

**Electromagnetic Fields,**  
**A Brief Summary**  
**For The Non-Scientist Executive,**  
*Houston We Have A Problem*  
**Summary #1** Rev. 3

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<http://www.rfreduce.com/robertsblog/research>

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## **A Note To The Busy Executive**

The text of this paper is only 9 pages.

The majority of this document is in Appendix 1, which offers references to various research studies that represent a small fraction of research in this area.

You don't have to read the Appendix but it is worth your while to glance through it and appreciate the **considerable research done in this area.**

Just read the first 9 pages.

# 1.0 Theory

## 1.1 Fields

This will not get too complicated, but do read through it.

There are:

- Electric Fields
- Magnetic Fields
- Electromagnetic Fields

## 1.2 The Electric Field

An electric field is a fundamental component of electricity, physics and technology. It is somewhat of an invisible influence that extends from (radiates from) a source.

In electrical circuits, the electricity has a voltage. Think of voltage as the “push” of the electricity. In other words the electricity wants to flow and voltage is “how strongly” it is trying to flow.

The D-cell battery has a voltage of 1.5 volts.

Typical residential utility service in the US has 120 volts.

The simple existence of a voltage on a circuit, wire, in an appliance, etc. is causing there to be an electric field in that vicinity. Therefore, if an appliance is plugged into a live electrical outlet, but the appliance is not turned on, there still will be an electric field radiating from that appliance and an electric field radiating from the electrical cord that connects the appliance to the electrical outlet. Simply because there is a voltage there, waiting to flow, trying to flow, then there is an electric field.

**IMPORTANT:** If the voltage is changing, then the electric field that it is producing is also changing.

In the case of the battery, the voltage is Direct Current (DC) and it is always 1.5 volts, so the electric field from that battery voltage is not changing.

In the case of the utility power, the 120 volts is an Alternating Current (AC) so the electric field from that voltage is changing. In the US it is changing at 60 cycles per second (60 Hz).

## 1.3 The Magnetic Field

A magnetic field is a fundamental component of electricity, physics and technology. It is somewhat of an invisible influence that extends from (radiates from) a source.

A magnetic field can be produced by a simple magnet, such as a simple bar magnet.

A magnetic field can also be created by the flow of current (electrons) in a conductor, such as the flow of current in a wire.

Do you remember the elementary school experiment where you created an electromagnet from an iron (steel) nail, a coil of wire and a battery?

It behaved as a magnet as long as the current (a flow of electrons) is flowing through the coil of wire from the battery.

**IMPORTANT:** If the current flowing in a conductor is changing, then the magnetic field that it is creating, is changing as well.

In the case of the grade school electromagnet experiment, the battery provides a Direct Current (DC), so the current (in this example) is not changing, as a result, the magnetic field from the coil of wire is not changing.

In the case of the utility power, the 120 volts is an Alternating Current (AC), so if there is, say, a lamp turned on in a residence, then there is a flow of current (a flow of electrons) through the wiring to that lamp that is constantly changing, and therefore, the magnetic field that is created by that flow of current, is constantly changing as well.

## 1.4 The Electromagnetic Field (EMF)

Both electric fields and magnetic fields, theoretically have an influence to the end of the Universe. The influence of either field, gets weaker as you move away from it so while a field may theoretically go a great distance through space, we don't have the ability to measure it at those far distances. So at some distance from the source of a field, we say that the field strength is essentially zero.

An electromagnetic field is a combination of an electric field and a magnetic field that are traveling together through space, with a well-defined relationship to each other.

Creation of An EMF

- If an electric field is changing, that changing electric field will create a changing magnetic field. They will be locked together in a precise way and they will travel outwards from their source.

- If a magnetic field is changing, that changing magnetic field will create a changing electric field. They will be locked together in a precise way and they will travel outwards from their source.

## 1.5 Radio Frequencies (RF)

Radio Frequency radiation is EMF. Let there be no misunderstanding on this point. It is not “something else” or “another type of radiation”.

Radio Frequency radiation is simply EMF that has a special purpose. Examples are the transporting of information (voice, video, data) or a use such as location determination systems (radio beacons, radar, etc.).

## 1.6 Induction (This Is Important)

Induction is the process where an electric field or magnetic field causes an effect in some system, circuit, matter, etc.

Examples:

- A radio receiver (AM/FM radio, TV, 2-Way radio, etc.) has an antenna. If there is an EMF in the neighborhood of the antenna, a voltage and current will be induced into the antenna, from that EMF.
- A power generator or alternator, works by incorporating a changing magnetic field, that induces voltage and current into a coil of wire that supplies power to an electrical load – such as a lamp.

The examples above are cases where the induction that is occurring is indeed intended.

### Definition of Induction

For the purposes of this paper, induction is defined as:

- A changing field causing a voltage and current to “appear” in some matter, device, circuit or system, where that matter, device, circuit or system is a conductor of electricity.

The changing field can be a pure electric field, a pure magnetic field or a combination of both, that is called an electromagnetic field (as defined earlier).

The two examples above (radio receiver and generator/alternator) are very common examples of a changing field causing voltage and current to “appear” in some circuit that conducts electricity.

## 1.7 Unintended Induction (This Is Very Important)

**When there is a changing field present in some location, a voltage and current will be induced into anything and everything that conducts electricity, unless some kind of shielding or protection is employed.**

Read the sentence above, again.

Of the plethora of sources of fields (electric, magnetic, electromagnetic) in any particular location, those fields will all be inducing voltages and currents into everything in that location that is a conductor of electricity, unless some technique of shielding or protecting is in place.

