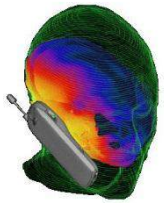
Sarah Loughran
Illawarra Health & Medical Research Institute
University of Wollongong, Australia

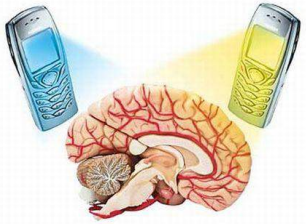
acebr Australian Centre for Electromagnetic Bioeffects Research

The Influence of Mobile Phone Emissions on Sleep

FRESEM
POPULATION HEALTH RESEARCH ON ELECTROMAGNETIC ENERGY

UNIVERSITY OF WOLLONGONG



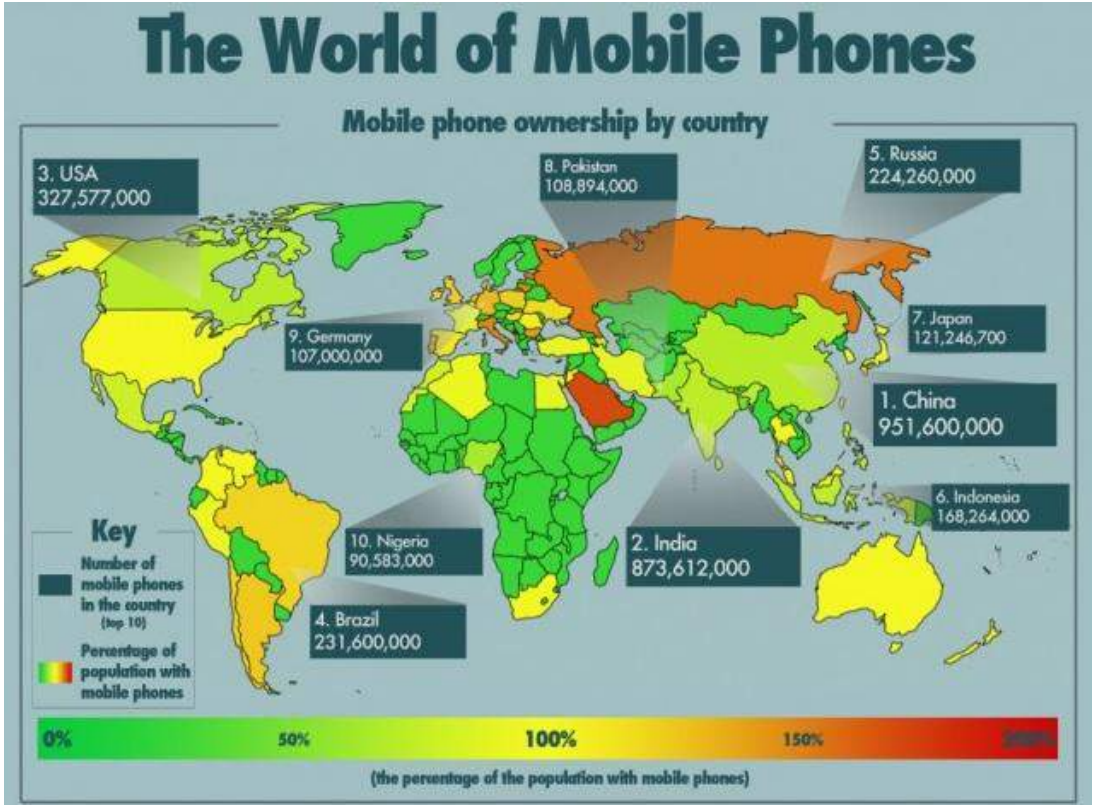


ihmri illawarra health and medical research institute

Overview

- Background
  - Mobile Phones and Health
  - Electroencephalography (EEG) and Sleep
  - Mobile Phone Signals and Exposure Metrics
- RF EMF and the Brain
  - Influence on sleep
  - Current state of knowledge
- Future research and public health policy

Mobile Phone Use is Ubiquitous…



…and Addictive!

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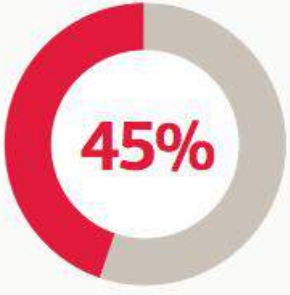
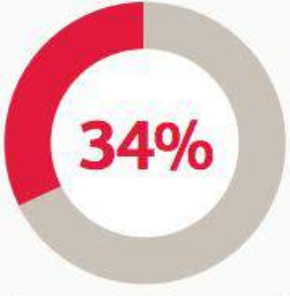
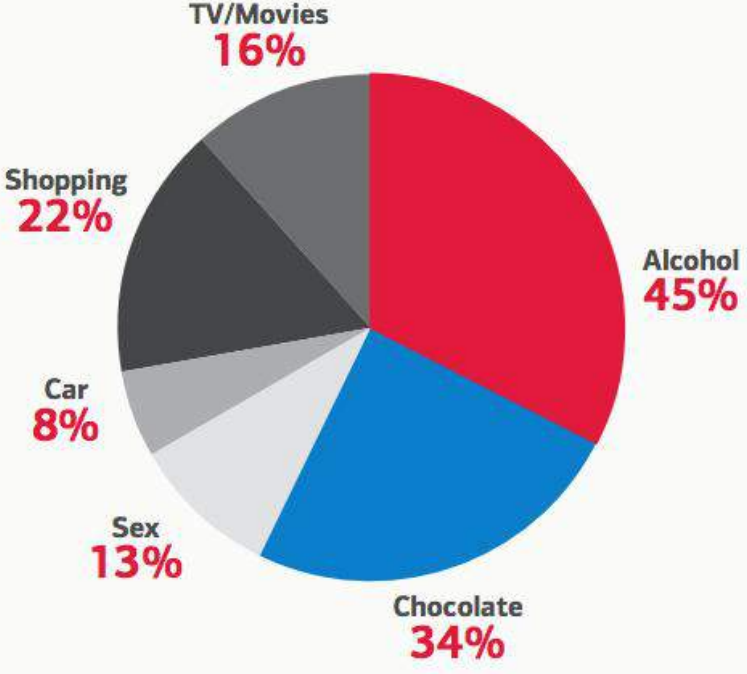
Most would **give up guilty pleasures** for their mobile phone



of respondents would be willing to **give up alcohol**



of respondents would be willing to **give up chocolate**



Mobile Phone Radiation & Human Health Constantly in the Media

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Lady Gaga says no to radiation from mobile phones

What is the Issue?

