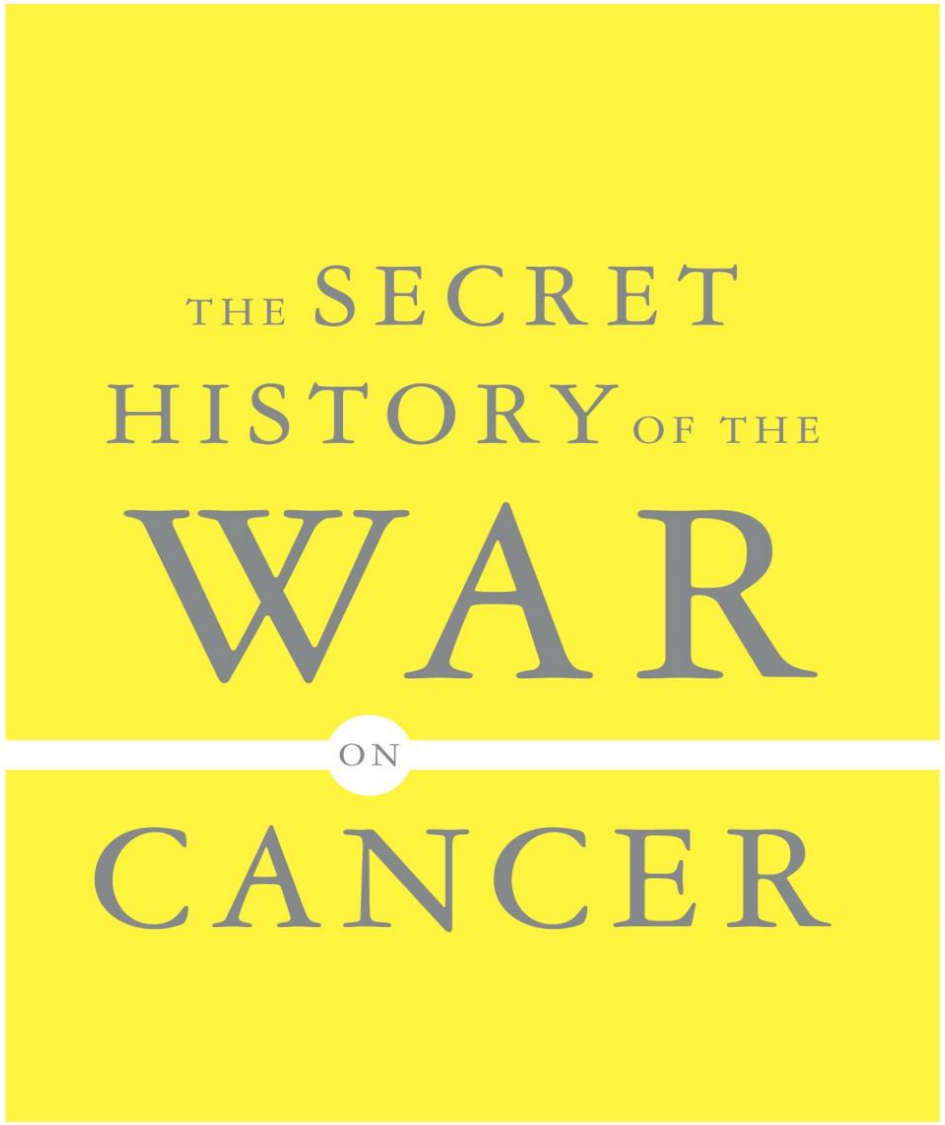
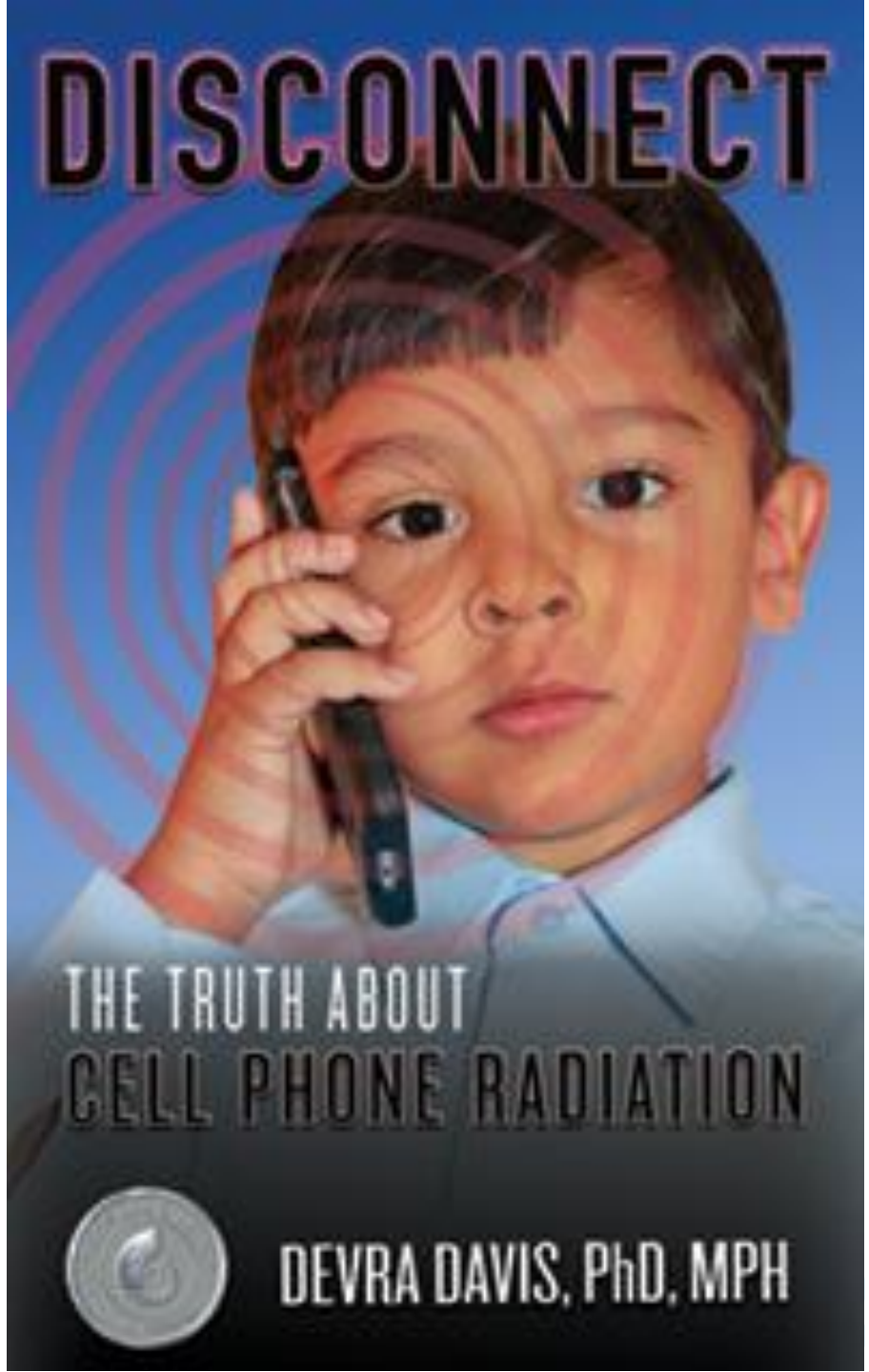
Devra Davis PhD, MPH
Founder and President of Environmental Health Trust
Visiting Professor of Medicine, The Hebrew University
New Hampshire State Commission on 5G

January 10, 2020

Devra Davis PhD, MPH, President, Environmental Health Trust

- Founding Director Board on Environmental Studies and Toxicology, National Research Council, National Academy of Sciences 1983-93 (group advising bans on indoor smoking)
- Founding Director, Center for Environmental Oncology, University of Pittsburgh Cancer Institute (issued recommendations on cell phones in 2009)
- Bi-partisan Senate approval as Presidential Appointee 1994-99 National Chemical Safety & Hazard Investigation Board
- Visiting Professor Medicine, Hebrew University, Hadassah Medical Center and Ondokuz Mayis Medical School, Samsun, 2014-
- Green America Lifetime Achievement Award
- More than 220 technical publications, 11 edited monographs, 3 popular books
- Danforth Foundation Fellow, University of Chicago, 1967-71, PhD in Science Studies National Cancer Institute Senior Post-Doctoral Fellow in Epidemiology, Johns Hopkins University, 1981-82, MPH
- Fellow, American College of Epidemiology





Ehtrust.org

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Overview of Key sources of information on RF

Experimental studies
- modelling of exposures
- In vivo—*every agent known to cause cancer in humans also produces it in animals*
- In vitro, i.e., measures of DNA damage
  - Animal cells
  - Human cells