Examples of Unintended Induction

- A fisherman is in a boat on a body of water, that is salt water. The fisherman has a walkie-talkie. When the fisherman keys the walkie-talkie to transmit, an EMF signal (a RF signal if you prefer) is sent out into the air, but some of it also goes into the body of water (salt water) that his boat is floating upon, and a voltage and current is induced into that salt water.
- Staying with the idea of a body of salt water ... Imagine that there are utility power lines, mounted on poles, going along the edge of a body of salt water. There are changing fields emanating from those power lines and those changing fields are inducing voltages and currents into the salt water.

Perhaps you have jumped ahead to the similarity of the above “body of salt water” to the human body. The human body is mostly water and has 12 different biochemical salts dissolved in that water. **Yes, any changing field that is in the same location as a human body, will cause corresponding voltages and currents to be present in, to be induced into, the human body.**

Yes there are means to shield the body. Indeed tower workers who climb radio frequency towers, will often wear metal netted suits to protect them from having voltages and currents induced into their bodies.

## 2.0 Sources of EMF

There are quite a few sources of EMF in the modern world. Some are stronger radiation than others. Here is a list of some of them:

- Power utility lines (50-60 Hz) and (Dirty Electricity: 100 Hz to 2 Mhz)
- Power utility transformers (50-60 Hz) and (Dirty Electricity: 100 Hz to 2 Mhz)
- Dirty Electricity from switching Inverters used in wind and solar power generation systems (16 Khz to 1 Mhz)
- Appliances: washer, dryer, refrigerator, electric ovens, heaters, furnaces, air conditioners, hair dryers, HiFi equipment, lamps, vacuum cleaners, fans, motors of all types, etc. (50-60 Hz to 2 Mhz)
- Computer equipment: CPU box, monitors, wireless peripherals (20 Khz to 5 Ghz)
- Cordless phones (50 Mhz to 5.4 Ghz)
- 2 way radio base stations, mobiles, walkie-talkies (1.8 Mhz to 1.8 Ghz)
- Mobile/Cell Phones, handsets and base stations, aka towers (150 Mhz to 3.2 Ghz)
- Communications links for computer and peripheral networking, Bluetooth, Wifi, WiMax, etc. (900 Mhz to 5.4 Ghz)
- Microwave relay base stations (300 Mhz to 18 Ghz)
- Radio Stations AM (500 Khz to 1.7 Mhz)
- Radio Stations FM (88 Mhz to 108 Mhz)
- Television Stations (54 Mhz to 1 Ghz)
- Radars: airport, weather, military ( 50 Mhz to 18 Ghz)
- Industrial induction heating (50-60 Hz to 2 Mhz)
- Arc welding (50-60 Hz to 18 Ghz)
- Various commercial and industrial equipment and infrastructure: electric fork lifts and man lifts, elevators, escalators, electric power tools, compressors, etc. (50-60 Hz to 2 Mhz)
- Electromagnetic warfare (Khz to Ghz)



## **3.0 EMF Effects On Humans**

### **3.1 Is There A Demonstrable Effect On Biological Systems From External EMF ?**

For decades there has been debate on the possibility of a threat to human health by EMF. While the characterization of the threat, including specific details of the associated EMF induction itself have been studied and argued, the existence of studies that report “no clear effect” at all, is no longer dominating this discussion.

Researchers Marino and Carrubba (Louisiana State University) have offered a clear analytical approach that they claim has indeed shown: that with correct data analysis, a demonstrable effect, from EMF, will always be identifiable in the biological system.

From Reference (1), the authors write:

“After the first concerns that man-made electromagnetic fields in the environment might be a hazard to public health were raised almost 40 years ago (Becker, 1972; Adey, 1976), the main counter-argument was that the reported EMF-induced bioeffects were inconsistent, thereby indicating only the existence of inconspicuous experimental errors, not real biological processes. There never was any reliable evidence that the argument was true. Now, there is clear evidence the argument is false; magnetosensory evoked potentials elicited by EMFs can be detected in essentially every subject examined when the proper form of analysis is used (Carrubba et al., 2008).”

By use of non-linear analysis, the authors claim that a clear effect in the biological system is indeed shown. Again from Ref (1) they write:

“When the effects of EMFs on brain electrical activity were analyzed using mathematical tools that had been developed for studying nonlinear systems, it became possible to capture the deterministic activity in the EEG caused by the stimulus (regardless of whether it was an increase or a decrease) prior to comparing means in a statistical analysis. Capturing the effect of the stimulus prior rather than subsequent to averaging the data was the key step that enabled us to overcome the problem that we identified, and allowed us to show that EMFs were consistently transduced by essentially all the animal and human subjects (Marino et al., 2002; Carrubba et al., 2007a). We showed that a fundamental effect of an EMF stimulus is the triggering of onset and offset evoked potentials in the brain (Carrubba et al., 2007a), and we described a procedure by which their presence can be demonstrated consistently, in every subject, with the requisite statistical reliability (Carrubba et al., 2008).”

For the scientists who have missed or choose to ignore the underlying truth that the human being is an expression of the field of unbounded consciousness, those scientists would perhaps say, that the human being is an extremely sophisticated electro-chemical system.

Regardless of the understanding and acknowledgment of the central and originating aspect of consciousness in the human, all will likely agree, that the human being has its own voltages and currents, of various frequencies. These will, and do, radiate electric or magnetic fields into space.

**Conversely, any fields that are externally imposed upon the human (from the sources cited in paragraph 2 above) will cause induction of voltages and currents into the human body.**

Can these voltages and currents, induced into the human body from external sources, cause ill health or exacerbate existing ill health conditions?

There are many researchers who have studied the effects of these externally induced voltages and currents and have elaborated a variety of causes and resulting health effects. Indeed the above-cited researchers along with other colleagues have conducted many research projects that address this very subject in an exacting way. See also Appendix 1.

### **3.2 Some Of The Cited Effects On Biological Systems From External EMF**

The following short list is neither authoritative, nor exhaustive. It serves as a sample of the many conditions and disorders that are cited in research studies as resulting from EMF exposure.

