There are transversal and longitudinal waves, with vibrations perpendicular and parallel, respectively, to a wave's direction of propagation. The word 'wave' does not do an expert job of sorting all these kinds out; ambiguity and exception seem to be thick in any definitional enterprise. To some extent, this is because of a history of analogy-making across domains. The notion that the universe is made up of waves of heat, sound, electricity, light, gamma rays is a social epistemological accomplishment that consolidates in the nineteenth century, as analogies between these different phenomena are calibrated to one another – and to a master symbolism of water waves.¹ The territory is prepared earlier; water waves are offered as metaphors for sound's form in classical texts (Vitruvius) and later theorized by Newton as models for physical phenomena that demonstrate harmonic motion or propagative dynamics.

Such metaphorical crosstalk persists. As Elizabeth Legge writes, in her analysis of Michael Snow's 1967 experimental film *Wavelength*, 'Inside the word "wavelength" a poetic oceanic comes up against a breakwater of structural, scientific rigour' (2009, p. 18). The meeting of the poetic and scientific has been expertly analyzed when it comes to the history of that encounter. Historians of science have described how Newton, Helmholtz, Fourier, Maxwell and Hertz activated a network of watery analogies to consolidate the wave idiom that organizes electromagnetism (see Beer, 1996, for a useful reading through this history). Gillian Beer has examined the making of wave theory alongside early twentieth-century modernism and its accomplishments: the unconscious, the etheric ocean of wireless radio (see also Sconce, 2000), a self-conscious relativism about representational schemes, Virginia Woolf's phenomenological novel, *The Waves* (1931).

I review this discussion because I am playing with the possibility of undertaking an ethnographic project about contemporary mobilizations of wavy science and sentiment. Treating 'waves' as an ethnographic object in their own right is a different kind of anthropological approach than identifying a pre-existing community of people to characterize, though Tim Ingold's 2007 *Lines* and Hugh Raffles' 2010 *Insectopedia* provide some recent precedent for taking abstractions and/or non-humans as ethnological starting points.

Many people, scientists and lay alike, continue to take the world, even in the age of digitality, to be made of waves, from the level of the quantum (where, to be accurate, entities are understood to be both wave and particle) to the cosmic, with stops at cultural and social phenomena on the way. And water imagery is never far behind. MIT physicist Seth Lloyd, in his *Programming the Universe*, writes that, 'the atom's states correspond to waves' (2007, p. 132), and suggests that those waves, available to quantum mechanical effects like superposition – which he explains by way of reference to children splashing in a bathtub – constitute the fabric of the universe, which he goes on to argue is a giant quantum computer.² French contemporary composer Eliane Radigue, after seeing a chart of the electromagnetic spectrum in the American Museum of Natural history, in 2009 wrote for the *Leonardo Music Journal* a fanciful history of Earthly evolution centered on the emergence of human hearing and music from 'the immense vibrating spectrum' (p. 48), culminating in the modulations of acoustic and electronic music which would permit one to be 'submerged in a continuous sound flow' (p. 49).³ No surprise that surfers have jumped on board with the message that the universe is waves all the way down. Thus Timothy Leary, back in 1978, in *Surfer* magazine: 'Everything is made of waves. At the level of electrons and neutrons ... it's part of a wave theory. Historical waves – cultural waves [...] sequential, cyclical, moving, ever-changing forms' (Pezman, 1978). What these statements have in common is attachment to the idea

that waves – quantum computed, manipulated in music, surfed – are the basis of the cosmos. They all share a fetish for the *ontological*.

But more self-conscious deployments of waves have lately come into view, calling attention to waves' varied cultural and, indeed, natural weight. I will just take a few examples here, attending particularly to waves in accounts of biology and social theory, domains about which I know most. I will sketch a trajectory from thinking of waves as simply natural to thinking of them as historical, political, cultural.