- Ecological studies
  - Trees & grasses
  - Bees

- Epidemiological studies
  - Cohort
  - Case-Control

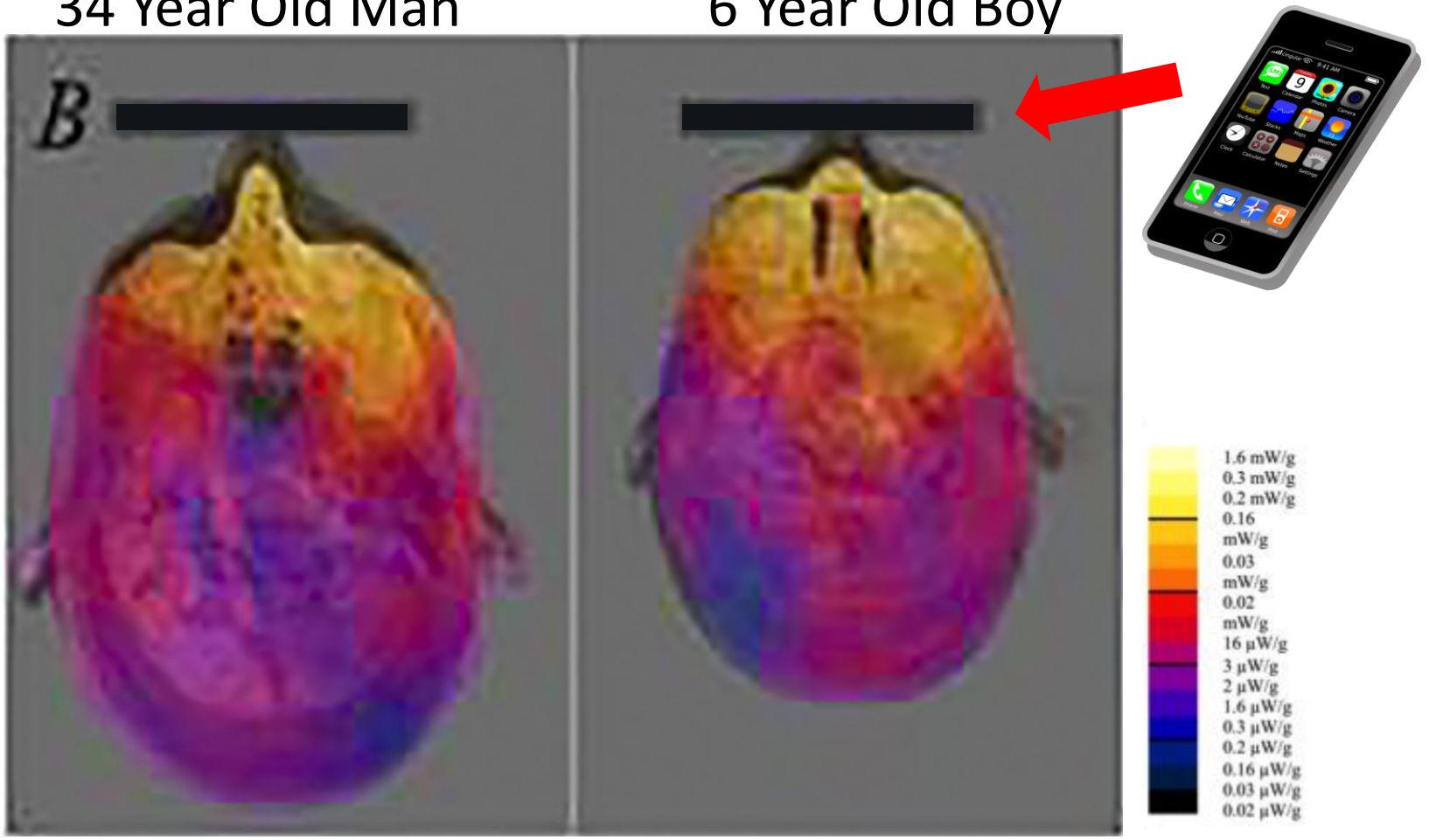
Children absorb proportionately more wireless radiation than adults.

"the average radio frequency radiation energy deposition for children exposed to mobile phone RF is two times higher in the brain and 10 times higher in the bone marrow of the skull, compared with mobile phone use by adults".
World Health Organization International Agency for the Research on Cancer

Microwave Radiation From Virtual Reality Simulations

34 Year Old Man

6 Year Old Boy



(Fernandez 2018)

Simulation of microwave radiation from smartphone in cardboard VR holder.

Yellow = highest

EU REFLEX Project Found DNA damage, 2004, replicating Lai and Singh, 1994

REFLEX Study Results

Below the current exposure limit of 2 W/kg, GSM-1800 and GSM-900 change the structure and function of genes in various human and animal cells after intermittent and continuous RF radiation exposures. The following effects were observed:

* Increase in single- and double-strand DNA breaks in human fibroblasts, HL60 cells, and rat granulosa cells, but not in human lymphocytes (9,10,11)
* Increase in micronuclei and chromosome aberrations in human fibroblasts (9)
* Change in gene and protein expression of several cell types, but especially in human endothelial cells and mouse embryo stem cells (9,12,13,14)

A significant increase in DNA strand breaks was observed in human fibroblasts at an SAR level as low as 0.3 W/kg.

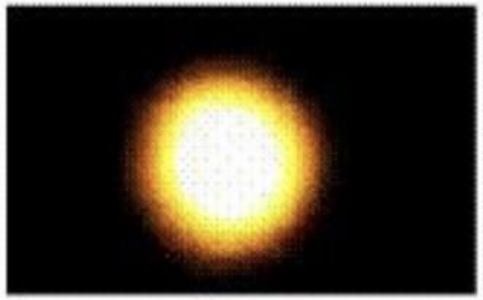
- 12 research groups in 7 nations
- Radiation levels equivalent to those from a phone prompted breaks in individual strands of DNA in a variety of human cells.

"We have found a mechanism that could cause chronic disease," study leader Franz Adlkofer of Verum, Munich, Germany **advised precautions regarding RF exposures**.

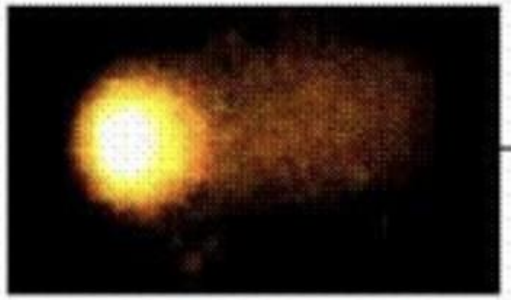
REFLEX

Comet-Assay

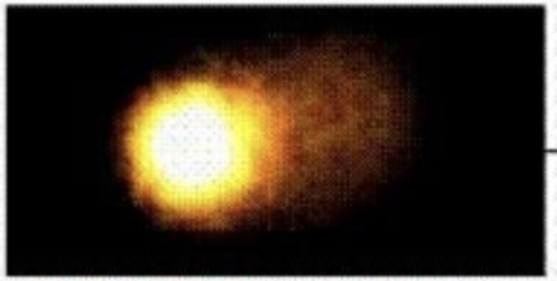
Ein typisches Bild nach RF-EMF-Exposition von HL60 Zellen



sham



γ-irradiation, 0.5 Gy



RF-EMF, 1800 MHz, SAR 1.3 W/kg, 24h, continuous wave

Comet Assay Measures Length of Unraveling DNA

1600 chest x-rays

24 h mobile phone
SAR=1.3 W/kg

ICNIRP/WHO = 2 W/kg

Igor Belyaev PhD, D.Sc., Conclusions on DNA damage and RF, 2005

Frequency-dependent effects of non-thermal microwaves from mobile phones on the DNA repair 53BP1/γ-H2AX foci in human cells observed. These persistent effects may indicate severe stress response and disruption of the balance between cellular repair systems and DNA damage.

Importantly, the same GSM frequency (915 MHz) affected all tested cell types: lymphocytes, fibroblasts and stem cells, while another frequency (905 MHz) did not.

Our data encourage identification of those frequency channels/bands for mobile communication, which do not affect human cells and may be used for safe mobile communication.

Belyaev, I. Y., L. Hillert, et al. (2005). "915 MHz microwaves and 50 Hz magnetic field affect chromatin conformation and 53BP1 foci in human lymphocytes from hypersensitive and healthy persons." Bioelectromagnetics **26**(3): 173-184.

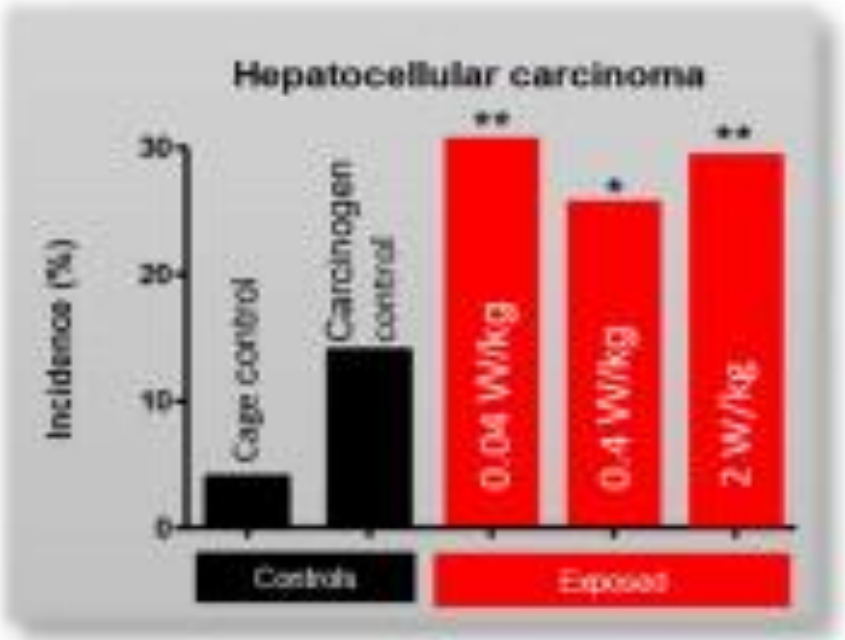
Belyaev, I. Y., E. Markova, et al. (2009). "Microwaves from UMTS/GSM mobile phones induce long-lasting inhibition of 53BP1/gamma-H2AX DNA repair foci in human lymphocytes." Bioelectromagnetics **30**(2): 129-41.