The following symptoms are found to be reported, very frequently, as an immediate ill health response.

- Insomnia
- Headache
- Dizziness
- Heart palpitations
- Irritability or agitation
- Impaired cognitive function
- Weakened immune system response

With continued exposure to EMF, or with high EMF field strength, increased severity of effects are reported, and also, additional symptoms and diseases are reported. Some of these diseases are quite serious. In the interest of keeping this document as an overview, those ailments will not be listed or discussed here.

## 4.0 The So-Called FCC Safe EMF Exposure Limits

Proponents of the proliferation of EMF for various purposes, will often cite that the EMF strengths that are being referred-to are within the FCC (U.S. Federal Communications Commission) so-called safe limits for exposure.

Researchers, public officials and citizens, who believe that the FCC exposure limits are too high, will counter those statements with arguments, that (to just name a few):

- the FCC limits do not address long term, chronic exposure.
- the FCC limits are considerably higher than other government (other countries) limits.
- the FCC limits are considerably (1,000 to 1,000,000s times) higher than studies have shown produce ill effects.
- the FCC limits address only thermal heating of tissues.
- **the FCC limits do not take into account the so-called “pulsed effect”.**

Interestingly, other agencies within the US Federal government agree that the FCC limits are inadequate for a variety of reasons and they have gone on record (public record) to recommend that the FCC overhaul it's limits.

One such agency is The Department of Health and Human Services, the National Institute For Occupational Safety and Health (NIOSH).

In a letter to the FCC, NIOSH clearly conveys that the FCC limits need overhauling. In a compelling, 173 page letter and research report attachments, NIOSH presents a convincing case.

This letter (and attachments) are dated January 1994.

NIOSH made the letter (and attachments) available as a series of PDF documents available at the web page below. When you reach the page below, scroll down to find the actual document links.

<http://www.rfreduce.com/robertsblog/research>

NOTE: As of the June – November 2013 time frame, it appears that the FCC may be looking at revision of its so-called exposure standards.

It has been 19 years .....

## 5.0 Summary

Electric, magnetic and electromagnetic fields are, just about, everywhere. They can and they do “get into” the human body.

The appendix of this paper gives a list of research papers that provide a sobering view that EMF has a profound effect on the human being and that “effect” is most often found to be damaging to human health. Despite the length of this list, it is actually a short list.

Executives can no longer ignore or dismiss this topic with the often-heard comment: “everyone is talking on cell phones anyway”. EMF in the modern world ranges from power line and dirty electricity frequencies, to the WiFi and Cell phone region, and beyond. The proliferation of EMF is increasing and increasing. The word “wireless” is considered by many to be a glorious war cry, which will bring convenience, efficiency and new and wonderful possibilities.

Many people believe that it has, and continues to bring, disease.

Do you want to be a part of that ?

## About The Author

I am a research and development engineer with 44+ years of experience in research, design and development of circuits, devices and systems. This has included a variety of measurement systems, such as electromagnetic instruments and devices. Twenty three years of my career were in aerospace where I designed spacecraft, launch vehicles and a wide variety of supporting ground equipment and systems.

I am currently active in a variety of equipment and system development projects, including custom embedded measurement systems. My brother Greg and I have produced a variety of products to mitigate, in one way or another, EMF from cell phones, dirty electricity, etc. Since this is not a sales brochure I will not elaborate those here. IF you are interested you may visit:

<http://mxdna.com>

You may contact me with questions or for consulting at:  
research AT rfreduce DOT com

My resume and video may be found at:

<http://robertpalma.com>

This document is located online at:

<http://rfreduce.com/mxdna2/downloads#emfbusyexecutive>

## **References ( 108 In All )**

[1] The Effects of Low-Frequency Environmental-Strength Electromagnetic Fields on Brain Electrical Activity: A Critical Review of the Literature  
SIMONA CARRUBBA AND ANDREW A. MARINO  
Department of Orthopedic Surgery, LSU Health Sciences Center,  
Shreveport, Louisiana, USA

## **Appendix 1 - Some Titles and Links To EMF Related Research Papers**

### **IARC Monographs On The Evaluation Of Carcinogenic Risks To Humans RadioFrequency Electromagnetic Fields Mono\_102.pdf**

This publication represents the views and expert opinions of an IARC Working Group on the Evaluation of Carcinogenic Risks to Humans, which met in Lyon, 24-31 May 2011. This report was published April 2013.

#### **Highlights of Findings**

The bulk of evidence came from reports of the INTERPHONE study, a very large international, multicentre case-control study and a separate large case-control study from Sweden on gliomas and meningiomas of the brain and acoustic neuromas. While affected by selection bias and information bias to varying degrees, these studies showed an association between glioma and acoustic neuroma and mobile-phone use; specifically in people with highest cumulative use of mobile phones, in people who had used mobile phones on the same side of the head as that on which their tumour developed, and in people whose tumour was in the temporal lobe of the brain (the area of the brain that is most exposed to RF radiation when a wireless phone is used at the ear). The Swedish study found similar results for cordless phones.

You may Left Click below to read the PDF document, or you may Right Click below to download the PDF document.

[IARC Monographs On The Evaluation Of Carcinogenic Risks To Humans RadioFrequency Electromagnetic Fields Mono\\_102.pdf](#)

## **Study by Carl Blackman, Phd**

Here Blackman uses the term “modulation” to refer-to the pulsing. “Modulation” means changing something about the 900 Mhz carrier and if we “turn it off and on” (pulsing) that is called Amplitude Modulation.

Blackman mentions various biological effects such as:

- causing changes in cell growth, differentiation and proliferation as a “cellular” basis for cancer
- changes in brain tissue chemistry from EMF
- changes in nerve growth factors from EMF, especially in children
- EMF induced changes on cell surfaces can dramatically alter homeostatic mechanisms

This study is included as a PDF.