Waves and the Generation and Manifestation of Biological Form

Is life a wave? Are life forms constituted in any way by wave-like dynamics? The field of theoretical biology – concerned with mapping the abstract properties of living things – might be the place to start looking for such claims. D'Arcy Thompson in his 1917 *On Growth and Form* sought to discern how organic forms – the shapes that constitute living things – emerged not so much from natural selection as from physical and mechanical forces. He appealed to water wave imagery to describe the making of form, as, for example, with discussions of the shapes made by water droplets as they splash, which he used to speculate on forms of jellyfish (pp. 72–3). Science writer Philip Ball revived Thompson's thinking in his 2009 book *Shapes*, in which a key chapter is entitled 'Making Waves.'

Proponents of the field of *cymatics* have followed Thompsonian logic. 'Cymatics' is a term coined by physician and theosophist Hans Jenny in 1967 to refer to the study of sound made visible in tangible media; a typical cymatic experiment places a plate of liquid on the cone of a loudspeaker emitting a pure frequency, which waveform then prompts the production of geometric patterns in the liquid medium.⁴ Acolytes of Jenny's have urged large claims for cymatics, linking it to the origin of Earthly life. Acoustics engineer John Stuart Reid, promoting cymatics as a tool useful across the sciences offers that, 'life formed in the stillness of cymatic patterns, on the surface of microscopic bubbles,' bubbles that had a 'sonic scaffolding' because of their formation in a world of vibration. Going further, he suggests that 'the angular aspects of the earliest primitive life forms and organisms is strong evidence that sound was involved in the shaping process' (www.cymascope.com/cyma_research/biology.html). Jenny himself made the sound connection, though sequestered it in quotes: 'What we want to do is, as it were, to learn to "hear" the process that blossoms in flowers, to "hear" embryology in its manifestations' (1967, 1974, p. 276). Reid reaches toward Thompson-esque explanations in juxtaposing wave forms generated with his 2004 invention, the 'cymascope,' with organic forms. Whether such pattern matching indicates explanatory homology rather than happenstance analogy is not clear. Few biologists have taken interest and the jury is still out on any connection to the origins of life.

Waves operate in the life sciences at other levels. Marine biologist Ernest Everett Just was in the 1930s interested in the inward propagation of biochemical waves from cell walls and considered this motion an impetus for cellular development motivated not by nucleic acids but by cytoplasm (Manning, 1983). The waves at issue here are not those that organize biological form at the organismic scale, but those that describe propagatory dynamics that deliver chemicals within cells. Spiral waves in frog oocytes, for example, transport calcium intracellularly (Lechleiter et al., 1991; Plessner, 1996). Some biological tissues – cardiac and neural – are excitable media, which means they can carry a propagating wave. There are other wave phenomena in bodies; during so-called 'slow-wave' sleep, the mammalian brain

produces ponto-geniculo-occipital (PGO) waves, which register on EEGs as evidence of REM sleep.

Mention of EEGs makes explicit that graphical traces of waves are *representations* of physical phenomena – and that it is possible to see them not simply as ‘natural’ phenomena, but as entangled with our tools of representation, as artifacts of semiotic labor. Think, for example, of the effects of electromagnetic phenomena on bodies. Here, a longstanding image of the electromagnetic spectrum as an aetheric ocean endures. In ‘The invisible topography of power: electromagnetic fields, bodies and the environment,’ Lisa Mitchell and Alberto Cambrosio (1997) discuss how ‘low frequency electromagnetic fields emitted from power lines, computers and electrical appliances have become a form of environmental pollution,’ with people describing their bodies as at risk from their immersion in a ‘sea’ of artificial electromagnetic fields. In the case Mitchell and Cambrosio discuss, which draws on evidence from public hearings in Quebec from 1983 to 1993 on the health effects of electromagnetic fields, a wide variety of players – ‘physicists, parents of children with leukaemia, public policy analysts, epidemiologists, New Age followers’ (p. 224) – all agree that the environment around them is full of waves, but differ in beliefs about whether these waves are harmless or harmful. All see boundaries between bodies and environment blurred; they have entered into a *bioelectromagnetic world* – a phrase that suggests that borders between nature and culture are rearranging, so that ‘life’ sits in a constitutively wavy world.⁵ And one not always understood in terms of some sublime immersion in vibration, as with cymatics. Waves of ionizing radiation from nuclear disaster, shock waves from TNT detonation – these are other examples of waves only unsteadily imagined as ‘natural.’