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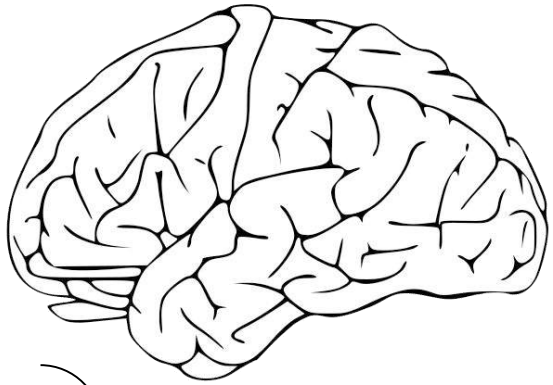
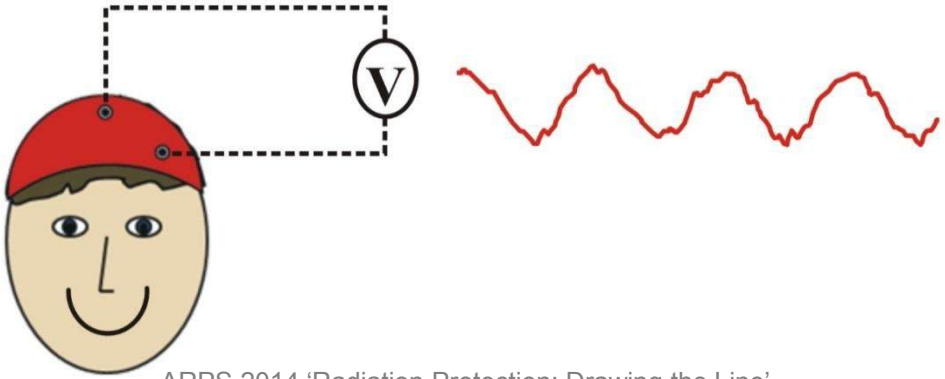
- Increasing mobile phone use → increase in concern and demand for scientific research
- Particular focus on potential effects of RF EMF on the human brain
  - Biological effects below current exposure limits/guidelines
- Currently no biophysical mechanisms capable of justifying these concerns



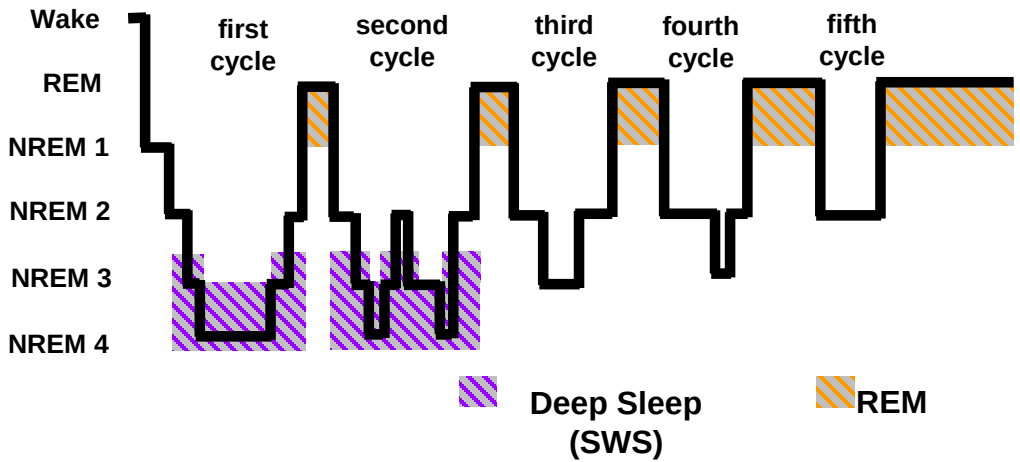
How do we address this issue?

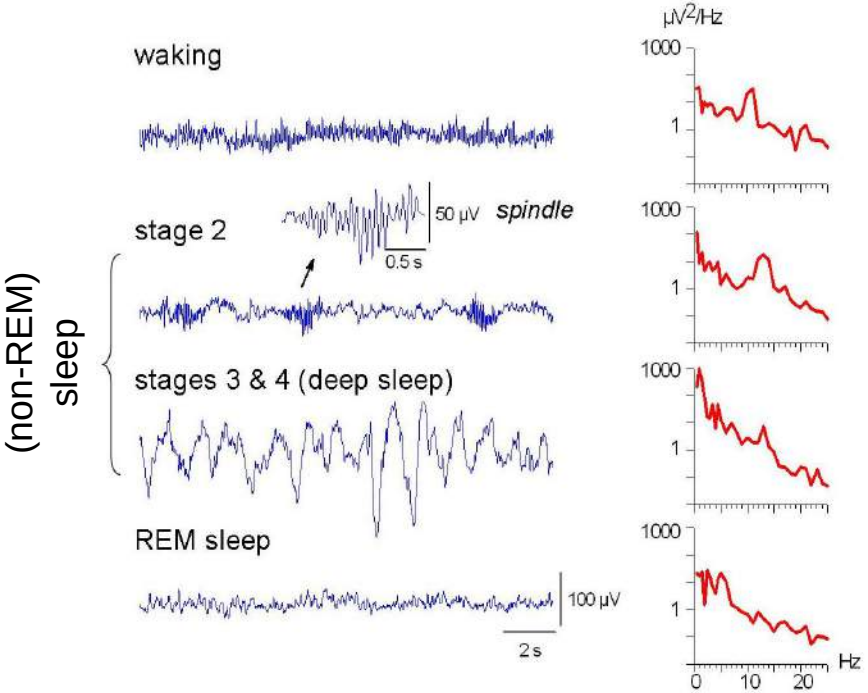
- Electroencephalogram (EEG)
  - Simple, non-invasive technique that reflects synchronous activity in cortical neurons
  - Recorded from electrodes placed on the scalp



Why use the EEG?