[Pulsed non-Thermal EMF Effects Literature Review Dr Carl Blackman.pdf](#)

## **Effects of Wi-Fi Signals On The P300 Component of Event-related Potentials During An Auditory Hayling Task.**

### Abstract

The P300 component of event-related potentials (ERPs) is believed to index attention and working memory (WM) operation of the brain. The present study focused on the possible gender-related effects of Wi-Fi (Wireless Fidelity) electromagnetic fields (EMF) on these processes. Fifteen male and fifteen female subjects, matched for age and education level, were investigated while performing a modified version of the Hayling Sentence Completion test adjusted to induce WM. ERPs were recorded at 30 scalp electrodes, both without and with the exposure to a Wi-Fi signal. P300 amplitude values at 18 electrodes were found to be significantly lower in the response inhibition condition than in the response initiation and baseline conditions. Independent of the above effect, within the response inhibition condition there was also a significant gender X radiation interaction effect manifested at 15 leads by decreased P300 amplitudes of males in comparison to female subjects only at the presence of EMF. In conclusion, the present findings suggest that Wi-Fi exposure may exert gender-related alterations on neural activity associated with the amount of attentional resources engaged during a linguistic test adjusted to induce WM.

[Click Here link to NIH Abstract](#)

## **The Controversial FCC (so-called) Safe Exposure Limits**

Proponents of the proliferation of EMF for various purposes, will often cite that the EMF strengths that are being referred-to are within the FCC so-called safe limits for exposure.

Researchers, public officials and citizens will counter those statements with arguments, that (to just name a few):

- the FCC limits do not address long term, chronic exposure.
- the FCC limits are considerably higher than other government (other countries) limits.
- the FCC limits are considerably (1000's to 100,000s times) higher than studies have shown produce ill effects.
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Interestingly, **other agencies within the US Federal government agree that the FCC limits are inadequate** for a variety of reasons and **they have gone on record** (public record) to recommend that the FCC overhaul it's limits.

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This letter (and attachments) are dated January 1994.

NIOSH made the letter (and attachments) available as a series of PDF documents available below.

[47 CFR Part 1 ET Docket No 93-62 NIOSH comments on FCC guidelines 1993 001-025.pdf](#)

[47 CFR Part 1 ET Docket No 93-62 NIOSH comments on FCC guidelines 1993 026-050.pdf](#)

[47 CFR Part 1 ET Docket No 93-62 NIOSH comments on FCC guidelines 1993 051-075.pdf](#)

[47 CFR Part 1 ET Docket No 93-62 NIOSH comments on FCC guidelines 1993 076-100.pdf](#)

[47 CFR Part 1 ET Docket No 93-62 NIOSH comments on FCC guidelines 1993 101-125.pdf](#)

[47 CFR Part 1 ET Docket No 93-62 NIOSH comments on FCC guidelines 1993 126-150.pdf](#)

[47 CFR Part 1 ET Docket No 93-62 NIOSH comments on FCC guidelines 1993 151-173.pdf](#)

### **Study, Dr. Andrew Goldsworthy on Bio Effects**

This study refers to a wide range of frequencies from low power line frequencies, sometimes referred-to as ELF, (extremely low frequency) all the way up to WiFi frequencies 2.4 Ghz (gigahertz, i.e. microwave frequencies).

Note as you peruse the study that there is reference to the pulsed effect of these EMF signals.

Here is a brief quote from Goldsworthy's paper:

#### ***Why Microwaves Are Particularly Damaging***

The frequency of the carrier wave is also important. Higher frequencies such as the microwaves used in cell phones, WiFi and DECT phones, are the most damaging. Our present exposure to man-made microwaves is about a million billion billion (one followed by eighteen zeros) times greater than our natural exposure to these frequencies. We did not evolve in this environment and we should not be too surprised to find that at least some people may not be genetically adapted to it. As with most populations faced with an environmental change, those members that are not adapted either become ill, die prematurely or fail to reproduce adequately. Ironically, those who are electromagnetically intolerant may be better equipped to survive since they are driven to do whatever they can to avoid the radiation.

[Biol Effects EMFs Dr Andrew Goldsworthy 2012 NZ2rev.pdf](#)



## **SENSORY TRANSDUCTION AS A PROPOSED MODEL FOR BIOLOGICAL DETECTION OF ELECTROMAGNETIC FIELDS**

**Harold Sonnier PhD and Andrew A. Marino PhD**

### **ABSTRACT**

Laboratory studies of the biological effects of low-frequency electromagnetic fields (EMFs) have demonstrated that the fields can produce or alter a wide range of phenomena. Explaining the diversity of the reported effects is a central problem. Our basic hypothesis is that the effects are generally indirect, and arise as a consequence of sensory transduction of the fields. In this view, EMF detection and its biological consequences occur in different types of cells. Experimental verification of the hypothesis will ultimately require data showing that the interaction of EMFs with tissue results in biological changes that are the same as or similar to changes that occur during sensory transduction. The goal was to identify the specific phenomena that would be expected to occur if the hypothesis were true. We therefore analyzed the presently accepted models of sensory transduction in the somatic and special senses. Many kinds of processes were identified in connection with transduction of different kinds of stimuli, but we found that a change in conductance of a membrane ion channel in a neuron or a neuroepithelial cell was the earliest process that occurred in all forms of sensory transduction. Evidence from an appropriate model excitable cell or tissue that EMFs affect membrane currents or membrane potential would therefore support the hypothesis that EMF transduction is a species of sensory transduction.

[SensoryTransduction.pdf](#)

### **ELECTROMAGNETIC FIELDS IN THE CLASSROOM by Andrew A. Marino, Ph.D.**

Electromagnetic fields (EMFs) are present in every area of our environment, including the classroom and the home. Dr. Marino shows that although they cannot be seen, EMFs may have a powerful effect on those exposed to high doses of them over a period of time. In describing EME sources outside the school, as well as inside the classroom, he answers questions that teachers and other school staff members often ask about the hazards of computers and other classroom equipment.