Waves in Social Explanation

Moving, then, more fully into the social, it is a cliché to speak of historical and cultural waves. Futurologist Alvin Toffler’s 1980 *The Third Wave* may be only the most well known of usages. I am not sure when wave talk begins, but Durkheim does discuss ‘waves’ of suicide as early as 1897. In 1962, Elias Canetti, in his *Crowds and Power* makes such socially generated waves material, palpable, with recourse to an oceanic metaphor: ‘The sea is multiple, it moves, and it is dense and cohesive. Its multiplicity lies in its waves [...] The dense coherence of the waves is something which men in a crowd know well. It entails a yielding to others as though they were oneself’ (p. 80).

Reflexivity about the wave image manifests not just in the bioelectromagnetic imagination, but also in critical social theory. So, for example, in ‘Representations and Metaphors of Reform in Shanghai,’ social anthropologist Jos Gamble writes that, ‘An intriguing aspect of [...] “watery metaphors” [...] is that many portray the consequences of human actions as though they are uncontrolled natural phenomena, such as waves and tides. Thus to see immigration as a “tide” or “flood” [...] involves a denial of human agency’ (2003, p. 63). Not to mention an erasure of legal and governmental institutions.

Consider the at-first-glance less loaded notion of ‘waves’ of feminism – where first wave feminism refers to suffrage movements, second wave feminism to the 1970s women’s liberation movement, and third wave feminism to critiques of liberal feminism from women of color, third world women, and lesbian and queer women. In the early 2000s, some feminist scholars began to worry about the wave metaphor. In an article in *Signs* in 2004, Lynn Spigel wrote, ‘with both its oceanic and avant-garde connotations, the waves thesis works to place old feminists on the beach – washed up like fish on the shore’ (pp. 1211–12). Ednie

Keah Garrison argued in 2005 that the ‘feminist oceanography’ (a term coined by Deborah Siegel) of the wave narrative homogenizes women, linearizes movement, and posits times of lulls, which mismeasures histories of activism. Garrison suggests leaping over to a radio wave metaphor, which, she argues, affords different possibilities – frequencies, interferences, and so forth (‘Third wave as modulation, not current’). Feminist electronic musician Tara Rodgers suggests that problems have arrived from the abstraction of waves as such; two-dimensional representations of waves – as on oscilloscopes – index a tradition of objectifying wave phenomena, which, Rodgers shows, in the context of histories of acoustics, works hand in glove with calculatively rationalist and masculinist desires to get an explicitly feminized flux into linear order.⁶ Alison Wylie is more sanguine about water waves, suggesting that ‘waves do not so much overtake and succeed/supersede one another as rise and fall again and again in the same place, transmitting energy in complicated ways. [...] waves propagate and interact even in the simplest of circumstances [...] waves are generated in many different ways: by river or tidal currents, by snags and obstructions under water, by wind and by traffic on the surface, and, on rare and catastrophic occasion, by grinding shifts in tectonic plates’ (2006, p. 173).

Let me page back to Timothy Leary’s psychedelic vision of surfing as the condition of the universe. A more self-conscious meditation on epistemologies that might be motivated by surfing comes from political scientist Eric Ishiwata, who, in ‘Local motions: surfing and the politics of wave sliding’ (2002), suggests that *he’e nalu* – Hawaiian for surfing or ‘wave sliding’ – can be a store of fresh thinking about the social. In Hawaii, waves are eminently *cultural* phenomena, accessed through technologies and bodily comportments. ‘The surfbreaks of Hawai’i,’ writes Ishiwata, are places not only where ‘locals carve out resistances’ to tourist encroachments, but also reclaim and overturn the commoditization of surf leisure. Waves can be modulated for explanatory ends. They are not simply ‘natural’ objects or processes.⁷

Which leads me to conclude with a swerve: an image from a children’s movie about surfing penguins that I have been watching with my son. From the DVD extras, we learn that animators working on *Surf’s Up* hoped to render waves in the movie using the tools of computer simulation, but found such virtual waves did not pack enough emotion, were not ‘real.’ Eventually, the animators produced a virtual wave ‘puppet,’ so that waves could be, as they put it, ‘characters.’ Perhaps this – waves as characters, as entities with biographies and sociologies in addition to physics – is one way to begin a cultural study, an anthropology, of waves.