- Well-characterised
  - Correlated with vigilance state and cognitive functioning/processing during waking
  - Reflects different stages of sleep





Aeschbach (1995)

High Intra-Individual Stability

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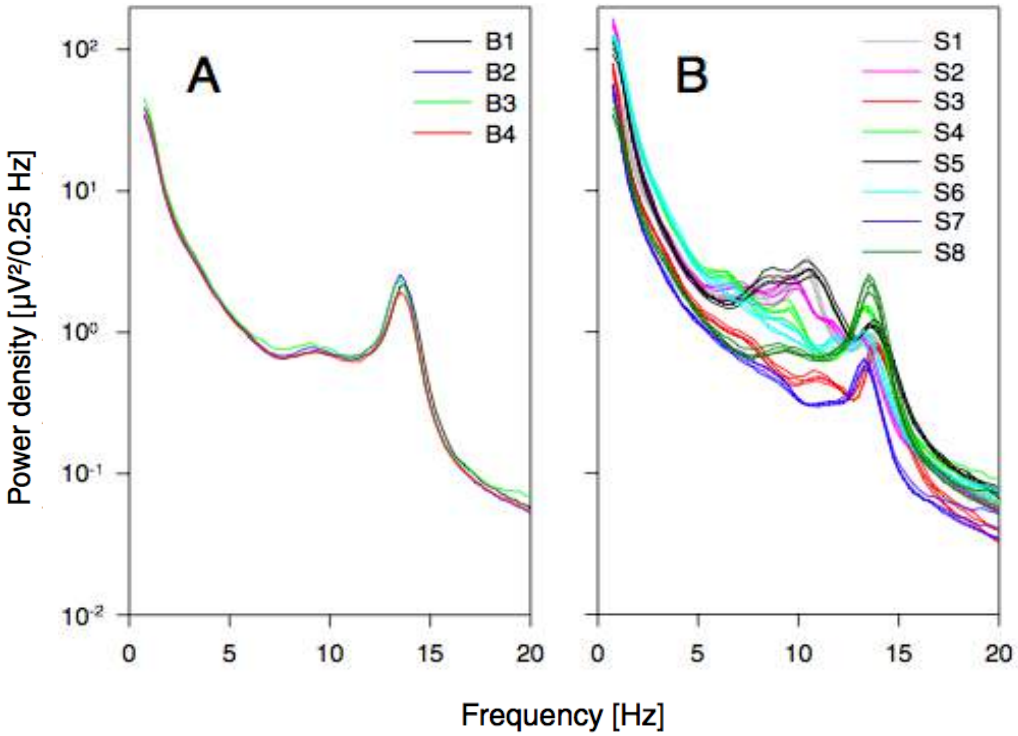
NREM Sleep



Buckelmüller et al., 2006

Mobile Phone: Signal Characteristics and Exposure Metrics

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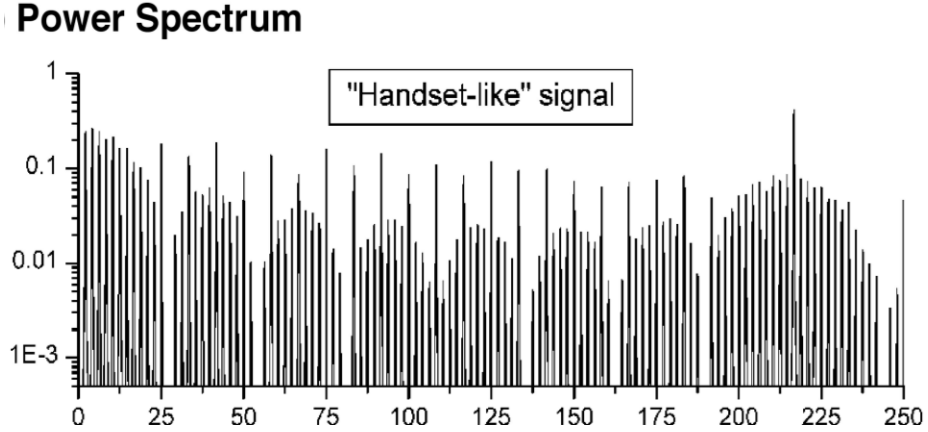
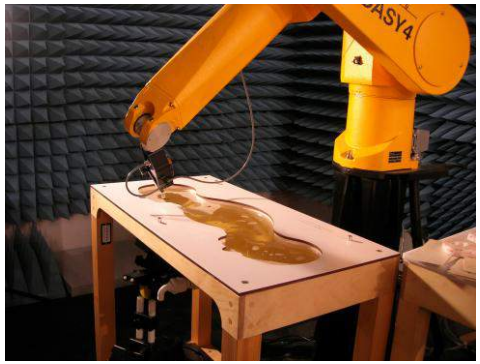
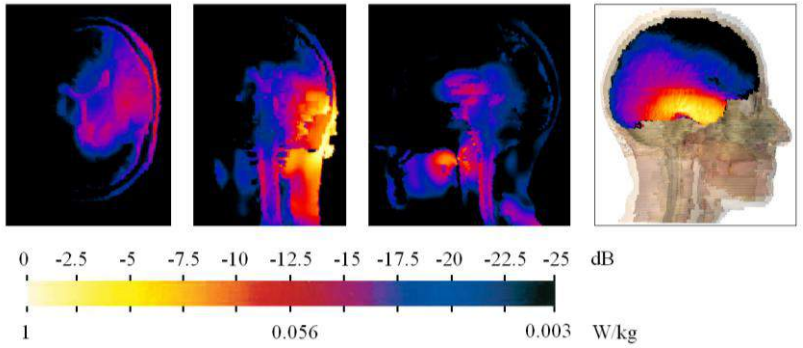
- Global System for Mobile Communications (GSM)
  - Carrier Frequency: 900 MHz/1800 MHz
- Pulse Modulation
  - 2 Hz (Discontinuous transmission, DTX)
  - 8 Hz (Multi frame structure)
  - 217 Hz (GSM pulse repetition rate)



- Specific Absorption Rate (SAR)





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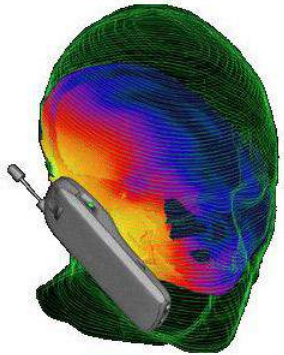
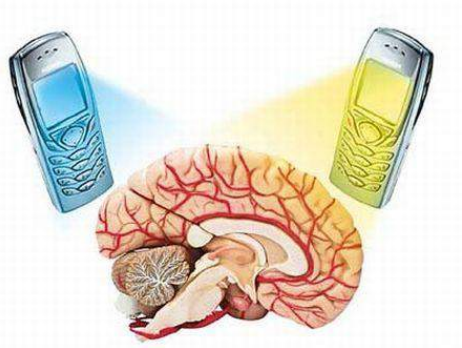
Effects of RF EMF on Sleep and the EEG