[ELECTROMAGNETIC FIELDS IN THE CLASSROOM.pdf](#)

**THE EFFECTS OF MOBILE PHONE ELECTROMAGNETIC FIELDS ON  
BRAIN ELECTRICAL ACTIVITY: A CRITICAL ANALYSIS OF THE  
LITERATURE**

**Andrew A. Marino, Ph.D.  
Professor Department of Orthopaedic Surgery  
LSU Health Sciences Center**

[MobilePhoneEffects.pdf](#)

**Electromagnetic Energy In The Environment And Human Disease**

**Andrew A. Marino, Ph.D.  
Professor Department of Orthopaedic Surgery  
LSU Health Sciences Center**

[Electromagnetic Energy In The Environment And Human Disease.pdf](#)

**Cell-Phone EMFs Alter Brain Electrical Activity**

**Andrew A. Marino, Ph.D.  
Professor Department of Orthopaedic Surgery  
LSU Health Sciences Center**

If cell-phone electromagnetic fields (EMFs) are hazardous, there must be a process by which the body detects the fields. We hypothesized that pulses produced by cell phones were detected in the same way the body detects ordinary environmental stimuli. We planned to accept as evidence of this theory the observation that cell-phone pulses produced a specific kind of change in brain electrical activity termed the evoked potential (EP). We reasoned that since only typical environmental stimuli are known to produce EPs, evidence that cell-phone EMFs also did so would be evidence that they were detected like the ordinary stimuli. We found that a simulated cell-phone pulse produced EPs, as predicted.

<http://andrewamarino.com/PDFs/164-EBM2009.pdf>

## **Effects of Cell Phone Radiofrequency Signal Exposure on Brain Glucose Metabolism**

### **Introduction To Conclusions of The Study**

Nora D. Volkow, MD; Dardo Tomasi, PhD; Gene-Jack Wang, MD; Paul Vaska, PhD; Joanna S. Fowler, PhD; Frank Telang, MD; Dave Alexoff, BSE; Jean Logan, PhD; Christopher Wong, MS

These results provide evidence that the human brain is sensitive to the effects of RF-EMFs from acute cell phone exposures. The findings of increased metabolism in regions closest to the antenna during acute cell phone exposure suggest that brain absorption of RF-EMFs may enhance the excitability of brain tissue. This interpretation is supported by a report of enhanced cortical excitability to short transcranial magnetic stimulation pulses (1 msec) following 40-minute RF-EMF exposures.

[Read the study here – Effects of Cell Phone Radiofrequency Signal Exposure on Brain Glucose Metabolism](#)

Sensory transduction of weak electromagnetic fields: role of glutamate neurotransmission mediated by NMDA receptors. C. Frilot II, S. Carrubba & A.A. MARINO. *Neuroscience*, 2013, In Press.

Electromagnetic hypersensitivity syndrome revisited again. A.A. MARINO. *Int. J. Neurosci.* 123:593–594, 2013. [PDF file]

Response to Letter to the Editor Concerning “Electromagnetic Hypersensitivity: Evidence for a Novel Neurological Syndrome.” A.A. Marino, S. Carrubba & D.E. McCarty. *Int. J. Neurosci.* 122:402–403, 2012. [PDF file].

Electromagnetic hypersensitivity: Evidence for a novel neurological syndrome. D.E. McCarty, S. Carrubba, A.L. Chesson, Jr., C. Frilot II, E. Gonzalez-Toledo & A.A. Marino. *Int. J. Neurosci.* 121:670–676, 2011. [PDF file]. (Introduction, an MP3 audio file).

Transient and steady-state magnetic fields induce increased fluorodeoxyglucose uptake in the rat hindbrain. C. Frilot II, S. Carrubba & A.A. Marino. *Synapse* 65:617–623, 2011. [PDF file]

Numerical analysis of recurrence plots to detect effect of environmental-strength magnetic fields on human brain electrical activity. S. Carrubba, C. Frilot II, A.L. Chesson Jr. & A.A. Marino. *Med. Eng. Phys.* 32:898–907, 2010. [PDF file]

Simulated MR magnetic field induces steady-state changes in brain dynamics: implications for interpretation of functional MR studies. A.A. Marino, S. Carrubba, C. Frilot II, A.L. Chesson Jr. & E. Gonzalez-Toledo. *Magn. Reson. Med.* 64:349–357, 2010. [PDF file]

Mobile-phone pulse triggers evoked potentials. S. Carrubba, C. Frilot II, A.L. Chesson Jr. & A.A. Marino. *Neurosci Lett.* 469:164–168, 2010. [PDF file]

The effects of mobile-phone electromagnetic fields on brain electrical activity: a critical analysis of the literature. A.A. Marino & S. Carrubba. *Electromag. Med. Biol.* 28:250–274, 2009. [PDF file]

Evidence that transduction of electromagnetic field is mediated by a force receptor. A.A. Marino, S. Carrubba, C. Frilot & A.L. Chesson, Jr. *Neurosci. Lett.* 452:119–123, 2009. [PDF file]

The effects of low-frequency environmental-strength electromagnetic fields on brain electrical activity: a critical review of the literature. S. Carrubba & A.A. Marino. *Electromagn. Biol. Med.* 27:83–101, 2008. [PDF file]

Magnetosensory evoked potentials: consistent nonlinear phenomena. S. Carrubba, C. Frilot, A.L. Chesson, Jr., C.L. Webber, Jr., J.P. Zbilut & A.A. Marino. *Neurosci. Res.* 60:95–105, 2008. [PDF file]