Markova, E., L. Hillert, et al. (2005). "Microwaves from GSM Mobile Telephones Affect 53BP1 and gamma-H2AX Foci in Human Lymphocytes from Hypersensitive and Healthy Persons." Environ Health Perspect **113**(9): 1172-1177.

Sarimov, R., L. O. G. Malmgren, et al. (2004). "Non-thermal GSM microwaves affect chromatin conformation in human lymphocytes similar to heat shock." IEEE Transactions on Plasma Science **32**(4): 1600-1608.

Lerchl 2015:RF Below Safety Limits Promotes Tumors

Replication Study w/Mice: 24/7 RF Exposure, in utero ENU



Higher liver and lung tumors
2.5 fold increases in Lymphoma
Nonlinear effect “may be due to metabolic changes”

This research replicates Tillman.
Lerchl et al 2015

“Our findings may help to understand the repeatedly reported increased incidences of brain tumors in heavy users of mobile phones”

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National Toxicology Program

Headquartered at the
National Institute of Environmental
Health Sciences NIH-HHS

Cell Phone Radio Frequency Radiation Studies

The $30 million NTP studies took more than 10 years to complete and are the most comprehensive assessment, to date, of health effects in animals exposed to RFR. The results will help guide other studies of newer technologies.

If you are concerned about potential health risks from RFR, the FDA suggests the following tips:[2]

- *Use speaker mode or a headset to place more distance between your head and the cell phone.*
- *Reduce the amount of time spent using your cell phone.*

NTP studies found that exposure to high levels of RFR, like that used in 2G and 3G cell phones, was associated with:

- **Clear evidence of tumors in the hearts of male rats.** The tumors were malignant schwannomas.
- **Some evidence of tumors in the brains of male rats.** The tumors were malignant gliomas.
- **Some evidence of tumors in the adrenal glands of male rats.** The tumors were pheochromocytomas.

For female rats, and male and female mice, it was unclear, also known as equivocal, whether cancers observed in the studies were associated with exposure to RFR.

The conclusions were based on the NTP four categories of evidence that a substance may cause cancer.

- Clear evidence (highest)
- Some evidence
- Equivocal evidence
- No evidence (lowest)

NTP found lower body weights among newborn rats and their mothers, especially when exposed to high levels of RFR during pregnancy and lactation, yet these animals grew to normal size.

Excerpts from
NIH NTP Factsheet
November 2018

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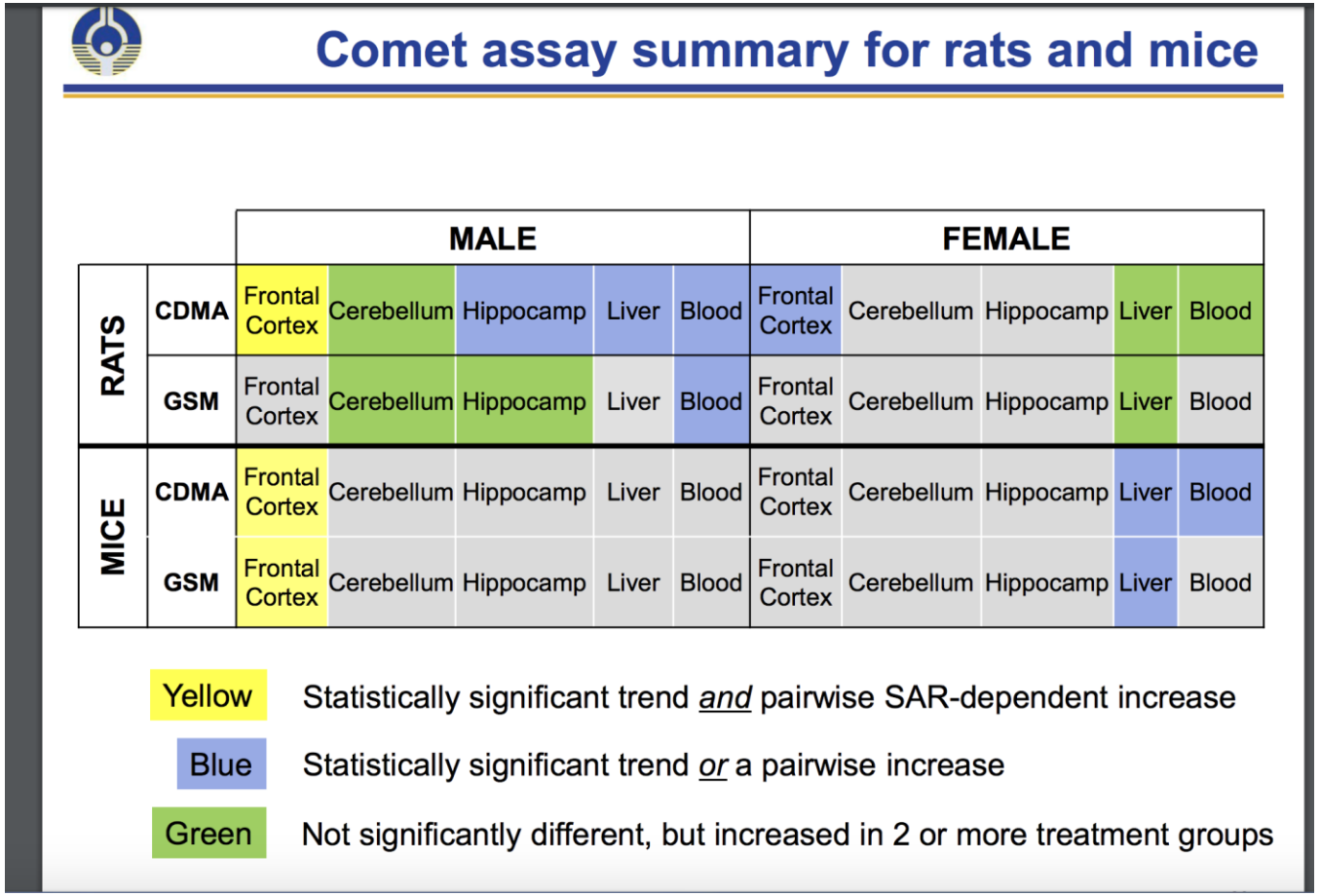
DNA Damage Results from NTP recently replicate REFLEX study, Belyaev & others, 2016-19



Comet assay summary for rats and mice

		MALE					FEMALE				
RATS	CDMA	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood
	GSM	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood
MICE	CDMA	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood
	GSM	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood

Yellow — Statistically significant trend *and* pairwise SAR-dependent increase

Blue — Statistically significant trend *or* a pairwise increase

Green — Not significantly different, but increased in 2 or more treatment groups

Smith-Roe et al, 2019

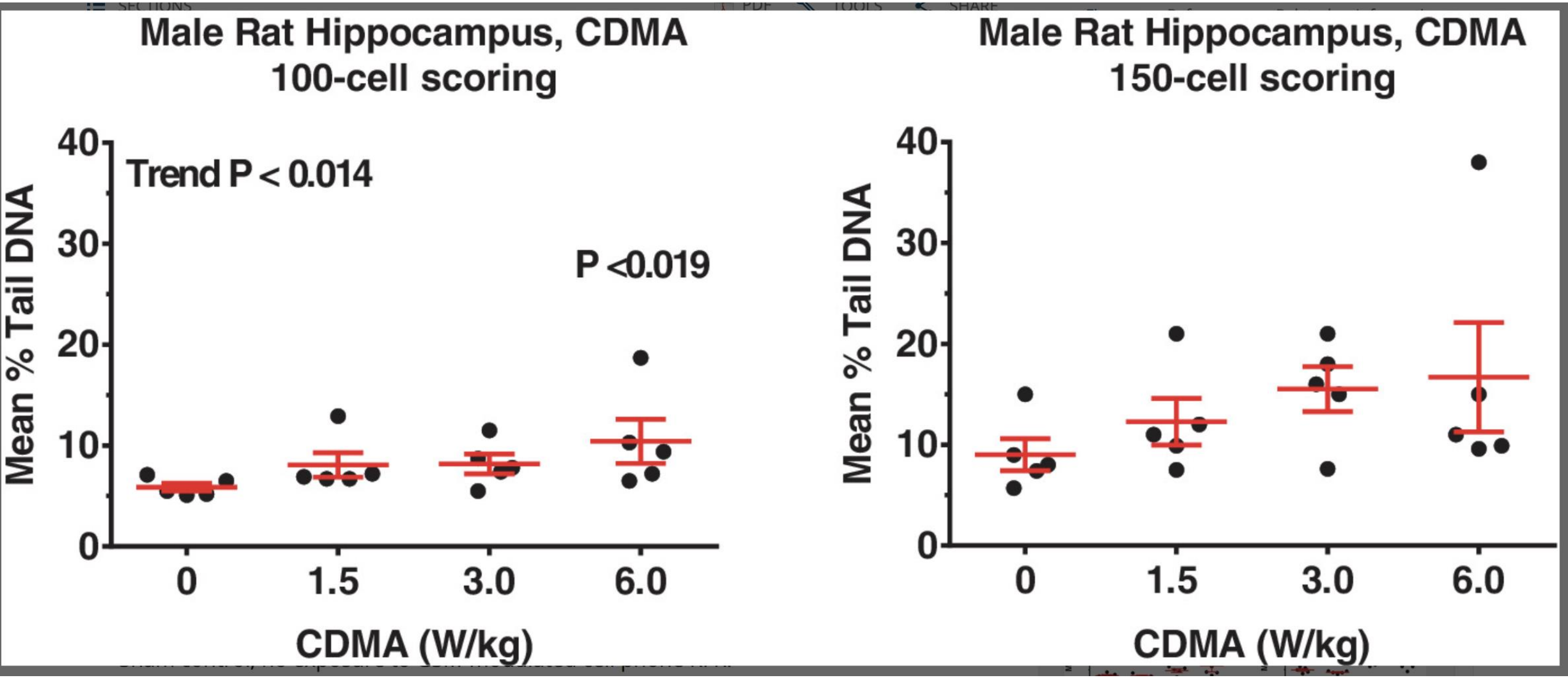
NTP Summary of DNA Findings, 2019

"Results of the comet assay showed significant increases in DNA damage in the frontal cortex of male mice
(both modulations), leukocytes of female mice (CDMA only), and hippocampus of male rats (CDMA only).
Increases in DNA damage judged to be equivocal were observed in several other tissues of rats and mice."

"In conclusion, these results suggest that exposure to RFR is associated with an increase in DNA damage."

Smith-Roe SL, Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure , Environ Mol Mutagen. 2019

DNA Damage in Male Rat Hippocampus, Smith-Roe, 2019



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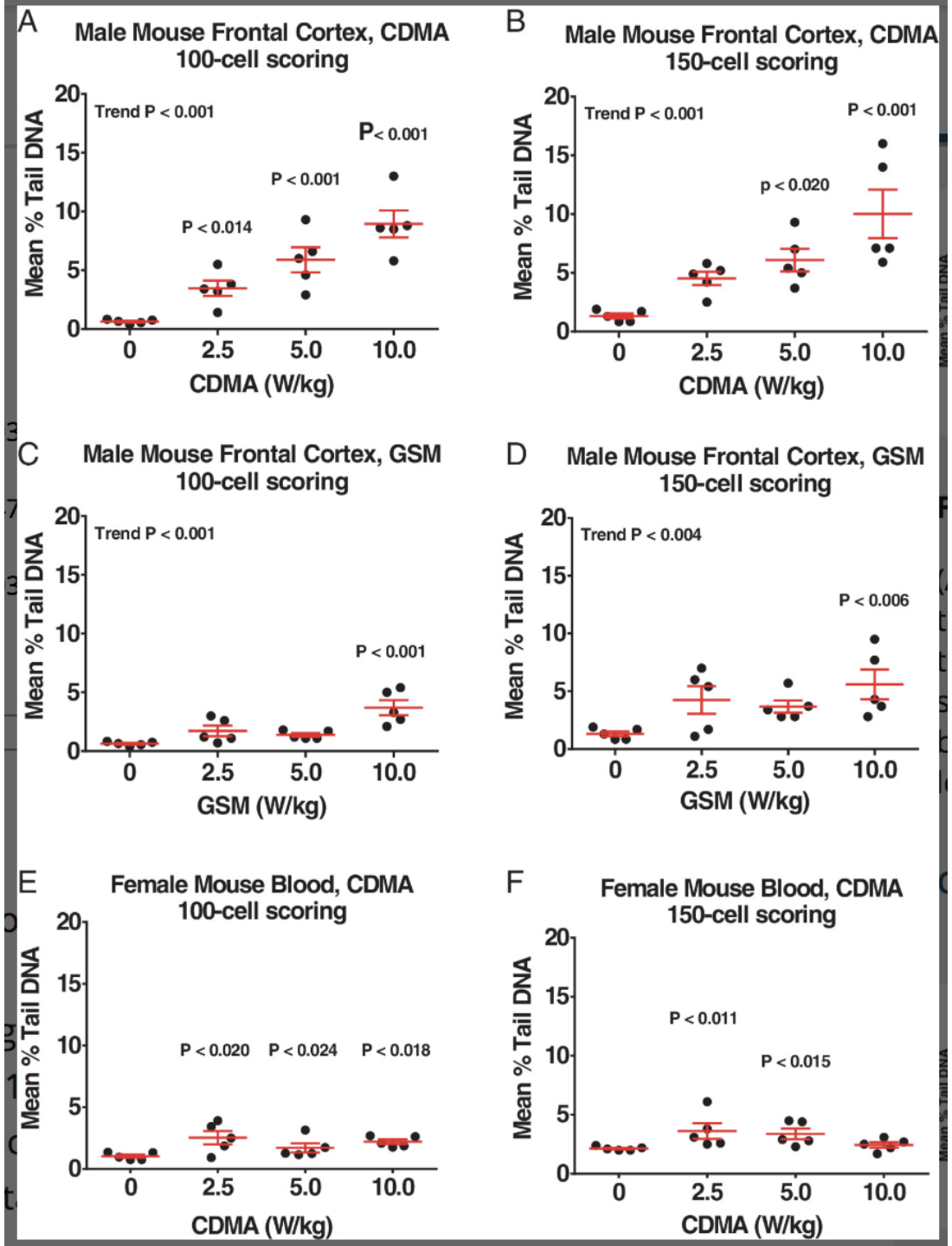
DNA damage from non-thermal Cellphone radiation In Male & Female Mice

Smith-Roe, 2019



NTP Implications: FCC Limits are Inadequate

- Study was designed to test the assumption underlying FCC and ICNIRP exposure limits- *that heat is the only effect*. The findings refute this assumption, as effects arose without heat.
  - Increases in the incidence of brain tumors (gliomas) and malignant Schwannomas of the heart corroborate human studies.
  - Support IARC classification based on gliomas and acoustic neuromas among long term users of cell phone
  - Exposure intensities, which were limited by potential heat effects at higher levels, are similar to or slightly higher than RF emissions from cell phones
- **DNA damage in multiple organs in both rats and mice**
- **Latest FCC order fails to show due diligence by not addressing mounting evidence of reproductive, genetic and carcinogenic impacts**

Increased level of endogenous DNA repair foci in human stem cells, Belyaev, 2009

ehp ENVIRONMENTAL HEALTH PERSPECTIVES

Microwaves inhibit DNA repair foci in human stem cells stronger than in differentiated cells: mechanistic link to possible cancer risk

Journal:	*Environmental Health Perspectives*
Manuscript ID:	09-00781-ART
Manuscript Type:	Research Article
Date Submitted by the Author:	10-Mar-2009
Complete List of Authors:	Belyaev, Igor; Stockholm University, Dept of Genetics, Microbiology and Toxicology Markova, Eva; Cancer Research Institute, Laboratory of Molecular Genetics Malmgren, Lars; Lund University, MAX-lab
Keywords:	Electromagnetic field, Stem cells < Mechanistic descriptors, Cell culture < In vitro models < Testing [hazard identification], Assessment < Risk, Non-ionizing radiation, DNA breaks, DNA repair