Early Report of RF EMF Effects on Sleep

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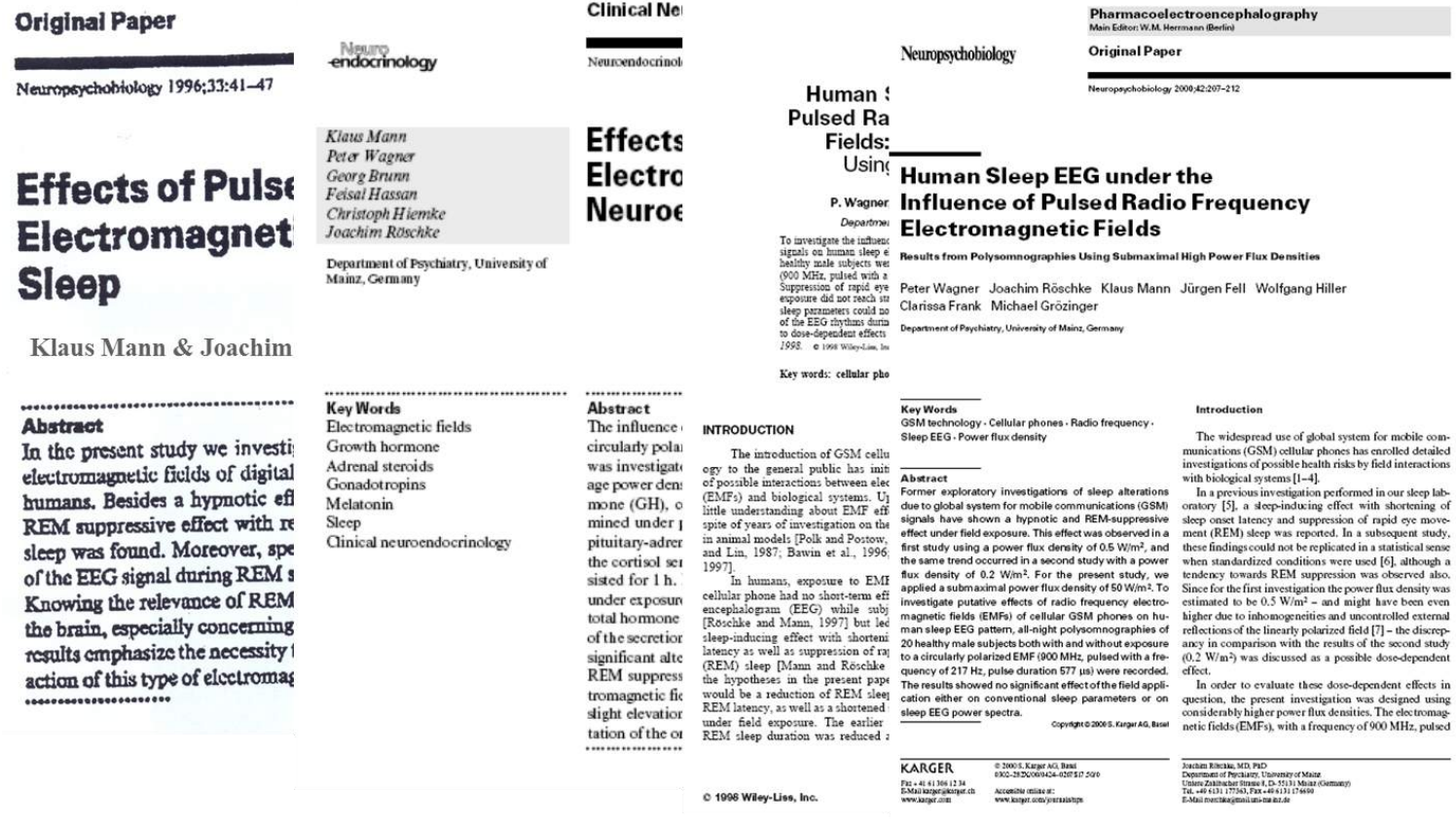

Original Paper

Neuropsychobiology 1996;33:41–47

Effects of Pulse Electromagnet Sleep

Klaus Mann & Joachim

Abstract

In the present study we investi electromagnetic fields of digital humans. Besides a hypnotic eff REM suppressive effect with re sleep was found. Moreover, spe of the EEG signal during REM s Knowing the relevance of REM the brain, especially concerning results emphasize the necessity action of this type of electromag

Neuro endocrinology

Klaus Mann
Peter Wagner
Georg Brunn
Feisal Hassan
Christoph Hiemke
Joachim Röschke

Department of Psychiatry, University of Mainz, Germany

Key Words
Electromagnetic fields
Growth hormone
Adrenal steroids
Gonadotropins
Melatonin
Sleep
Clinical neuroendocrinology

Clinical Ne

Neuroendocrinol

Effects Electro Neuroe

Abstract

The influence circularly pola was investigat age power dens mone (GH), o mined under pituitary-adrer the cortisol se sisted for 1 h. under exposur total hormone of the secretion significant alte REM suppress tromagnetic fie slight elevation tation of the o

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Human Pulsed Ra Fields: Using

P. Wagner

Depart

To investigate the influenc signals on human sleep e healthy male subjects wer (900 MHz, pulsed with a Suppression of rapid eye exposure did not reach st sleep parameters could no of the EEG rhythms durin to dose-dependent effects 1998. © 1998 Wiley-Liss, In

Key words: cellular pho

INTRODUCTION

The introduction of GSM cellu egy to the general public has init of possible interactions between elec (EMFs) and biological systems. U little understanding about EMF eff spite of years of investigation on the in animal models [Polk and Postow, and Lin, 1987; Bawin et al., 1996; 1997].

In humans, exposure to EMF cellular phone had no short-term eff encephalogram (EEG) while subj [Röschke and Mann, 1997] but led sleep-inducing effect with shorteni latency as well as suppression of ra (REM) sleep [Mann and Röschke the hypotheses in the present pape would be a reduction of REM sleep REM latency, as well as a shortened under field exposure. The earlier REM sleep duration was reduced

Neuropsychobiology

Pharmacoelectroencephalography
Main Editor: W.M. Herrmann (Berlin)

Original Paper

Neuropsychobiology 2000;42:207–212

Human Sleep EEG under the Influence of Pulsed Radio Frequency Electromagnetic Fields

Results from Polysomnographies Using Submaximal High Power Flux Densities

Peter Wagner Joachim Röschke Klaus Mann Jürgen Fell Wolfgang Hiller
Clarissa Frank Michael Grözinger

Department of Psychiatry, University of Mainz, Germany

Key Words
GSM technology · Cellular phones · Radio frequency · Sleep EEG · Power flux density

Abstract

Former exploratory investigations of sleep alterations due to global system for mobile communications (GSM) signals have shown a hypnotic and REM-suppressive effect under field exposure. This effect was observed in a first study using a power flux density of 0.5 W/m², and the same trend occurred in a second study with a power flux density of 0.2 W/m². For the present study, we applied a submaximal power flux density of 50 W/m². To investigate putative effects of radio frequency electromagnetic fields (EMFs) of cellular GSM phones on human sleep EEG pattern, all-night polysomnographies of 20 healthy male subjects both with and without exposure to a circularly polarized EMF (900 MHz, pulsed with a frequency of 217 Hz, pulse duration 577 µs) were recorded. The results showed no significant effect of the field application either on conventional sleep parameters or on sleep EEG power spectra.