Notes

¹ ‘Sound and electricity were conceptually linked through the concept of water waves and related terms such as current, channel, and flow’ (Rodgers under review).

² Maxwell, commenting in 1878 in the *Encyclopedia Britannica* on the proliferation of aether in physical explanations of substrates through which phenomena of all sorts might travel, used fluidic language to characterize the postulated media: ‘Aethers were invented for the planets to swim in, to constitute electric atmospheres and magnetic effluvia, to convey sensations from one part of our bodies to another, and so on, until all space had been filled three or four times over with aethers.... The only aether which has survived is that which was invented by Huygens to explain the propagation of light.’

Lloyd also uses sonic similes: ‘A classical computation is like a solo voice – one line of pure tones succeeding each other. A quantum computation is like a symphony – many lines of tones interfering with one another’ (p. 138).

³ British music theorist Steve Goodman, who performs as dubstep artist Kode9, in his 2010 book *Sonic Warfare*, posits a ‘vibrational ontology,’ grounded ultimately ‘at the molecular or quantum level’ (p. 83), with ‘all sonic phenomena [...] conceived of as problems of fluid or aerodynamic turbulence’ (p. 113). And ‘The micropolitics of frequency points toward the waves and particles that abduct consumers immersed in both the transensory and nonsensory soup of vibro-capitalism. The backdrop here is an electromagnetic environment that is saturated by radio and television broadcasting transmissions, police, military, air traffic control and meteorological radar, satellite communications systems, and microwave relay links. To the foreground lies the infrasonic and ultrasonic ecology of hydraulic gurgles, industrial rumbles, the seismology of traffic, a cultural tectonics and the synthetic birdsong of alarms, ring tones, bleeps, indicators, and crowd repellents’ (Goodman, 2010, p. 188; cf. Evens, 2005; Kahn, forthcoming).

⁴ Cymatics, writes Steve Goodman, ‘revolve around the way in which materials, objects, and entities affect and are affected by vibration and the way rhythmic motion can become apparent in static objects as well as in moving objects, producing not just patterns but forms continuous with the vibrational environment’ (Goodman, 2010, p. 78; cf. Lauterwasser, 2006).

⁵ Coming from another angle, reading electromagnetic spectra from other planets can produce clues about the composition of distant atmospheres, which can in turn afford material for speculating on the presence of organic compounds and, therefore, life (Des Marais et al., 2002).

⁶ Rodgers quotes Luce Irigaray, from ‘The ‘Mechanics’ of Fluids,’ writing that fluids are ‘a *physical reality* that continues to resist adequate symbolization and/or that signifies the powerlessness of logic to incorporate in its writing all the characteristic features of nature.’ Fluids are often envisaged in an ideal state ‘so as to keep it/them from jamming the works of the theoretical machine.’ According to Irigaray, ‘historically the properties of fluids have been abandoned to the feminine’ (Irigaray 1985a, pp. 106–07, 111, 116 – in Rodgers).

As evidence of this sort of view, consider anthropologist Edmund Leach: ‘Visible, wild Nature is a jumble of random curves; it contains no straight lines and few regular geometrical shapes of any kind. But the tamed man-made world of Culture is full of straight lines,

rectangles, triangles, circles and so on' (Leach, 1976, p. 51; Ingold, 2007, p. 155). Tim Ingold analyzes such analyses: 'a powerful impulse in modern thought to equate the march of progress, whether of culture or civilization, with the increasing domination of an *unruly* – and therefore non-linear – nature' (2007, p. 155).

⁷ Other cultural studies of waves include Evers, 2006, 2009; Finney, 1966. An attempt to model waves and bodysurfing comes in de Mestre, 2004. Even when waves are 'natural,' their effects cannot often be separated from the 'social' – the 2004 Indian Ocean tsunami is a case in point (see Helmreich, 2006). See also 'Hidden waves pack a big punch: Thomas Peacock sheds light on an odd but powerful phenomenon of sea and sky,' David L. Chandler, MIT News Office: web.mit.edu/newsoffice/2009/waves-091809.html

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Insights

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