

Integrating information in the brain's EM field: the cemi field theory of consciousness

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Mike Phuycharoen

Physically integrated information

‘Love is a smoke made with the fume of sighs’

William Shakespeare, Romeo and Juliet

‘What’s the best way to fix a bicycle that has a rope caught in its spokes?’

Gary Marcus ‘Deep Learning: A Critical Appraisal’ ([Marcus 2018](#))

- how is information integrated and perceived as one concept?

Neuronal firing rates thereby encode information about the outside world because some of its degrees of freedom are correlated with degrees of freedom of the outside world.

Binding problem

“many studies that demonstrate that the binding provided by consciousness is indeed required to solve general intelligence problems, particularly sequential tasks that require working memory, such as

- *memory trace conditioning (Carter et al. 2006),*
- *multi-step calculations (Dehaene and Cohen 2007),*
- *goal-directed behaviour and strategic planning (Dehaene and Naccache 2001),*
- *learning over time (Fuster 1991),*
- *language (but not word) comprehension (Hagoort and Indefrey 2014),*
- *social intelligence and interactions (Dunbar et al. 2010; Lieberman 2012) and creativity (Kaufman et al. 2010).”*

What is conscious neuronal information?

information encoded in the brain that correlates with the information encoded in the subjective reports (the receiver) of a conscious observer.

What is the physical manifestation?

- motion of ions through neuronal membrane,
- the motion of neurotransmitters within the synaptic cleft,
- the opening and closing of ion channels,
- blood flow or electromagnetic (EM) field perturbations generated by the motion of electrically charged particles

Category error

- *visitor to Oxford (who) visits the library and colleges but then asks 'But where is the University?'*
- *The integration is via a causal chain of operations in **time**, rather than physical integration in space.*

AND gate – information integrated causally in time

The integration exists as a correlation in time, not as a physical integration in space.

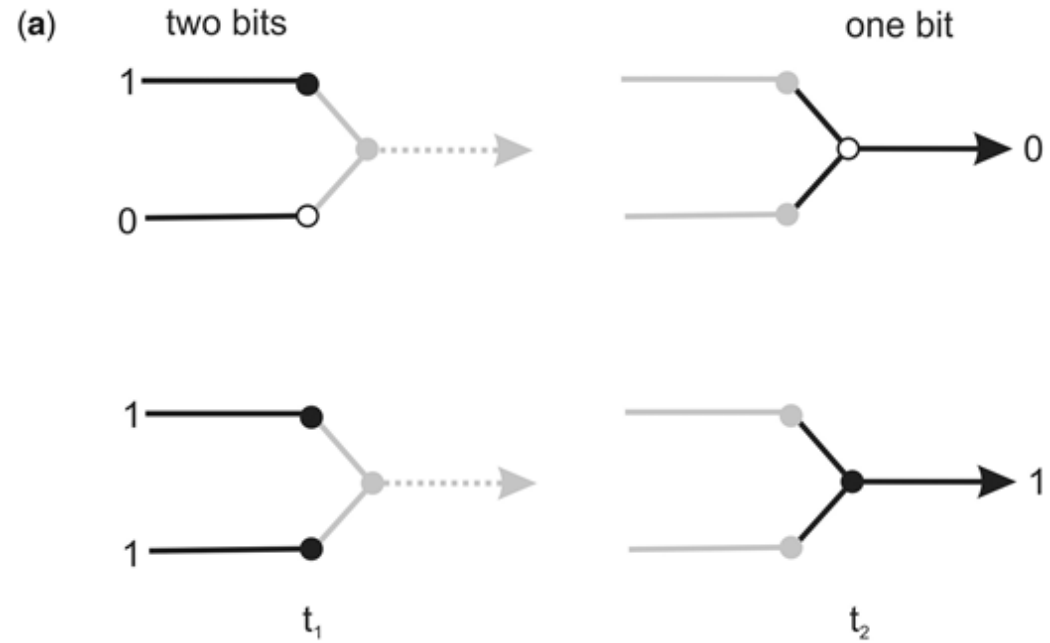
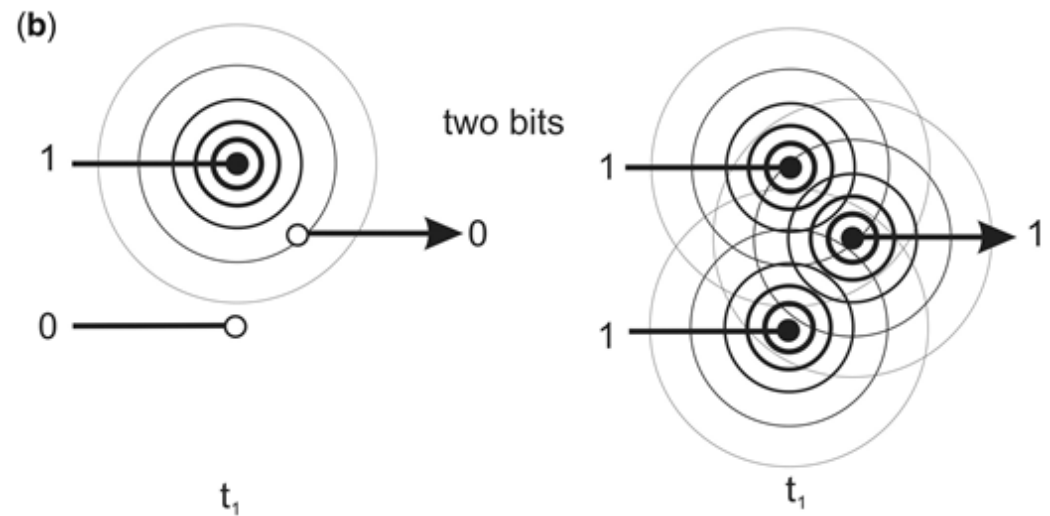