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Introduction

The widespread use of global system for mobile communications (GSM) cellular phones has enrolled detailed investigations of possible health risks by field interactions with biological systems [1–4].

In a previous investigation performed in our sleep laboratory [5], a sleep-inducing effect with shortening of sleep onset latency and suppression of rapid eye movement (REM) sleep was reported. In a subsequent study, these findings could not be replicated in a statistical sense when standardized conditions were used [6], although a tendency towards REM suppression was observed also. Since for the first investigation the power flux density was estimated to be 0.5 W/m² – and might have been even higher due to inhomogeneities and uncontrolled external reflections of the linearly polarized field [7] – the discrepancy in comparison with the results of the second study (0.2 W/m²) was discussed as a possible dose-dependent effect.

In order to evaluate these dose-dependent effects in question, the present investigation was designed using considerably higher power flux densities. The electromagnetic fields (EMFs), with a frequency of 900 MHz, pulsed

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Joachim Röschke, MD, PhD
Department of Psychiatry, University of Mainz
Untere Zahlbacher Strasse 8, D–55131 Mainz (Germany)
Tel. +49 6131 177563, Fax +49 6131 174690
E-Mail roschke@mail.uni-mainz.de

Pulse Modulated RF EMF Affects Non-REM Sleep EEG

Australian Centre for Electromagnetic Bioeffects Research

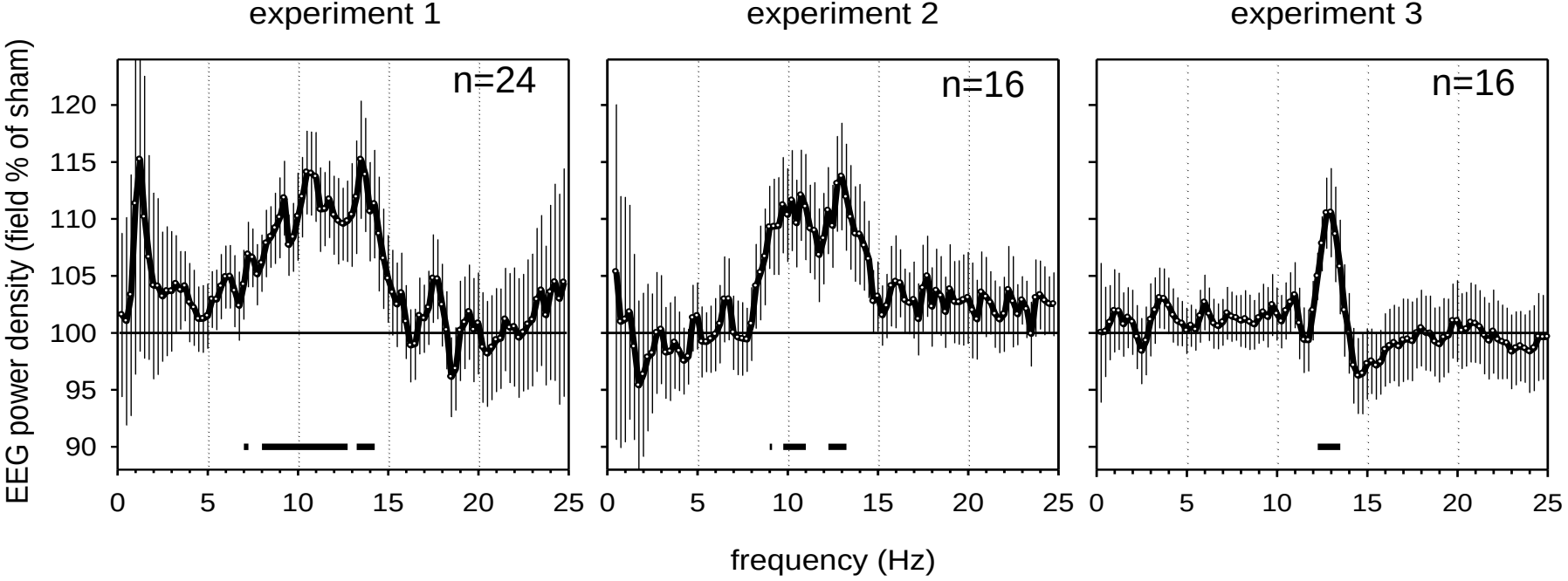
base-station-like RF EMF

handset-like RF EMF

Exposure during sleep

Exposure prior to sleep

SAR = 1 W/kg

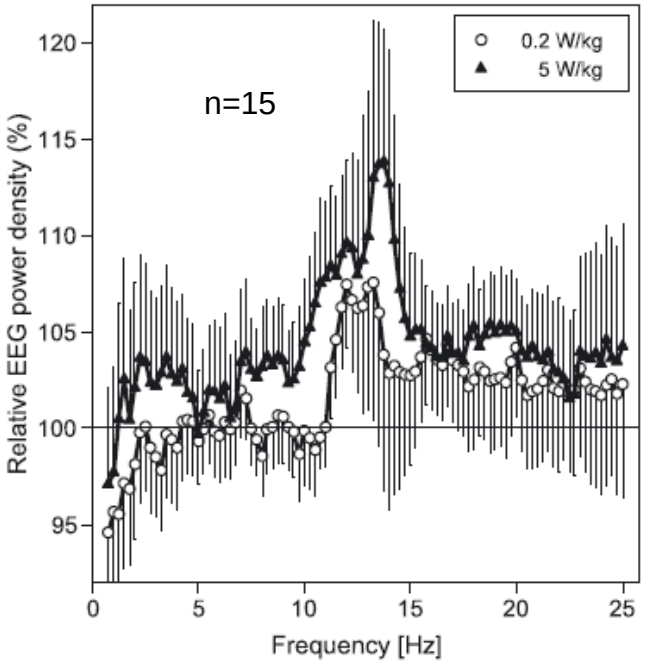


Borbély et al. 1999

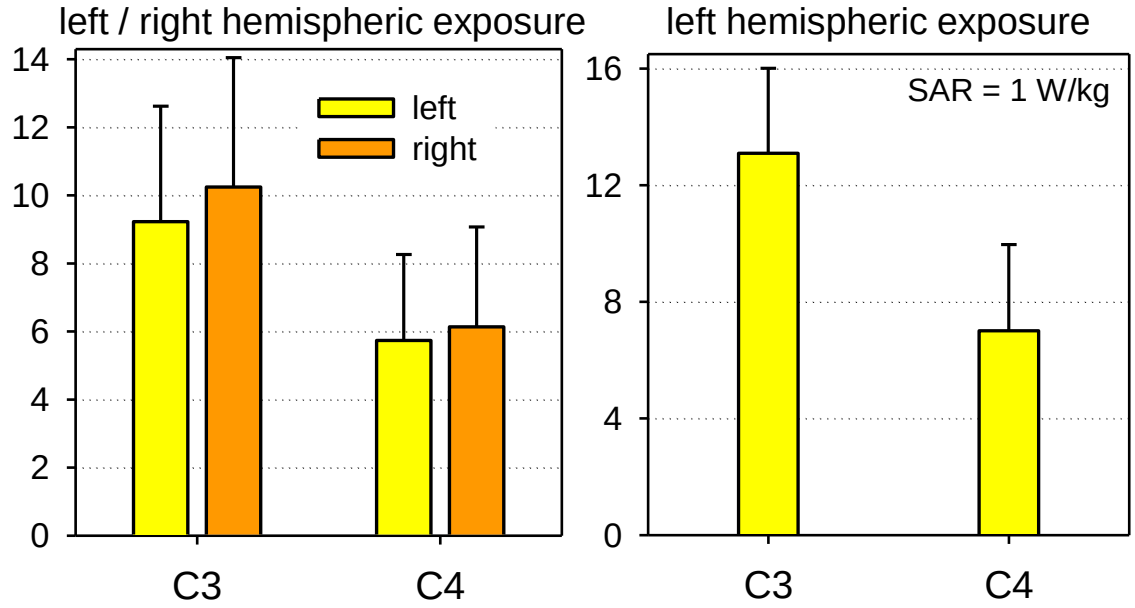
Huber et al. 2000

Huber et al. 2002

Effect is Dose-Dependent and Independent of Side of Exposure



Regel et al., 2007



Huber et al., 2000, 2002

Effect Independently Replicated

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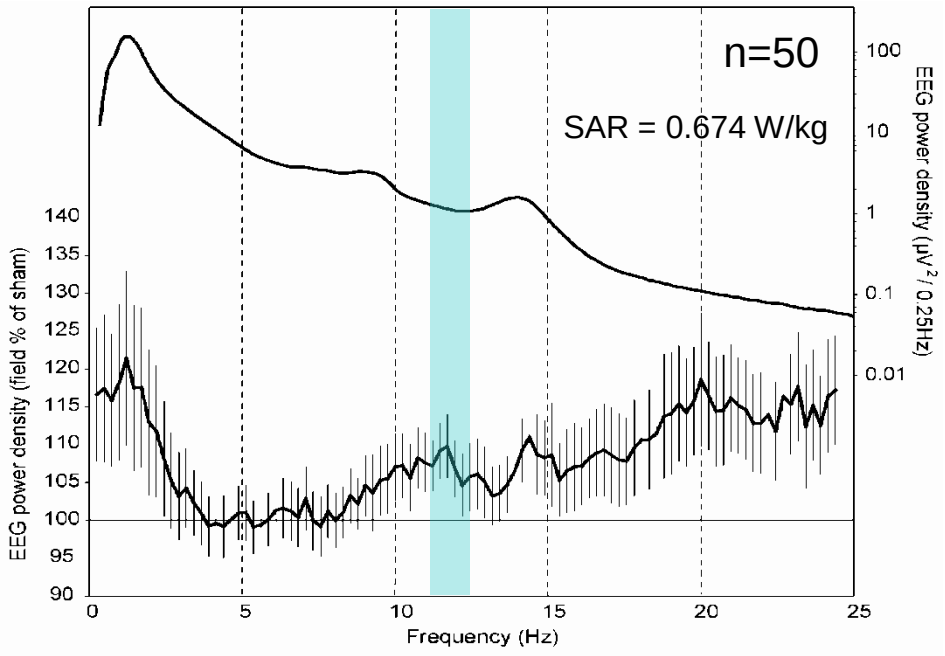
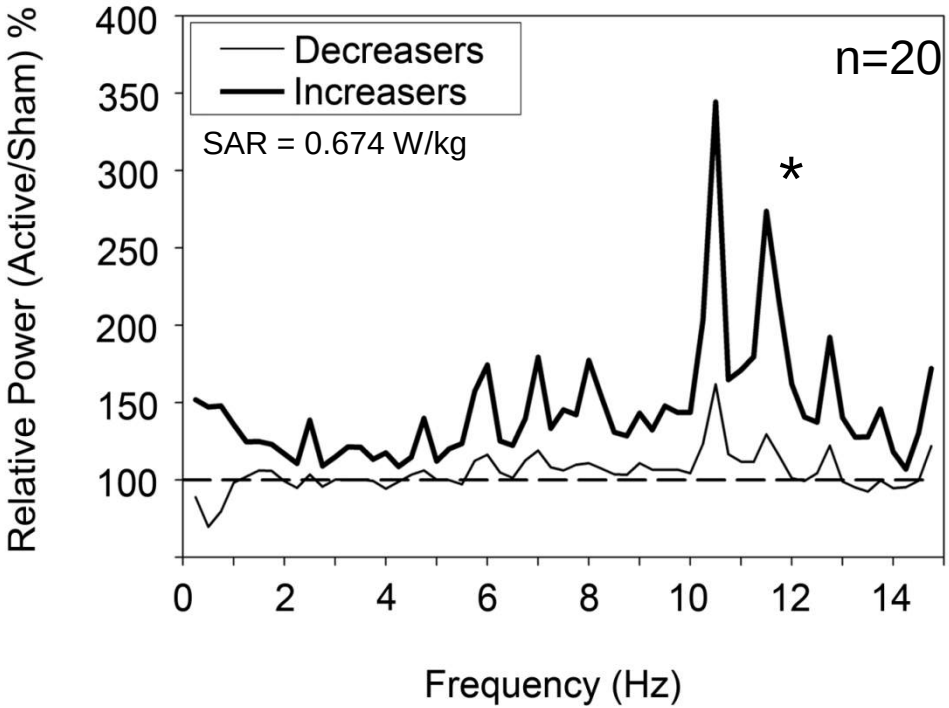