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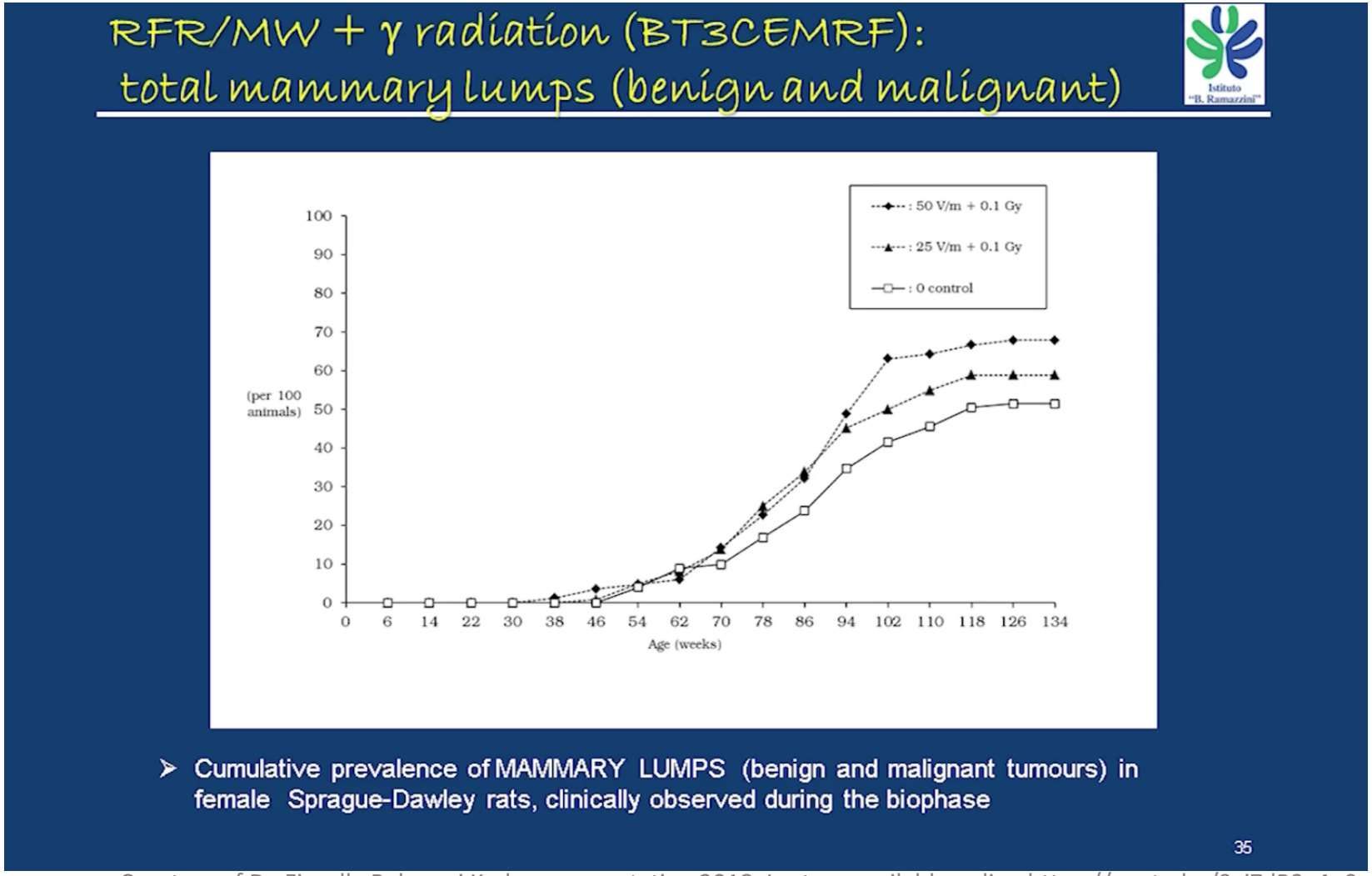
Ramazzini Institute Study (Falconi et al., 2018)
Increased Schwannoma of the Heart & Low Birth Weight

Radiofrequency Radiation Exposures far lower than the NTP and the highest exposure was lower than FCC limit.

RI Study: Lifetime RF Exposure to Rats

- Increased Schwannoma of heart in male rats, as was found in the NTP.
- Lower litter weight

Ramazzini Institute Research on Base Station RF Levels *+ Gamma Radiation* Decreased Fertility, Lower Weight, Increased Tumors



Courtesy of Dr. Fiorella Belpoggi Krakow presentation 2018, Lecture available online https://youtu.be/9vjZdRSu4u0

New: Preliminary findings from latest research on RF (GSM 1.8 GHZ) + Gamma Radiation (.1Gy)

In a presentation to Polish government Dr. Belpoggi revealed preliminary findings from latest Ramazzini study - on RF and known carcinogen - that found decrease in fertility index, pregnancy index, lower litter weights. Increased in mammillary lumps on palpitation (unknown if tumors are benign or malignant.)

Effects of Cell Phone Radiofrequency Exposure on Human Brain Glucose Metabolism

ND Volkow, D Tomasi, G-J Wang,
P Vasca , JS Fowler, F Telang,
D Alexoff, J Logan, C Wong

NIDA NATIONAL INSTITUTE ON DRUG ABUSE

BROOKHAVEN NATIONAL LABORATORY

NIAAA National Institute Alcoho Abuse and Alcoholism

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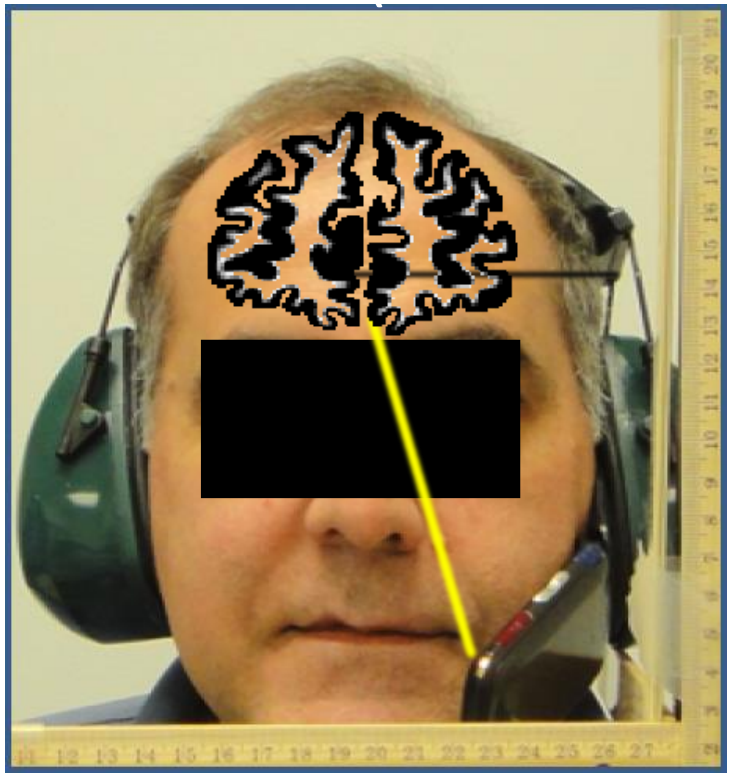
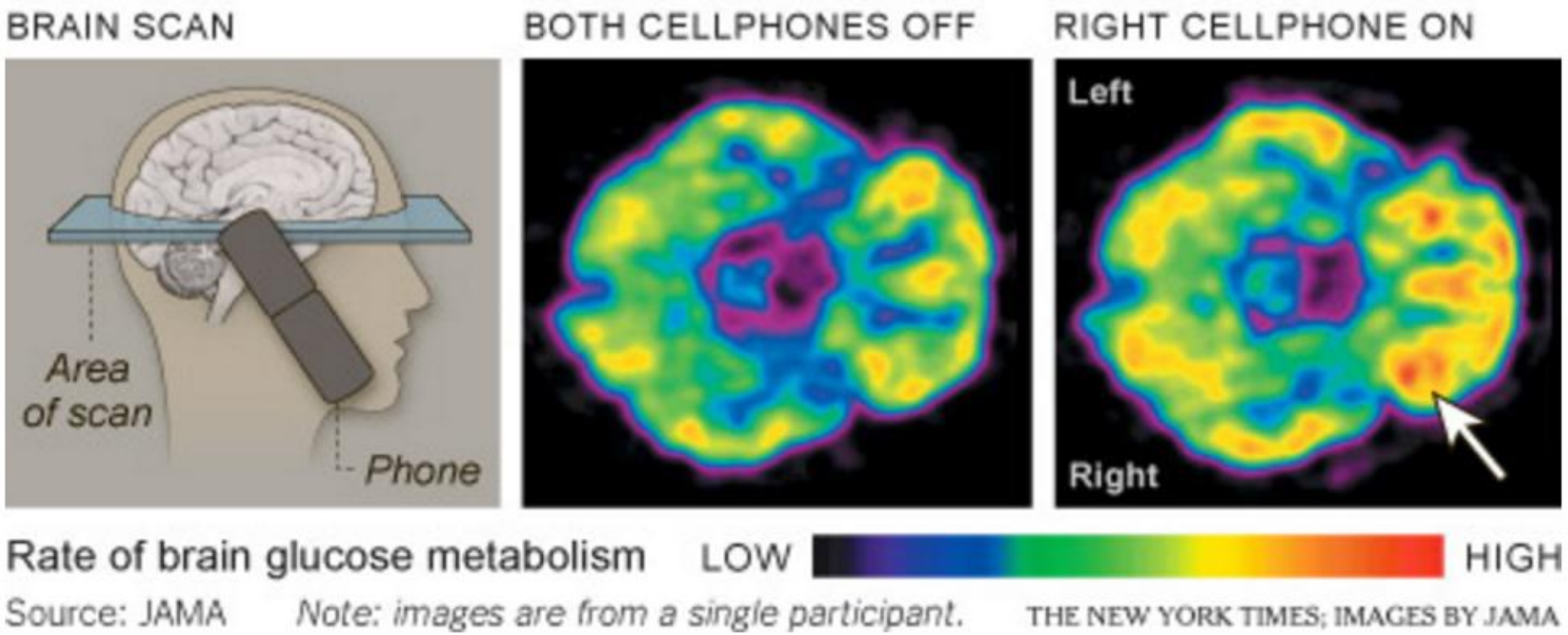
Position of the CP in the head and regions in the brain closest to the cell phone's antenna