Nonlinear EEG activation by low-strength low-frequency magnetic fields. S. Carrubba, C. Frilot, A.L. Chesson & A.A. Marino. *Neurosci. Lett.* 417:212–216, 2007. [PDF file]

Evidence of a nonlinear human magnetic sense. S. Carrubba, C. Frilot II, A.L. Chesson Jr. & A.A. Marino. *Neuroscience* 144:356–367, 2007. [PDF file]  
2006

Detection of nonlinear event-related potentials. S. Carrubba, C. Frilot, A. Chesson & A.A. Marino. *J. Neurosci. Meth.* 157:39–47, 2006. [PDF file]

Effect of low-frequency magnetic fields on brain electrical activity in human subjects. A.A. Marino, E. Nilsen, A.L. Chesson Jr., & C. Frilot. *Clin. Neurophysiol.* 115:1195–1201, 2004. [PDF file]

Nonlinear changes in brain electrical activity due to cell-phone radiation. A.A. Marino, E. Nilsen & C. Frilot. *Bioelectromagnetics* 24:339–346, 2003. [PDF file]

Comment on "Proposed test for detection of nonlinear responses in biological preparations exposed to RF energy." A.A. Marino & C. Frilot. *Bioelectromagnetics* 24:70–72, 2003. [PDF file] [Comment by Adair] [Reply to Adair]

Action potentials from neuroblastoma cells in weak magnetic fields. H. Sonnier, O. Kolomytkin & A. Marino. *Neuroscience Letters* 337:163–166, 2003. [PDF file]

Consistent magnetic-field induced dynamical changes in rabbit brain activity detected by recurrence quantification analysis. A.A. Marino, E. Nilsen & C. Frilot. *Brain Res.* 951:301–310, 2002. [PDF file.]

IL-1 $\beta$ -induced production of metalloproteinases by synovial cells depends on gap-junction conductance during the early stage of signal transduction. O.V. Kolomytkin, A.A. Marino, D.D. Waddell, J.M. Mathis, R.E. Wolf, K.K. Sadasivan & J.A. Albright. *Am. J. Physiol: Cell Physiol.* 282:C1254–C1260, 2002. [PDF file]

Nonlinear determinism in the immune system. In vivo influence of electromagnetic fields on different functions of murine lymphocyte subpopulations. A.A. Marino, R.M. Wolcott, R. Chervenak, F. Jourdeuil, E. Nilsen & C. Frilot II. *Immunol. Invest.* 30:313–334, 2001. [PDF file]

Nonlinear dynamical law governs magnetic field changes in lymphoid phenotype. A.A. Marino, R.M. Wolcott, R. Chervenak, F. Jourdeuil, E. Nilsen & C. Frilot II. *Bioelectromagnetics* 22:529–546, 2001. [PDF file]

Coincident nonlinear changes in the endocrine and immune systems due to low-frequency magnetic fields. A.A. Marino, R.M. Wolcott, R. Chervenak, F. Jourdeuil, E. Nilsen, C. Frilot II & S.B. Pruet. *NeuroImmunoModulation* 9:65–77, 2001. [PDF file]  
130. Sensory transduction as a proposed model for biological detection of electromagnetic fields. H. Sonnier & A.A. Marino. *Electro- and Magnetobiology* 20:153–175, 2001. [PDF file]

In the eye of the beholder: The role of style of thought in the determination of health risks from electromagnetic fields. Andrew A. Marino. *Frontier Perspectives* 9:22–27, 2000. [PDF file]

Nonlinear response of the immune system to power-frequency magnetic fields. A.A. Marino, R.M. Wolcott, R. Chervenak, F. Jourdeuil, E. Nilsen & C. Frilot II. *Am. J. Physiol Regulatory Integrative Comp. Physiol.* 279:R761–R768, 2000. [PDF file]

Resting potential of excitable neuroblastoma cells in weak magnetic fields. H. Sonnier O.V. Kolomytkin & A.A. Marino. *Cell. Molec. Life Sci.* 57:514–520, 2000. [PDF file]

Low-frequency electromagnetic fields alter the replication cycle of MS2 bacteriophage. J. Staczek, A.A. Marino, L.B. Gilleland, A. Pizarro & H.E. Gilleland, Jr. *Current Microbiology* 36:298–301, 1998. [PDF file]

Electromagnetic fields can affect osteogenesis by increasing the rate of differentiation. P.S. Landry, K.K. Sadasivan, A.A. Marino & J.A. Albright. *Clin. Orthop. Relat. Res.*, 338:262–270, 1997. [PDF file]

Electromagnetic fields enhance chemically-induced hyperploidy in mammalian oocytes. J.B. Mailhes, D. Young, A.A. Marino & S.N. London. *Mutagenesis*, 12:347–351, 1997. [PDF file]

Piezoelectricity in the human pineal gland. S.B. Lang, A.A. Marino, G. Berkovic, M. Fowler & K.D. Abreo. *Bioelectrochem. Bioenerg.* 41:191–195, 1996. [PDF file]  
A36. Comments on "Short exposures to 60 Hz magnetic fields do not alter MYC expression in HL60 or Daudi cells" by Saffer and Thurston. (*Radiat. Res.* 144:18–25, 1995). *Radiat. Res.* 145:513–515, 1996. [PDF file]

Low-level EMFs are transduced like other stimuli. A.A. Marino, G.B. Bell & A. Chesson. *J. Neurolog. Sci.* 144:99–106, 1996. [PDF file]

Electromagnetic fields in the classroom. A.A. Marino, in *The Healthy School Handbook*. N. Miller, ed., NEA Professional Library, Washington, DC, 221–241, 1995. [PDF file]  
109. Different outcomes in biological experiments involving weak EMFs: Is chaos a possible explanation? A.A. Marino. *Am. J. Physiol.* 268 (Regulatory Integrative Comp. Physiol. 37: R1013–R1018, 1995. [PDF file]