Loughran et al., 2005

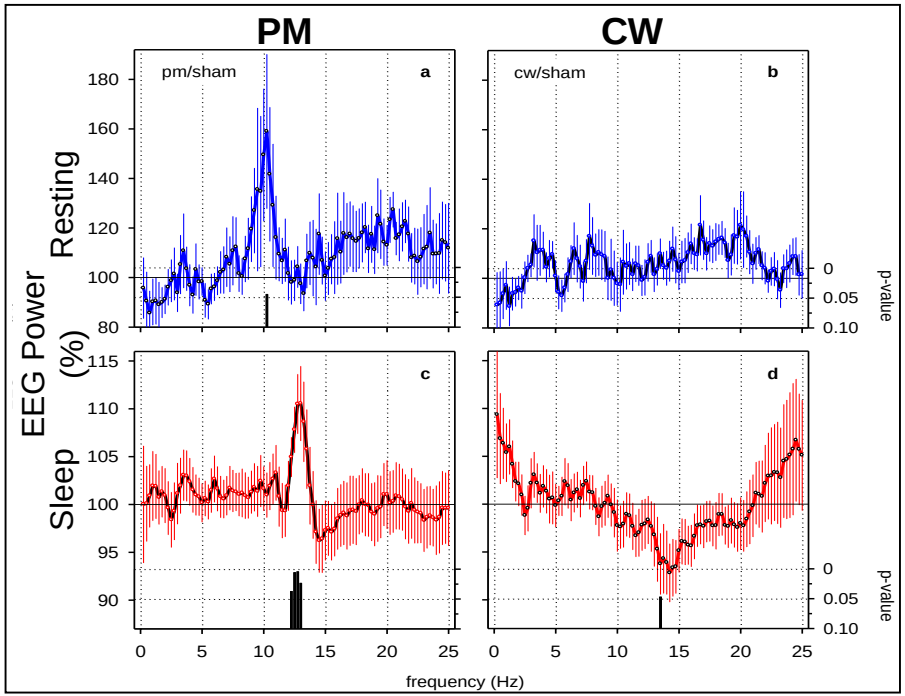
Sensitive to Individual Variability



*p<0.05

Loughran et al., 2012

Pulse Modulation of Signal Important

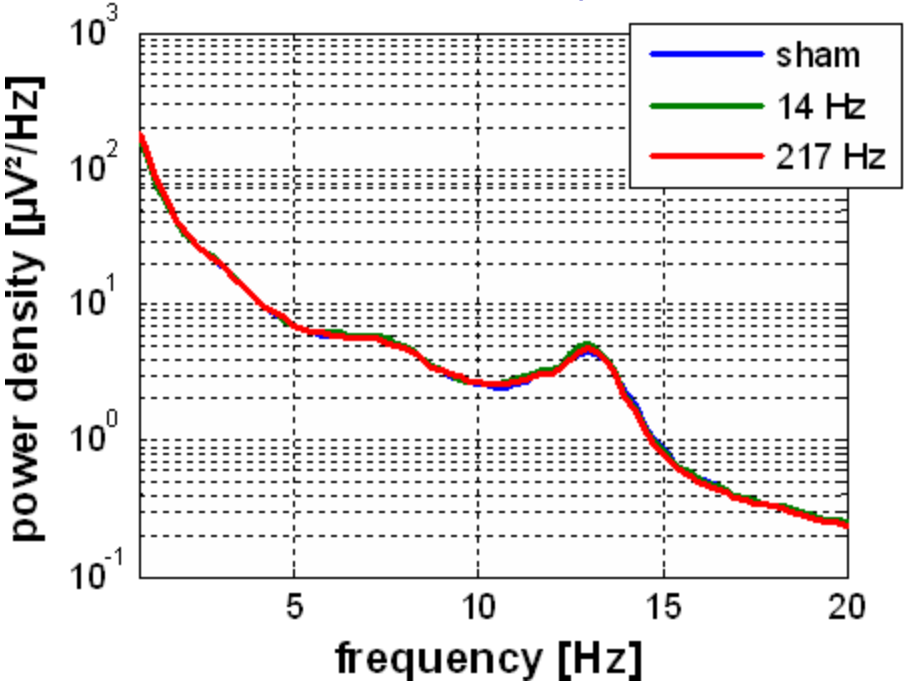


SAR = 1 W/kg

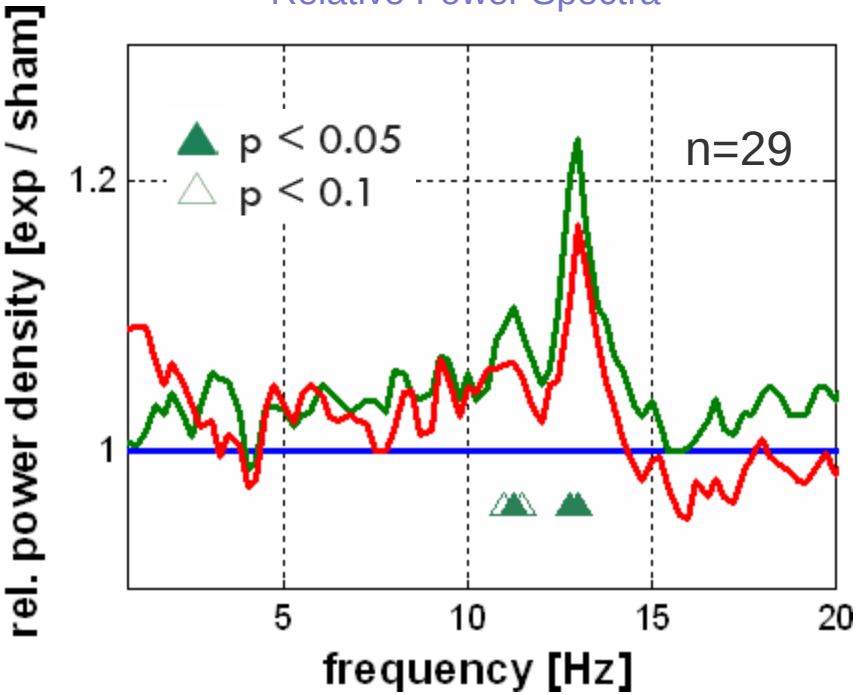
Huber et al., 2002

Specificity of Pulse Modulation

Absolute Power Spectra



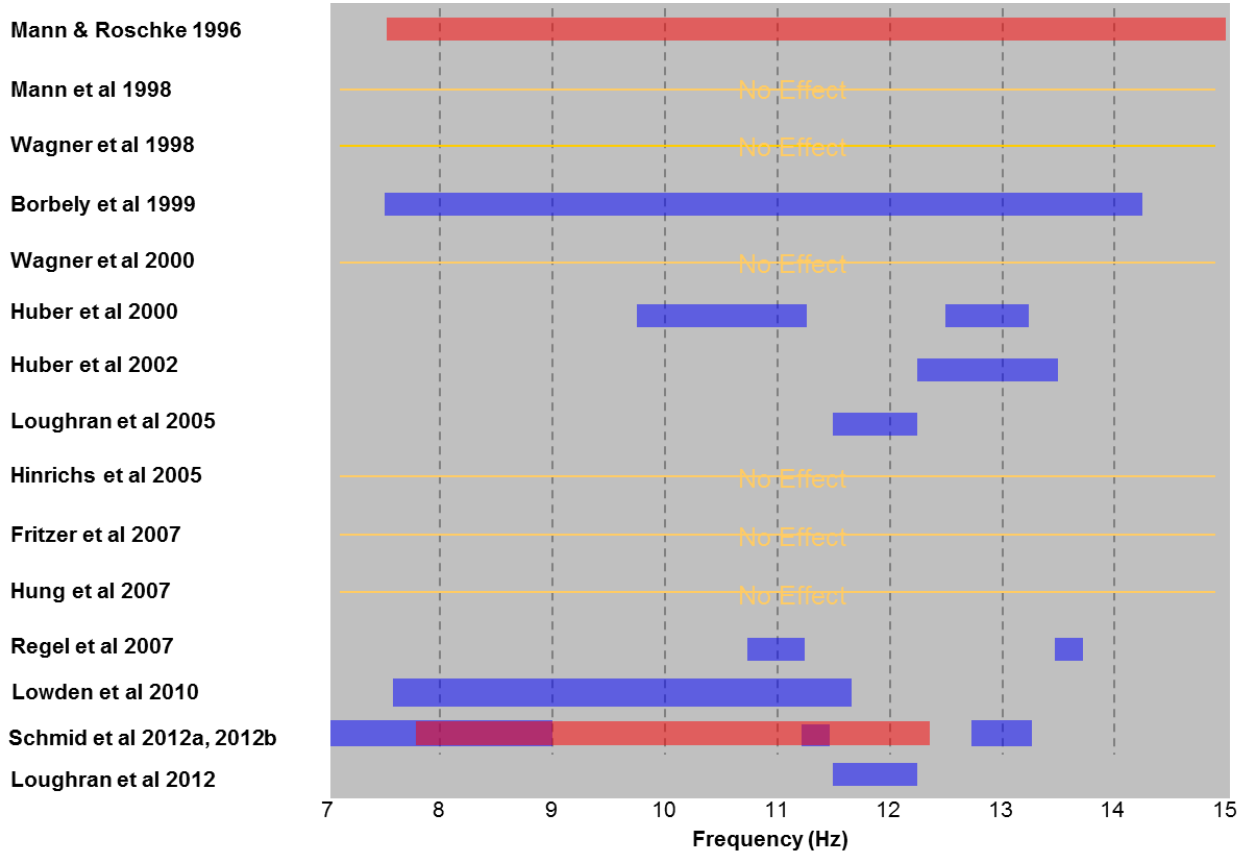
Relative Power Spectra



Stage 2, Non-REM sleep, 2nd sleep cycle

Schmid et al., 2012

RF EMF and Sleep EEG:
Summary of Previous Research



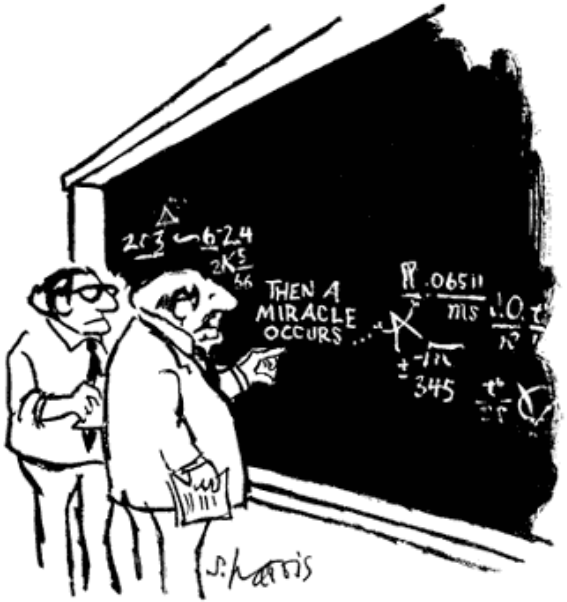
Why The Variation?

- Differences in exposure parameters
  - Exposure conditions often ill-defined
  - Dosimetry not specified
  - Single-blind conditions / no blinding
  - Variable exposure conditions across studies (studies not comparable)
- Differences in study design
  - Cognitive tasks
  - Sleep measurements
  - EEG recordings
  - Between subjects vs. within subjects design
- Magnitude of effect
  - Sample size
- Statistics
  - Multiple Comparisons
- Individual Variability

Summary of Current State of Knowledge

- Exposure to pulse-modulated RF EMF affects:
  - Non-REM sleep EEG (spindle and alpha frequency ranges)
- Pulse modulation critical for RF EMF-induced EEG effect
  - Critical field parameters associated with the effects unknown
  - Frequency of pulse modulation appears to be non-specific
- RF EMF effects:
  - Outlast exposure