Orbitofrontal cortex

Temporal pole

50 min on Cell Phone Significantly Alters Glucose Metabolism



Microwaves Damage Blood Brain Barrier

Replicated studies 1975-2015

Control

RF Exposed

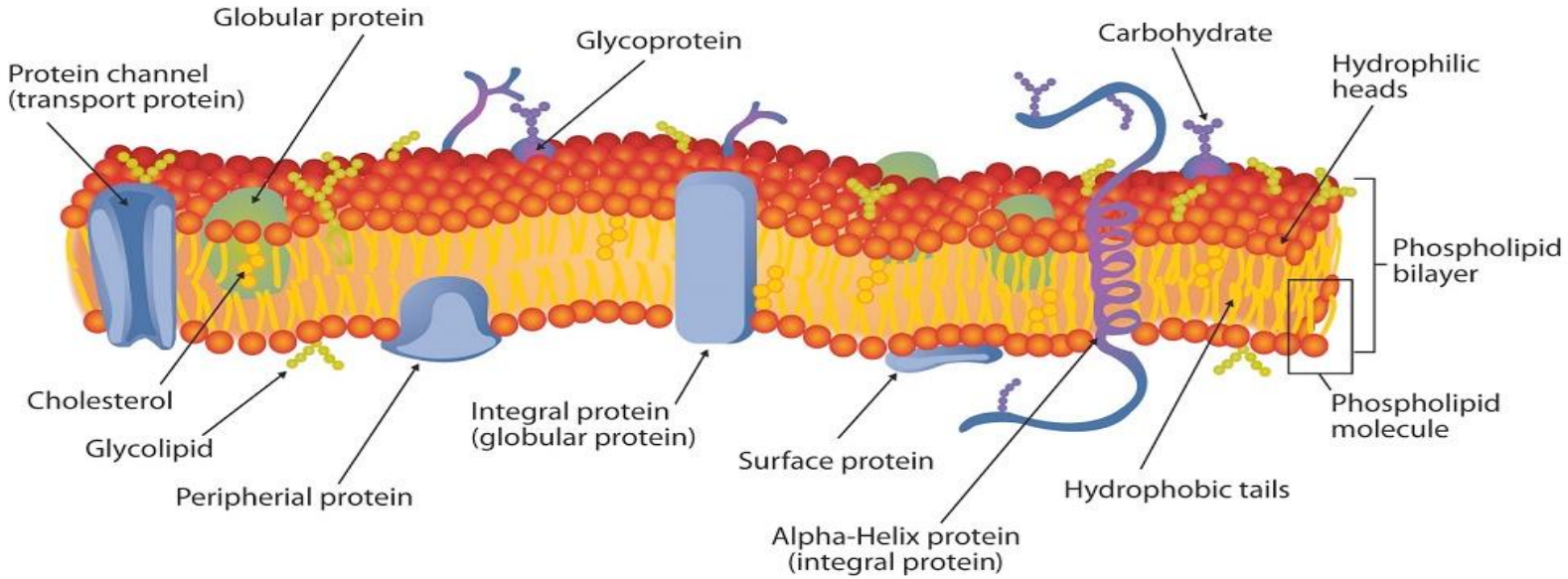
Dr. Leif Salford , 2009

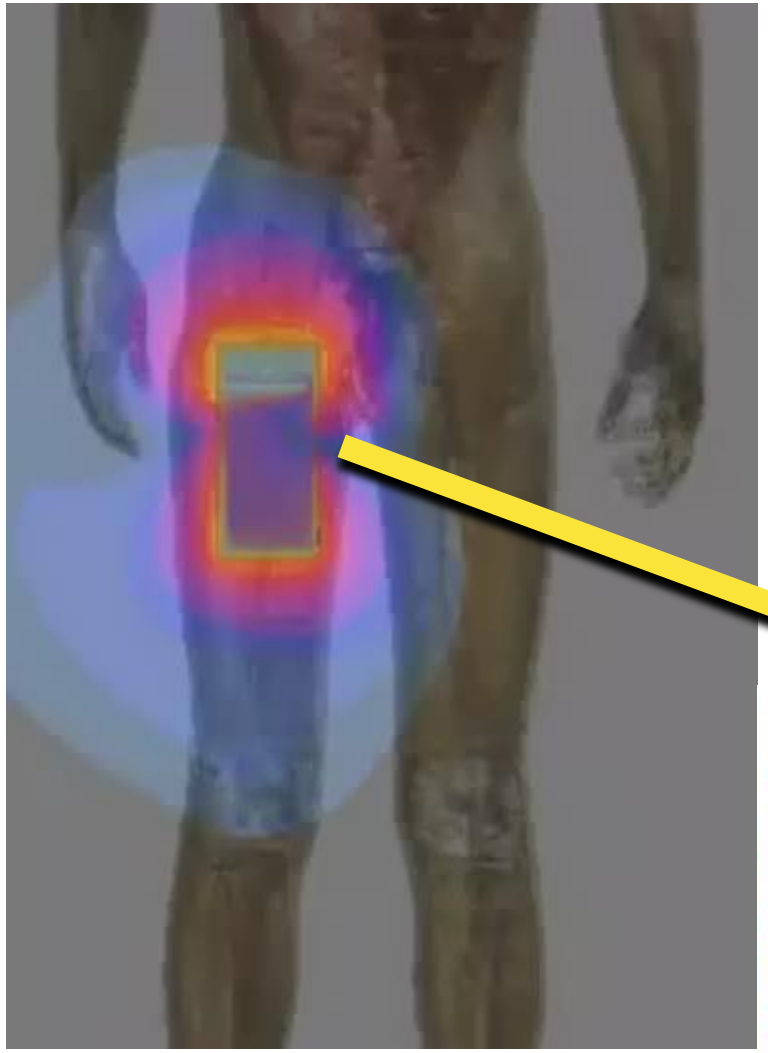
Tang 2015, Nittby 2009, Nittby 2008, Belyaev 2006, Salford 1994,
1975 Allan Frey-Annals of the New York Academy of Sciences

MW/RFR AND LIPID BILAYER MEMBRANES

- Broad implications for function -

- Localized heating of polar constituents causes lipid bilayer membrane damage, shedding of proteins, leakage of ionophores
- Disruption of membrane-associated reactions (metabolism, synthesis of macromolecules) in mitochondria, ribosomes, nucleus, endoplasmic reticulum, etc.
- Disruption of barriers – e.g., blood-brain barrier
- Myelin damage
- Testes damage
- Eye damage

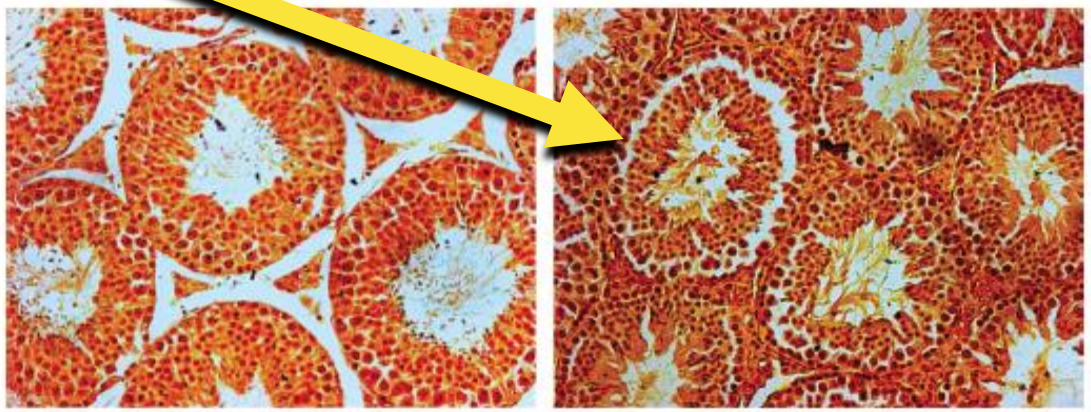




Fernandez, Environmental Health Trust (2016)

Cell Phone Radiation Can Damage Testes

"It's best to keep your cell phone as far from The testes as you can."
- Cleveland Clinic



