

http://www.scholarpedia.org/article/Field_theories_of_consciousness

notes on *Field Theories of Consciousness* by Dr. Susan Pockett

This means that in these theories, consciousness is seen as having not only duration, but also extension in space.

Karl Lashley's test of the validity of EM fields as the basis of consciousness was to lay several gold strips across the entire surface of one monkey's brain, and insert about a dozen gold pins into a rather small area of each hemispheric visual cortex of another monkey. The idea was that these strips or pins should short-circuit the hypothesized figure currents.

Lashley felt justified in concluding from this that "the action of electric currents, as postulated by field theory, is not an important factor in cerebral integration." Later Roger Sperry (Sperry et al 1955) did experiments similar to Lashley's, reporting similarly negative results.

No present-day neurophysiologist would expect Lashley's (or Sperry's) slices, strips and pins to produce any significant changes in the field potentials that modern researchers would understand as underpinning a field theory of consciousness. Field potentials are generated by the flow of current into and out of [neurons](#), not across large regions of extracellular space.

The central idea of the electromagnetic (EM) field theory of consciousness is that conscious perceptions ... are identical with certain spatiotemporal electromagnetic patterns generated by the normal functioning of waking mammalian brains.

Susan Pockett started trying to publish such a theory in the *Journal of Consciousness Studies* in 1995 (Pockett 2002) without success.

Pockett worked the concept into a book manuscript (which was again rejected by a series of academic publishers) and eventually put the book out using a demand publisher in the year 2000 (Pockett 2000).

Two years later, the *Journal of Consciousness Studies* finally accepted the electromagnetic field theory of consciousness as an original contribution from Johnjoe McFadden

During this initial period, a great many objections to the basic idea were advanced in various fora.

Probably the most obvious *a priori* objection is that common external electromagnetic fields – radio waves, mains voltage, the magnetic fields inside [MRI](#) (magnetic resonance imaging) machines – demonstrably have no effect on consciousness.

plausible refutations of the original objection are that (a) radio waves are of much higher frequency than the proposed conscious fields, so would not be expected to affect their relevant features (b) mains voltage is about the same frequency as the [oscillations](#) proposed as being conscious, but electromagnetic oscillations at these frequencies radiate so inefficiently that virtually no power is detectable a few cm from a wall socket (c) the magnetic field inside an MRI machine is powerful enough, but does not have the right spatial configuration to couple with the putative conscious field.

But the killer refutation of this objection is essentially a generalization of (c). It is that none of the common ambient EM fields is patterned in the spatial domain. If the inverse spatial pattern of a putatively conscious field pattern were applied externally, the conscious pattern would indeed be cancelled and the conscious experiences represented should be ablated. But if spatially unpatterned external fields are imposed on the brain, the physics of [electromagnetism](#) dictates that the putatively conscious field pattern will simply ride up and down on the spatially unpatterned external field, as a boat rides up and down on the waves of an ocean. In the jargon of physics, there will be no coupling between the two fields, so both will continue, unaffected by the presence of the other.

A third commonly advanced objection to the electromagnetic field theory of consciousness is that it has no obvious advantages over the widely accepted neural identity theory and therefore should not be adopted. Two answers to this objection are that (a) even if it were true that the electromagnetic field theory of consciousness made no significant predictions over and above those of the psycho-neural identity theory, it is not necessarily true that the first theory to appear is the right one, and (b) in fact the electromagnetic field theory does, in at least one major respect, deliver more than the psycho-neural identity theory ever could. The difference is that the electromagnetic field theory of consciousness predicts that in principle, consciousness could be generated using hardware instead of wetware. This single prediction not only renders the electromagnetic field theory testable where the neural identity theory is not – it also opens wondrous vistas with respect to possible future technologies.

(b) Controversy about possibility of causal action of proposed conscious patterns

First, it has never been disputed that electromagnetic fields can and do affect neuronal function. Chapter 7 of Pockett (2000) lists a number of circumstances in which brain-generated em fields had already been shown to affect brain function, in areas that probably do not generate consciousness (including the medulla of the gold-fish, the [cerebellum](#) and the [hippocampus](#) of mammals).

McFadden (2013) supplies more recent examples of the demonstrated action of external EM fields, both *in vitro* (mammalian brain slices) and *in vivo* (the occipital cortex of anaesthetized ferrets).

It is thus quite clear that electromagnetic fields absolutely do have the capacity to influence neuronal activity... in conscious brain tissue.