Illustration of how dynamic EM field information can integrate information and function as a logic gate.



Neurons

- *...only encode a single firing rate that cannot represent anything more than a tiny fraction of the information present in conscious percept.*
- *Neurons integrate information but, as for logic gates, the integration is temporal, not physical, as the information to be integrated is separated in both space and time.*
- *This kind of temporal integration cannot correspond to 'our capacity to integrate information across time, space, attributes and ideas' (Treisman 1999).*
- *All that is required is a causal chain.*

Neural networks

- *If physical connectedness was sufficient for consciousness, then we would be aware of all of the information encoded in our entire body at all times.*
- *Neural networks, on their own, cannot be responsible for physically integrating conscious information because, like integrated circuits, they integrate information only temporally, not physically.*

Integrating information in space

- *the EM field at any point in space represents an integration of information concerning the type, distribution and motion of local charges.*
- *In contrast to the temporal integration described above, force fields physically integrate complex information that may be simultaneously downloaded from any point in the field.*

- *Note that the magnetic field-encoded information would be present whether the iron filings were there or not. The coding of the image would exist in space as invisible integrated information. **This kind of coding is, I argue, much closer to the physical reality of our thoughts, than a firing neuron.***



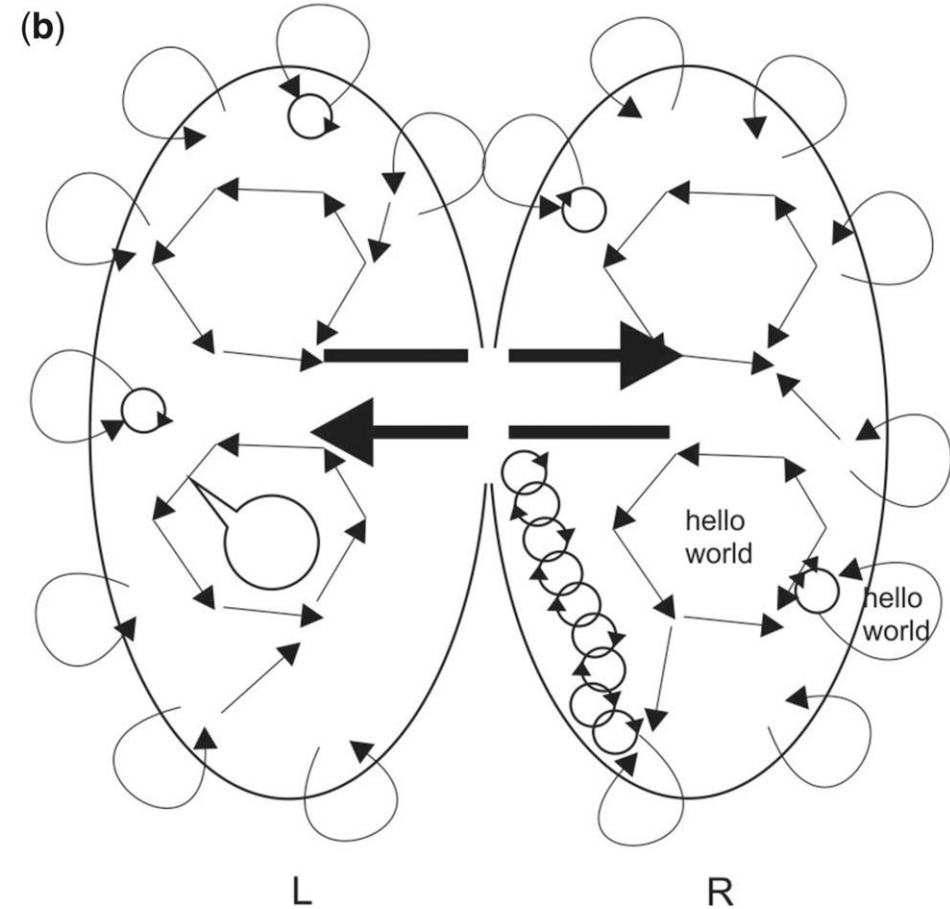
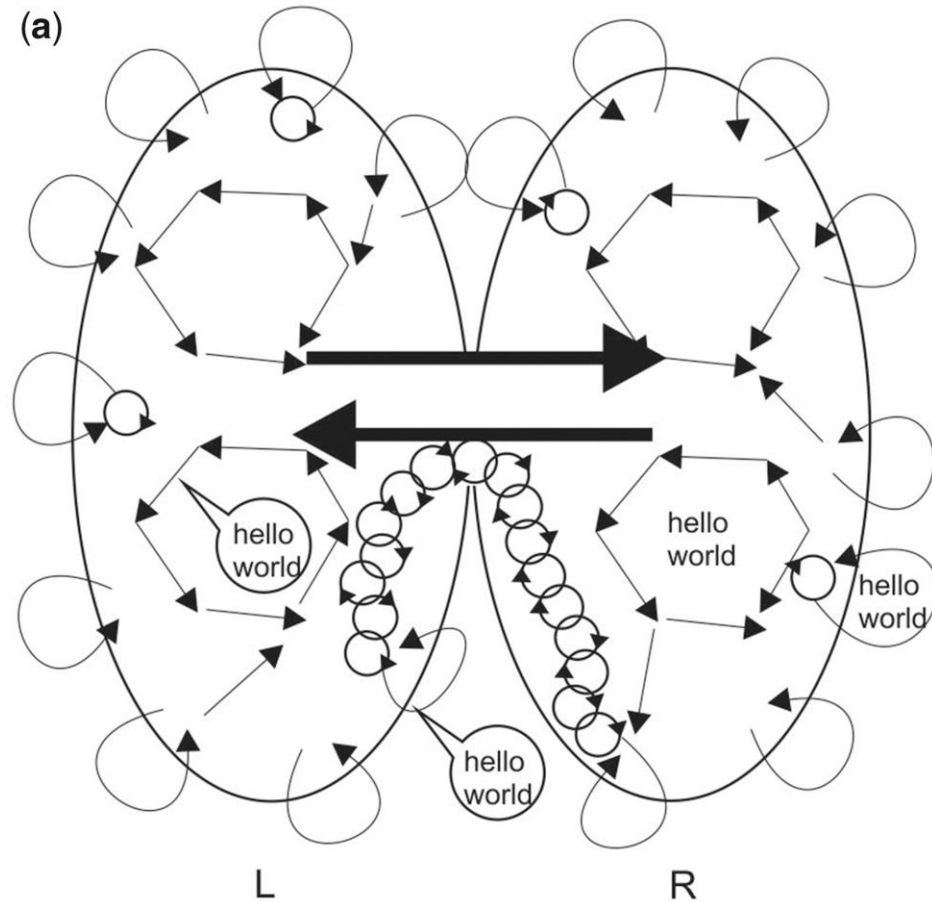
Consciousness

In this sense, the field possesses features in common with holograms that similarly store distributed information. But in the case of the cemi field, the information exists as an algorithm in space, rather than time. It is physically integrated information.