Time-dependent hematological changes in workers exposed to electromagnetic fields. A.A. Marino. *Am. Ind. Hyg. Assoc. J.* 56:189–192, 1995. [PDF file]

Frequency-specific responses in the human brain caused by electromagnetic fields. G.B. Bell, A.A. Marino & A.L. Chesson. *J. Neurol. Sci.* 123:26–32, 1994. [PDF file]  
101. Frequency-specific blocking in the human brain caused by electromagnetic fields. G.B. Bell, A.A. Marino & Andrew L. Chesson. *NeuroReport* 5:510–512, 1994. [PDF file]

Electromagnetic fields, cancer, and the theory of neuroendocrine-related promotion. A.A. Marino. *Bioelectrochem. Bioenerg.* 29:255–276, 1993. [PDF file]

Alterations in brain electrical activity caused by magnetic fields: detecting the detection process. G.B. Bell, A.A. Marino & A.L. Chesson. *Electroencephalog. Clin. Neurophysiol.* 83: 389–397, 1992. [PDF file]

Electrical states in the rabbit brain can be altered by light and electromagnetic fields. G. Bell, A.A. Marino, A. Chesson & F. Struve. *Brain Res.* 570:307–315, 1992. [PDF file]  
1991

Human sensitivity to weak magnetic fields. G. Bell, A.A. Marino, A. Chesson & F. Struve. *Lancet* 338:1521–1522, 1991. [PDF file]

Meta-analysis of multi-generational studies in mice exposed to power-frequency electric fields. A.A. Marino. *J. Bioelectricity* 9:213–231, 1990. [PDF file]

Partisanist discrimination in California favors electric power companies (Editorial). A.A. Marino. *J. Bioelectricity* 9(2):v–vii, 1990. [PDF file]

Bioelectricity. A.A. Marino. *Collier's Encyclopedia*, 1990. [PDF file]

Beauty and a beast (Editorial). A.A. Marino. *J. Bioelectricity* 9(1):v–vi, 1990. [PDF file]

Trust me, I'm a doctor (Editorial). A.A. Marino. *J. Bioelectricity* 8(2):v–vi, 1989. [PDF file]

Piezoelectricity in cementum, dentin, and bone. A.A. Marino & B.D. Gross. *Arch. Oral Biol.* 34:507–509, 1989. [PDF file]

Negative studies and common sense (Editorial). A.A. Marino. *J. Bioelectricity* 8(1):v–vii, 1989. [PDF file]

Environmental electromagnetic fields and public health. A.A. Marino, in *Foundations of Modern Bioelectricity*, A.A. Marino, ed., Marcel Dekker, New York, 965–1044, 1988. [PDF file]

Are powerline fields hazardous to health? A.A. Marino. *Public Power* 45:1820, 1987. [PDF file]

Electric man and the work of Björn Nordenström. A.A. Marino. *J. Appl. Nutr.* 39:106–108, 1987. [PDF file]

Health risks from electric power facilities. A.A. Marino, in *Proceedings of International Utility Symposium, Health Effects of Electric and Magnetic Fields*, Ontario Hydro, Toronto, 1986. [PDF file]

Penetration of electric fields into a concentric-sphere model of biological tissue. F.X. Hart & A.A. Marino. *Med. & Biol. Eng. & Comput.* 24:105–108, 1986. [PDF file]

Chronic electromagnetic stressors in the environment: A risk factor in human cancer. A.A. Marino & D.M. Morris. *J. Environ. Sci.* C3(2):189–219, 1985. [PDF file]

Electromagnetic energy in the environment and human disease. A.A. Marino. *Clin. Ecol.* 3(3):154–157, 1985. [PDF file]

Electromagnetic fields and public health. A.A. Marino, in *Assessments and Viewpoints on the Biological and Human Health Effects of Extremely Low Frequency Electromagnetic Fields*, American Institute of Biological Sciences, Arlington, Va., 205–232, 1985. [PDF file]

We need a science court (Editorial). A.A. Marino. *J. Bioelectricity* 4(1):vii–viii, 1985. [PDF file]

Public health aspects of the energy flux of high-voltage powerlines. F.X. Hart & A.A. Marino. *Innov. Tech. Bio. Med. (French)* 5:636–640, 1984. [PDF file]

Where is the EPA's sense of decency? (Editorial) A.A. Marino. *J. Bioelectricity* 3(12):1–2, 1984. [PDF file]

Weak electrical fields affect plant development. A.A. Marino, F.X. Hart & M. Reichmanis. *IEEE Trans. Biomed. Eng. BME* 30: 833–834, 1983. [PDF file]

Bioelectric considerations in the design of high-voltage power lines. M. Reichmanis & A.A. Marino. *J. Bioelectricity* 1: 329–338, 1982. [PDF file]

ELF dosage in ellipsoidal models of man due to high-voltage transmission lines. F.X. Hart & A.A. Marino. *J. Bioelectricity* 1: 129–154, 1982. [PDF file]  
1981

Environmental power-frequency magnetic fields and suicide. F.S. Perry, M. Reichmanis, A. Marino, & R. Becker. *Health Phys.* 41: 267–277, 1981. [PDF] Letters to Editor. [PDF] 52. Separating disputes over facts from disputes over values. A. Mazur, A.A. Marino & R.O. Becker, in *The Dynamics of Technical Controversy*, A. Mazur, Communications Press, Inc., Washington D.C., 1981. [PDF file]

Sensitivity to change in electrical environment: a new bioelectric effect. A.A. Marino, J.M. Cullen, M. Reichmanis, R.O. Becker & F.X. Hart. *Am. J. Physiol.* 239 (Regulatory Integrative Comp. Physiol. 8): R424–427, 1980. [PDF file]

Power frequency electric field induces biological changes in successive generations of mice. A.A. Marino, M. Reichmanis, R.O. Becker, B. Ullrich & J.M. Cullen. *Experientia* 36: 309–311, 1980. [PDF file]