The generation of EM fields by the brain and the generation of consciousness require [synchronous](#) firing of large numbers of chemical synapses on neocortical pyramidal cells. This fact is pointed out on p.95 et seq. of the hard copy version of Pockett (2000), as well as in a number of papers by McFadden (2002a,b; 2006; 2013). The mechanism by which extracellular electromagnetic fields are generated by the synchronous activity of chemical synapses on neocortical pyramidal cells is illustrated diagrammatically in Pockett (2012).

The question at issue is whether spatial EM patterns like those proposed as being conscious can *transfer the information encoded in their spatial patterning* back to their own brains in such a way that this information can be the direct cause of specific behaviours.

McFadden argues on general grounds that they can. Pockett argues on specific grounds that they can not.

The spatial patterns in question are highly likely to be composed of multiple electric dipoles (each generated by the synchronous action of many synapses on many neocortical pyramidal cells) in a series of adjacent cortical columns (Pockett 2007, 2012). The basic physics of electromagnetism dictates that the strength of the EM field produced by an electric dipole falls off ... with the *cube* of distance from the source. This means that the EM field encoding a conscious percept is very local. In other words, the spatial EM pattern encoding any given conscious experience is undetectable quite a short distance away from where it was generated.

This in turn means that putatively conscious EM patterns should be capable of acting *as patterns* only on the same neurons that generated them. Neurons even slightly further away would simply not “see” these patterns at all.

Since the neurons directly causing behaviour are in general much too far away from the neurons that generate ... sensory experiences, the implication is that if sensory experiences and decisions *are* spatial EM patterns, consciousness (or at least sensory consciousness and conscious decisions) *should not be able directly to cause behaviour*.

This general argument is potentially damaging if not fatal to the EM field theory of consciousness. If, as we all intuitively believe, our voluntary actions are generated by our conscious thoughts, putatively conscious EM fields should be able to generate actions...

It thus becomes important to know whether consciousness (irrespective of what that may turn out to be) does directly cause behaviour.

Counterintuitively, it turns out that a large confluence of evidence has accumulated over the last decade to suggest that largely, it does not (Pockett 2004; 2011; Pockett et al

2006). Even behaviour generally accepted as being voluntary turns out to be initiated unconsciously.

(c) Proposal on 3-D shape of conscious as opposed to unconscious em patterns

The realization that the initiation of bodily actions is not accessible to consciousness allows a proposal about the 3-D structure distinguishing conscious em patterns from non-conscious em patterns (Pockett 2012).

It is now well accepted that sensory consciousness is not generated during the first, feed-forward pass of neural activity from the [thalamus](#) through the primary sensory cortex. Recurrent activity from other cortical areas back to the primary or secondary sensory cortex is necessary. Because the feedforward activity goes through architectonic Lamina 4 of the primary sensory cortex (which is composed largely of stellate cells and thus does not generate synaptic dipoles) while recurrent activity operates through synapses on pyramidal cells (which do generate dipoles), the conscious em patterns resulting from recurrent activity in the 'early' sensory cortex have a neutral area in the middle of their radial pattern. The common feature of brain areas that can not generate conscious experience – which are now seen to include [motor cortex](#) as well as hippocampus, cerebellum and any sub-cortical area – is that they all lack an architectonic Lamina 4. Therefore none of the brain areas that are unable to generate consciousness produces EM fields with a neutral region in the middle of their radial pattern. Thus the feature that distinguishes conscious from unconscious patterns is proposed to be a neutral area corresponding to Lamina 4.

http://www.scholarpedia.org/article/Field_theories_of_consciousness/Field_theories_of_global_consciousness

It is probably worth noting at this point that the electromagnetic field theory of consciousness described in the main article does allow for the conceptualization of a form of global consciousness, as the totality of all the individual conscious electromagnetic fields generated by individual brains. However, the standard physics of [electromagnetism](#) dictates that the individual conscious fields proposed by the electromagnetic field theory of consciousness would not ordinarily propagate well through space, because their [oscillation frequency is too low \(of the order of 1-100 Hz\)](#). The optimal antenna for picking up a radio signal is about one wavelength long. The wavelength of a 40 Hz electromagnetic oscillation is approximately 8,000 km. So on the electromagnetic field theory of consciousness, either a major increase in power (such as could conceivably be provided by a large assembly of brains all doing the same thing at the same time), or a very sensitive detector (such as could conceivably be provided by the brains of a few, rare, 'psychically gifted' individuals) – or an 8,000 km wide brain – would be needed to underpin any kind of action-at-a-distance effects of or on human consciousness.