Field-implemented algorithms such as these, but in the brain, are, I argue, the physical substrate of conscious thoughts.

- Consciousness is what physically integrated information *feels like*, from the frame of the photons encoding that information.

I estimated that the EM field electrical perturbation from the firing of a single neuron extends into a volume of only about $80\ \mu\text{m}$ encompassing a maximum of about 200 neurons (McFadden 2002a). So, in contrast to matter-based signals that do not attenuate with distance, signals passing through the cemi field will tend to act only locally, unless boosted by chains of synchronization (see below).



- Note however, and very importantly, that, in contrast to temporally integrated information, an algorithm in space can function only when its computational nodes fire synchronously so that their inputs are simultaneously available to all the components of the network.

Therefore, a key prediction of the proposal that consciousness is distributed EM field-based algorithms is that **conscious information will be correlated with synchronously firing neurons.**

- (Wilke *et al.* 2006) investigated awake monkeys.

They demonstrated that spiking of neurons in cortical areas V1 and V2 was totally uncorrelated with the monkey's perception of the target; however, low frequency (alpha range, particularly 9–30 Hz) modulation of local field potentials—presumed to be generated by synchronously firing neurons—in these same regions did correlate with perception.

- conscious auditory perception is correlated with long-range synchrony of gamma oscillations (Steinmann *et al.* 2014).
- highly synchronized brain activity, such as is typical for epileptic seizures, disrupt consciousness.

'Free' will

- EM field potential changes of less than 1 mV across the neuronal membrane are nevertheless capable of modulating neuronal firing (Schmitt et al. 1976)
- for neurons poised close to the critical firing potential, the opening of just a single ion channel may be sufficient to trigger firing (Arhem and Johansson 1996).
- brain's endogenous EM field influences brain activity in a feedback loop (...) is entirely causal.

The cemi field theory of consciousness

- *when searching for an appropriate substrate in the brain that can physically integrated complex information, the move draws an immediate payoff, as it effortlessly solves the binding problem*
- *information in the field, (...) is always integrated yet distributed*
- *it also provides a feasible physical substrate for the notions of working memory and/or the global workspace*

Consciousness

- *The dominant information in consciousness will then be the one that is associated with the strongest EM field perturbation capable of modulating neural firing within that singular field.*
- *competition between rival percepts is resolved through positive feeding back loops within re-entrant circuits*

$$E = mc^2$$

- *Matter and energy are equally physical;*
- *(Note that, by illustrating this idea with Einstein's equation, I am not, of course, proposing any interconversion of matter and energy in the brain.)*
- *This is a kind of dualism, but it is scientific dualism based on the physical difference between matter and energy, rather than a metaphysical distinction between matter and spirit.*

Conscious and non-conscious

- *brain operates simultaneously in both conscious and non-conscious streams*
- *impact of the brain's endogenous EM field on neuronal computations is likely to be both positive and negative.*
- *neuronal circuits in which EM fields enhance fitness would have been positively selected; as would genes that decrease EM field sensitivity in neuronal circuits in which EM fields decreased fitness*

Complexity

- *the theory does not predict that, (...) information integration is either exclusive to, or maximal in, consciousness.*
- *tasks that require a considerable degree of information integration, such as recognizing words, or whether one number is greater or less than another, may be performed without awareness*
- *natural language comprehension, require the simultaneous spatial integration provided by the cemi field*

Learning

- Consciousness is required for learning
- *when learning a new motor skill, such as playing the piano, the small conscious pushes and pulls towards or away from neural firing (as anticipated by William James) provided by the brain's endogenous EM field may be essential for delivering the fine motor control needed to hit the right notes at the right times*

Serial and parallel execution

- *That the non-conscious mind can operate in parallel is not problematic. With 100 billion neurons...*
- *two thoughts emerging within a brain's global EM field will always interfere with one another*

Is toaster conscious?