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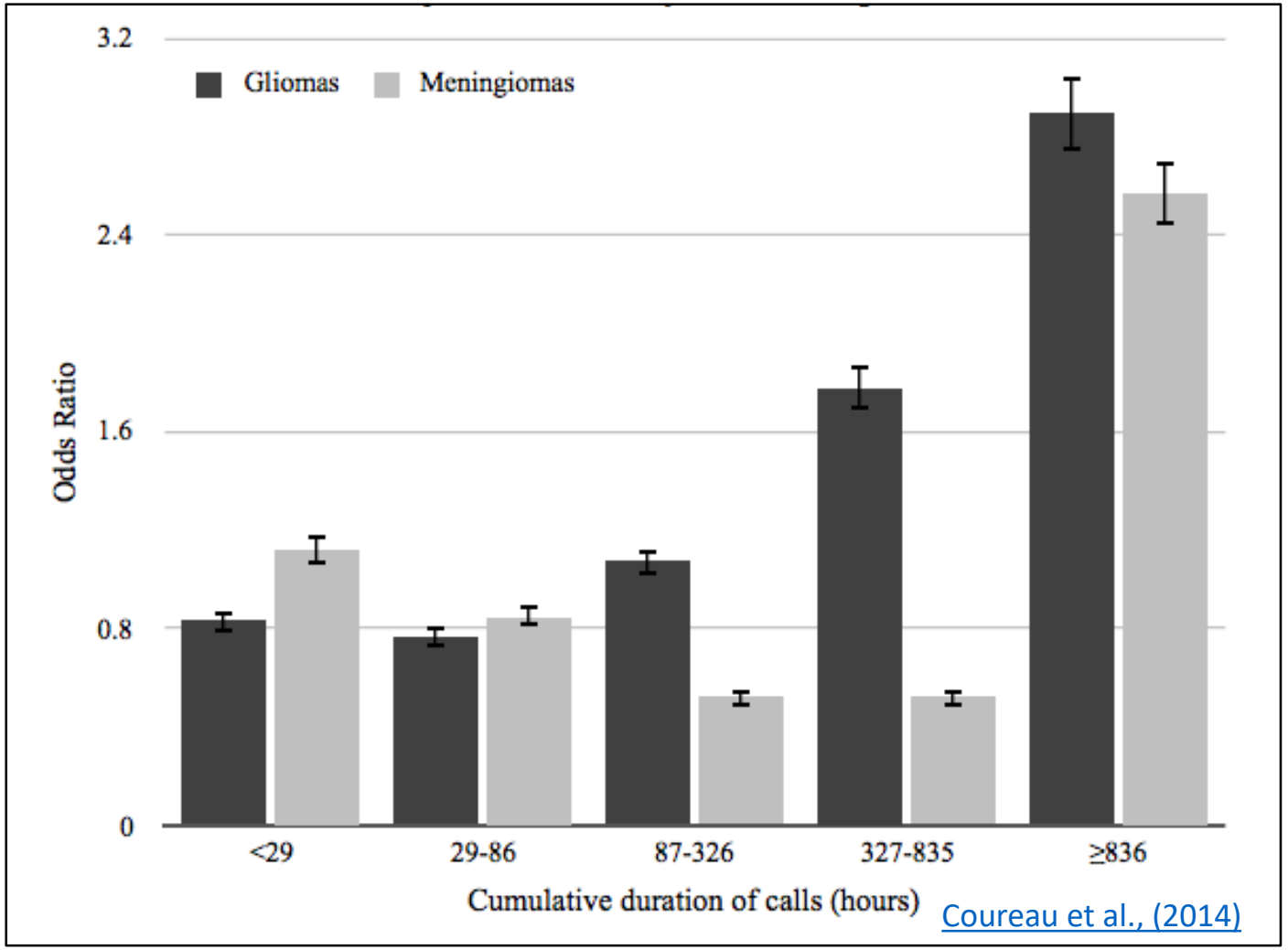
Consistently Increased Glioma risk in case-control studies

Study		Odds ratio
CERENAT 2014	≥896 h	2.89*
	≥18 360 calls	2.10*
	≥15 h/month	4.04*
2015 reanalysis	ipsilateral – cases only	2.40*
	>25 y latency	3.0*
Hardell et al. Meta-analysis 2015	>1y ipsilateral	1.8*
	first use <20 y old	1.8*
	first use <20 y old ipsilateral	3.1*

CERENAT 2014 CERENAT 2015 Hardell et al. 2015

French national study finds increased risk of brain tumors with heaviest users



Coureau et al., (2014)

Increased gliomas & meningiomas with cumulative hours of use

Independent Scientists, 2018, Replication Radiofrequency Radiation is a Human Carcinogen

Environmental Research xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/envres

Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102)☆

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[b] Environmental Health Trust, Berkeley, CA, United States
[c] Rutgers University School of Public Health, United States
[d] Environmental Health Trust, Teton Village, WY, United States
[e] Hebrew University of Jerusalem, Israel

ARTICLE INFO

Keywords:
Brain cancer
Vestibular schwannoma
Salivary gland tumor
Electric hypersensitivity
Glioma
Meningioma
Radio frequency fields
Cell phones
Mobile phones

ABSTRACT

Epidemiology studies (case-control, cohort, time trend and case studies) published since the International Agency for Research on Cancer (IARC) 2011 categorization of radiofrequency radiation (RFR) from mobile phones and other wireless devices as a possible human carcinogen (Group 2B) are reviewed and summarized. Glioma is an important human cancer found to be associated with RFR in 9 case-control studies conducted in Sweden and France, as well as in some other countries. Increasing glioma incidence trends have been reported in the UK and other countries. Non-malignant endpoints linked include acoustic neuroma (vestibular Schwannoma) and meningioma. Because they allow more detailed consideration of exposure, case-control studies can be superior to cohort studies or other methods in evaluating potential risks for brain cancer. When considered with recent animal experimental evidence, the recent epidemiological studies strengthen and support the conclusion that RFR should be categorized as carcinogenic to humans (IARC Group 1). Opportunistic epidemiological studies are proposed that can be carried out through cross-sectional analyses of high, medium, and low mobile

Miller et al 2018, Hardell and Carlberg 2017 & 2019, Peleg et al., 2018, Kelly 2015,

Radiofrequency Radiation damages DNA, increases antioxidants in peripheral blood lymphocytes of humans closest to mobile phone base stations*

- Study evaluated the effect of radiofrequency radiation from mobile phone base stations.

Compared residents- matched for demographics.

- Exposed group: Within 80 meters
- Control group: Over 300 meters

RF measurements ensured all RF levels were below India's limits (1/10 of ICNIRP)

Significant biological effects found on individuals closer to mobile base stations (within 80 meters).

- Alteration in antioxidant status in the plasma of exposed individuals
- Decreased glutathione concentration, activities of catalase, superoxide dismutase
- Increase in lipid peroxidation

** *Zothansiama et al. 2017

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American Cancer Society Study: Thyroid Cancer Increased Significantly with Regular Cell Phone Use in certain SNPs, 2020

- Luo and colleagues (2020) at Yale University carried out case-control study and found doubled risk of thyroid cancer in those using phones for 1+ hour a day who also carried certain Single Nucleotide Excisions (SNP) that affect DNA repair processes

- Newer phones have antennas located closer to thyroid, which may account for part of the unexplained recent growth in this cancer especially in those under age 50

JAMA Pediatrics

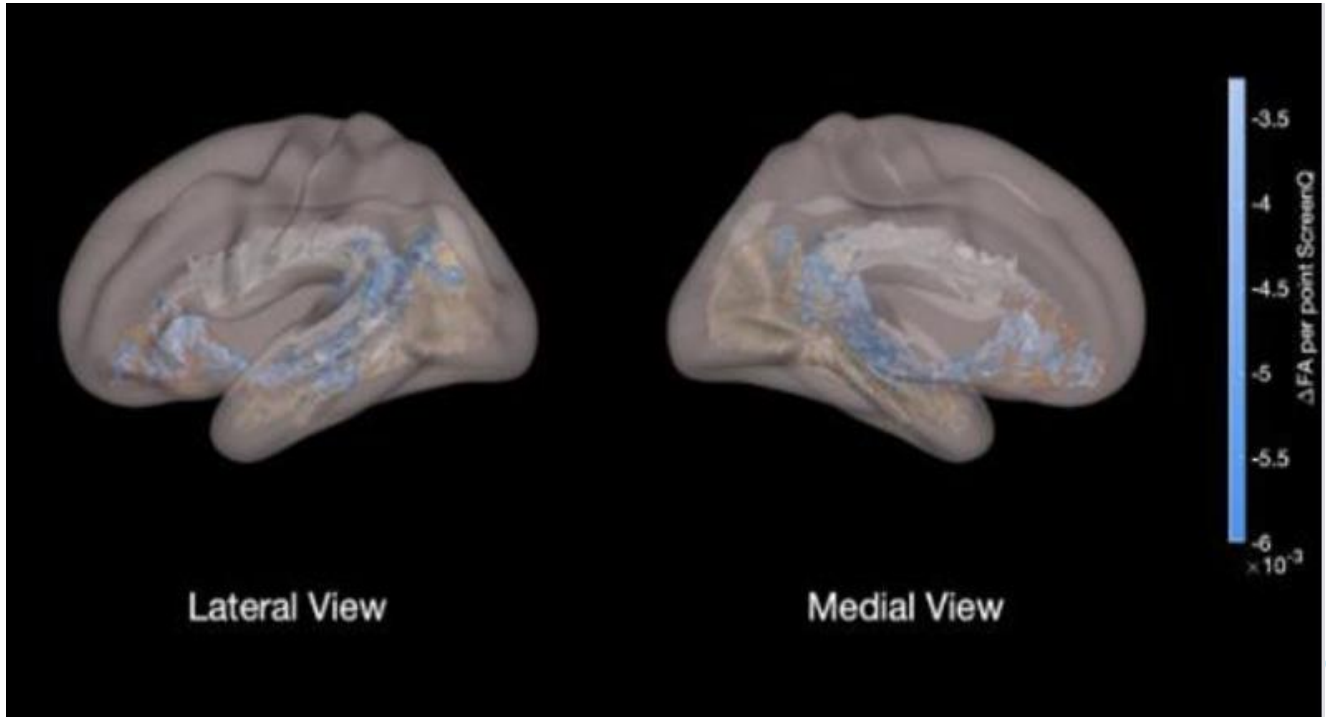
November 4, 2019

Associations Between Screen-Based Media Use and Brain White Matter Integrity in Preschool-Aged Children

John S. Hutton, MS, MD[1,2]; Jonathan Dudley, PhD[2,3]; Tzipi Horowitz-Kraus, PhD[1,2,3,4]; et al

Children aged 3 to 5 years
cognitive testing followed by diffusion tensor imaging (DTI), and screen survey by parents.