  - Independent of exposure side
  - May be dose-dependent
  - Large individual variability

Major Uncertainties and Health Policy



"I think you should be more explicit here in step two."

Uncertainties and Ramifications

- No consistent behavioural effects, but…
  - Consistent physiological effects (EEG)
  - Problematic for
    - International Standards (assumes only biophysical mechanism through which RF can affect the body is thermal)
    - Risk Communication

- Even greater level of uncertainty
  - ↑ public concern
  - Effects not clearly related to health, but public still want to know how these effects are taken into account

Summary

- Consistent, repeatable effects of RF EMF exposure on brain activity
- Effects occurring at exposure levels lower than current international guidelines
- Mechanisms, and potential ramifications, of effects unknown
- How to incorporate these effects and uncertainties into international standards, and appropriate risk communication, still needs to be addressed
- WHO high research priorities:
  - Identify neurobiological mechanisms underlying these effects
  - Investigate potential sensitivity in children and adolescents

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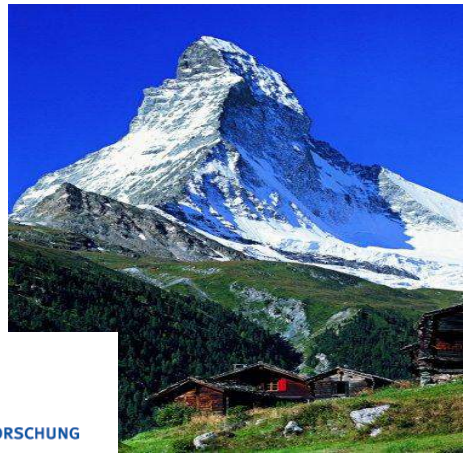

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Sarah Loughran
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Thank you for your attention…