- *The minimal characteristic of an EM field to qualify as conscious must surely be that it possesses sufficient complexity to encode complex computations together with causal power capable of transferring thoughts to another conscious being.*

Artificial consciousness

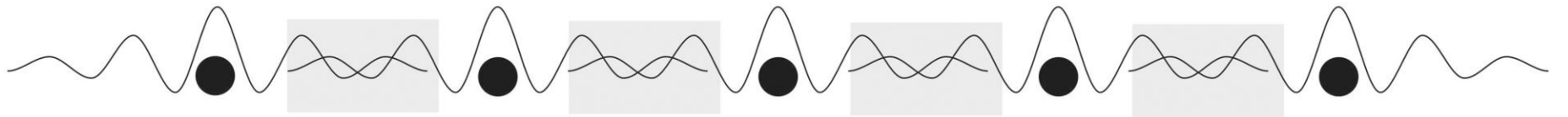
- *semi field theory insists that conventional computers will never be conscious*
- EM field-sensitive computer is needed
- *FPGA (...) distinguishing between two musical tones. After 5000 generations of this artificial selection, they succeeded (...). However, when they examined its circuit diagram they discovered that some of its components which, if removed, impaired function, yet were not connected by wires to either inputs or outputs. (...) The performance of the chip was erratic and tended to work best at night.*

de Broglie wavelength

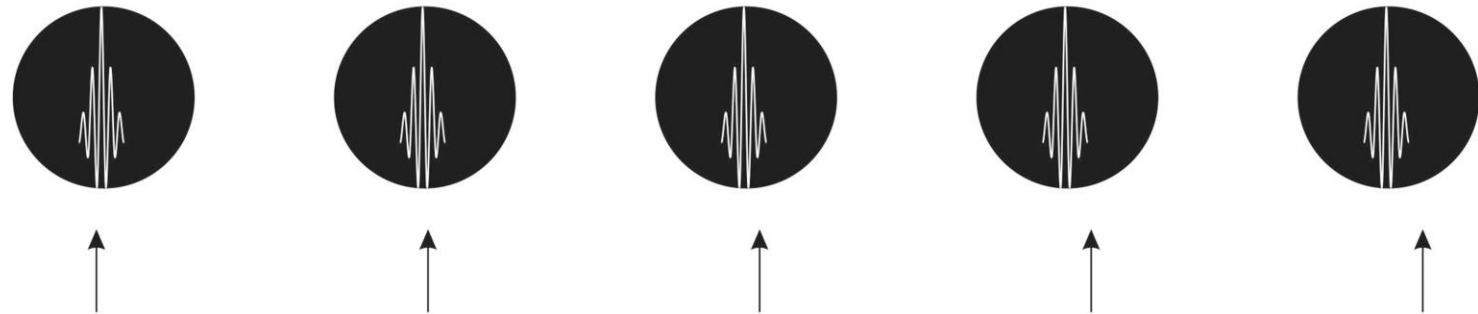
photons



electrons



protons



We can, for example, consider what it would be like to be one photon in the cloud of photons (the cemi field) that travel from emitting to receiving electrons in neuronal membranes of the brain. From their frame, since they are massless particles that travel at the speed of light, they experience neither space nor time between emission and reception.

Between these points, they may carry, say, up to 10 bits of information encoded in the photon's energy, spin and direction (Tentrup *et al.* 2017). However, between emission and absorption, photons are more properly considered as delocalized waves that obey Maxwell's laws.

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Conclusions

- Consciousness is what physically integrated information *feels like*, from the frame of the photons encoding that information.
- The cemi field is then the superposition of trillions of photon waves whose information is encoded in their ensuing pattern of constructive and destructive interference.
- **meaning** is an algorithm experienced, in its entirety from problem to its solution, as a single percept in the global workspace of brain's EM field.