Relation between suicide and the electromagnetic field of overhead power lines. M. Reichmanis, F.S. Perry, A.A. Marino & R.O. Becker. *Physiol. Chem. Phys.* 11: 395–403, 1979. [PDF file]

Kirlian photography: potential for use in diagnosis. A.A. Marino, R.O. Becker & B. Ullrich. *Psychoenerg. Syst.* 3: 47–54, 1979. [PDF file]

Space osteoporosis: an electromagnetic hypothesis. A.A. Marino, R.O. Becker, F.X. Hart & F. Anders, Jr. *Aviat. Space Environ. Med.* 50: 409–410, 1979. [PDF file]



Effect of electrostatic fields on the chromosomes of Ehrlich ascites tumor cells exposed in vivo. J.T. Mitchell, A.A. Marino, T.J. Berger & R.O. Becker. *Physiol. Chem. Phys.* 10: 79–85, 1978. [PDF file]

High voltage lines: hazard at a distance. A.A. Marino & R.O. Becker. *Environment* 20 (9): 6–15, 1978. [PDF file]

Power frequency electric fields and biological stress: a cause-and-effect relationship. A.A. Marino, J.M. Cullen, M. Reichmanis & R.O. Becker, in *Biological effects of extremely low frequency electromagnetic fields*. Proc. 18th Hanford Life Sciences Symposium, Richland Wash., U.S. Dept. of Energy. DOE symposium series; 50: 258–276, 1978. [PDF file]

Hazard at a distance: effects of exposure to the electric and magnetic fields of high voltage transmission lines. A.A. Marino & R.O. Becker. *Med. Res. Eng.* 12: 6–9, 1978. [PDF file]

Electromagnetic pollution. R.O. Becker & A.A. Marino. *The Sciences*, January, 1978, pp. 14, 15, 23. [PDF file]

In vivo bioelectrochemical changes associated with exposure to ELF electric fields. A.A. Marino, T.J. Berger, B.P. Austin, R.O. Becker & F.X.Hart. *Physiol. Chem. Phys.* 9: 433–441, 1977. [PDF file]

Evaluation of electric techniques for stimulation of hard tissue growth. R.O. Becker, J.A. Spadaro & A.A. Marino. *Bull. Prosthetics Res. BPR* 10-27: 180–184, 1977. [PDF file]

Biological effects of extremely low frequency electric and magnetic fields: a review. A.A. Marino & R.O. Becker. *Physiol. Chem. Phys.* 9: 131–147, 1977. [PDF file]

Energy flux along high voltage transmission lines. F.X. Hart & A.A. Marino. *IEEE Trans. Biomed. Eng. BME-24*: 493–495, 1977. [PDF file]

Biophysics of animal response to an electrostatic field. F.X. Hart & A.A. Marino. *J. Biol. Phys.* 4: 123–143, 1976. [PDF file]

Evaluation of electrochemical information transfer system. I. Effect of electric fields on living organisms. A.A. Marino, T.J. Berger, B.P. Austin & R.O. Becker. *J. Electrochem. Soc.* 123: 1199–1200, 1976. [PDF file]

The effect of continuous exposure to low frequency electric fields on three generations of mice: a pilot study. A.A. Marino, R.O. Becker & B. Ullrich. *Experientia* 32: 565, 1976. [PDF file]

Electrostatic field induced changes in mouse serum proteins. A.A. Marino, T.J. Berger, R.O. Becker & F.X. Hart. *Experientia* 30: 1274–1275, 1974. [PDF]

Electric field effects in selected biologic systems. A.A. Marino, T.J. Berger, J.T. Mitchell, B.A. Duhacek & R.O. Becker. Ann. N. Y. Acad. Sci. 238: 436–444, 1974.  
[PDF file]

Study of Risk of Brain Tumours and Acoustic Neuroma in  
Relation to Use of Mobile Phones: South East England  
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Health Effects from Radiofrequency Electromagnetic Fields  
UK Case-control Study of Adult Brain Tumours  
Dr P McKinney\*, Professor T Sorahan†, Dr K Muir‡ and Dr M Van Tongeran†  
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Study of Mobile Phone Users (Pilot Study)  
Professor P Elliott\*, Dr L Jarup† and Professor A Ahlbom‡  
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Risk of Leukaemia in Relation to Use of Mobile  
Phones  
Professor A J Swerdlow\*, Professor M F Greaves\* and Professor D C Linch†  
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Study of Cancer Incidence in Early Childhood and  
Proximity to Mobile Phone Base Stations  
Professor P Elliott, Dr N G Best, Professor D Briggs and Dr M P Little  
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Effects of Mobile Phone Radiation on Blood Pressure  
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Mobile Cellular Communication and Cognitive Functioning  
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Health Effects from Radiofrequency Electromagnetic Fields  
Effects of Mobile Phone Usage on Labyrinthine Function  
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in 'Normal' and 'Hypersensitive' Users  
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Assessment of Specific (Energy) Absorption Rate (SAR) in the Head from TETRA Handsets

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Traceability for Mobile Telecommunications and Health Research – Dosimetry in Support of the Programme

Mr R N Clarke\*, Mr B G Loader\*, Dr K Lees\*, Mr A P Gregory\*, Dr M J Hall\*, Mr S Harmon\* and Professor A W Preece†  
National Physical Laboratory\* and University of Bristol†

Traceability for Mobile Telecommunications and Health Research – Measurement of Magnetic Emissions from Commercial Mobile Phones

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SAR Testing of Hands-free Mobile Phones

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Measurement of the Power Density of Radio Waves in the Vicinity of Microcell and Picocell Base Stations

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Detection of Effects of Microwave Radiation on the Electrical Activity  
of the Brain

Dr S Butler and Professor A W Preece

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