“This study found an association between increased screen-based media use, compared with the AAP guidelines, and lower microstructural integrity of brain white matter tracts supporting language and emergent literacy skills in prekindergarten children.”



Memory Problems in Teens One Year of Cell Phone Use to Head -Replicated

Swiss Tropical and Public Health Institute study

- Seventh through ninth-grade teenagers.
- Follow up study with double sample size to 2015 study that found cumulative call duration associated with a decrease in figural memory performance (Schoeni 2015)
- Exposures

Key Findings: Decreased memory performance in adolescents from cumulative exposure to cell phone radiation (Foerster 2018).

Wireless Radiation Increases Impact of Other Toxicants

Cell Phone Calls and ADHD Potentiation of Lead Toxicity in Korean Children

"Mobile Phone Use, Blood Lead Levels, and Attention Deficit Hyperactivity Symptoms in Children"

Byun et al. 2013

2,422 children - 27 schools - 10 Korean cities - 2 y follow up

ADHD symptoms associated with voice calls, only among children with higher blood lead values (>2.35µg/dL; comparable to Canadian BLLs)

Thielens et al., Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz, Scientific Reports (2018)

Apis mellifera
Photo Credit: Charles J Sharp

"This is the first paper that investigates the exposure of electric fields with RF frequencies associated with 5 G wireless communication."

"Our simulations showed that a shift of 10% of the incident power density to frequencies above 6 GHz would lead to an increase in absorbed power between 3–370%."

" This could lead to changes in insect behavior, physiology, and morphology over time due to an increase in body temperatures, from dielectric heating."

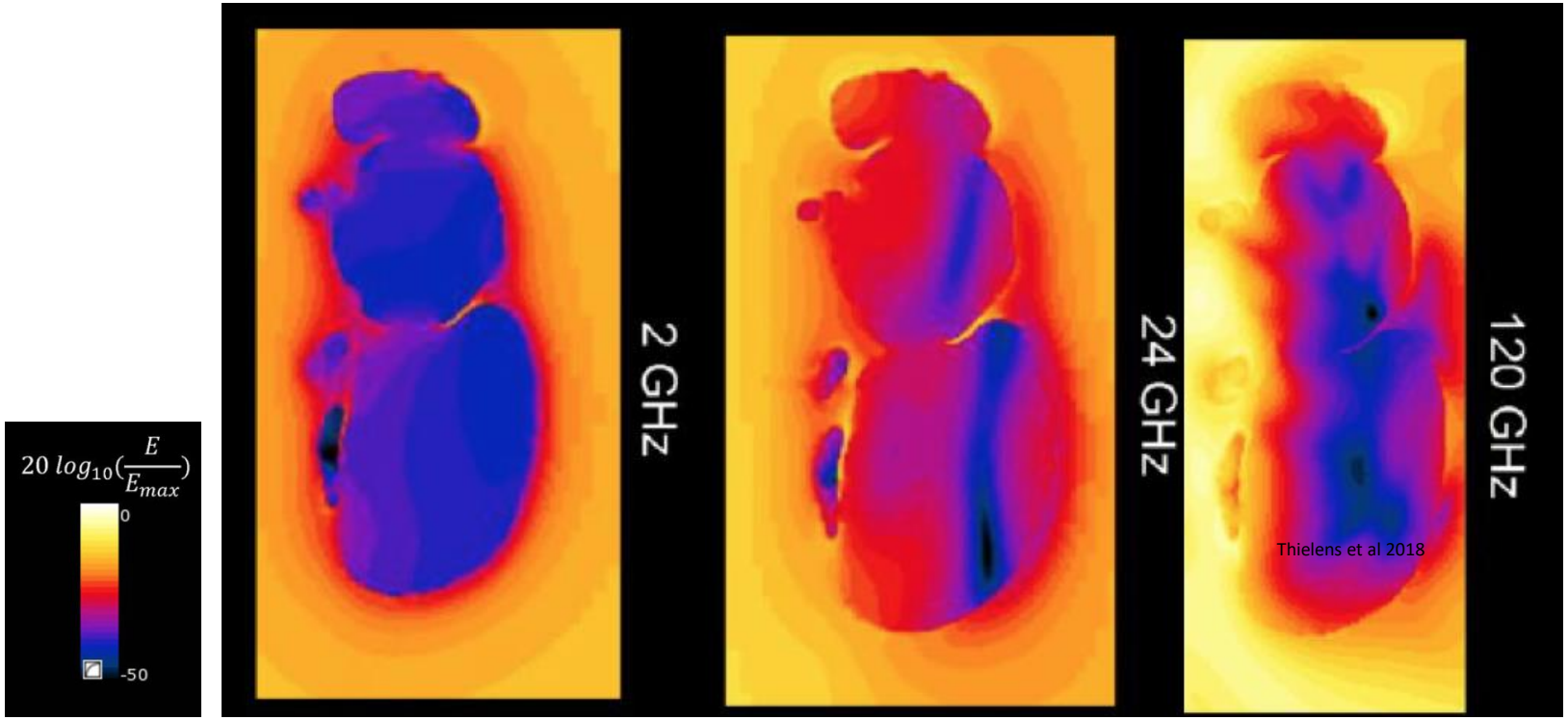


Figure 4. Normalized Electric field strength (dB) in a mid-transverse cross section of the **Western Honey Bee** as a function of frequency for a single plane wave incident.

CNN: Study Links Bee Decline to Cell Phones
Several published studies show impacts to bees.

Compelling Replicated Evidence of Synergies Between Toxic Exposures, EMFs & Cell Phone Radiation

"Modified health effects of non-ionizing electromagnetic radiation combined with other agents reported in the biomedical literature." *Microwave Effects on DNA and Proteins (*Kostoff and Lau 2017)

RF-EMF acts as tumor promoter at levels below government limits (Lerchl 2015)

- Carcinogen-induced tumor rates (lung, liver, lymphoma) were significantly higher when the animals were exposed to low level RF (0.04, 0.4 and 2 W/kg SAR)
- Replicated and expanded on Tillman 2010 study

Simultaneous exposures of children to lead and cell phone radiation.

- **Byun 2013:** ADHD symptoms (more voice calls and elevated blood lead levels).
- **Choi 2017:** Poor neurodevelopment up to 36 months (prenatal bbl and call time.)

ELF-EMF + Carcinogen Studies Find Synergistic Effects

Life-span exposure to MF and formaldehyde induces statistically significant carcinogenic effects in male rats. Am. J. Ind. Med. (Soffriti 2016)

Life-span exposure to sinusoidal-50 Hz magnetic field and acute low-dose γ radiation induce carcinogenic effects in Sprague-Dawley rats (Soffriti 2016)

Why so many conflicting studies?

- **Follow the money**

- *Microwave News, 2006* assessed funding bias
- 32 of the 35 studies paid for by the mobile phone industry and the U.S. Air Force show no effect.
- They make up more than 75% of all the negative studies.
- “You don't need to be a statistician to infer that money, more often than not, secures the desired scientific result.”

Motorola, Microwaves and DNA Breaks: "War-Gaming" the Lai-Singh Experiments

The following documents, recently obtained by Microwave News, *provide a rare behind-the-scenes glimpse of how a large corporation responds to the results of scientific research. On December 13, 1994, Norman Sandler of Motorola's corporate communications department sent two memos to Michael Kehs of the Burson-Marsteller public relations firm in Washington. Sandler discussed how to respond to findings by Drs. Henry Lai and Narendra Singh of the University of Washington, Seattle, and enclosed an eight-page draft of an internal strategy paper on the Lai-Singh work.*

Lai and Singh had found an increase in single-strand DNA breaks in the brain cells of rats after a single two-hour exposure to 2.45 GHz microwaves, at power levels considered safe according to current exposure standards. These results had not yet been published, but—as Motorola's strategy paper noted—they were about to be reported by Microwave News *(see* MWN, *N/D94; also J/F95, M/A95, J/A95, N/D95, J/F96 and M/J96).*

Below are the full text of one of the memos and excerpts from the internal strategy paper, which Sandler and Kehs were editing. "Rusty," referred to in the memo, is Albert R. Brashear, a Motorola corporate vice president and director of corporate communications. Bob Weisshappel is an executive vice president, and manager of Motorola's Cellular Subscriber Group.

MEMORANDUM

To: Michael Kehs *Date:* December 13, 1994

I'm off to Dallas, but obviously am reachable if necessary. I'm hoping we can get this document revision out of the way and return to more pressing matters (at least in terms of long-term priorities). I think we have sufficiently war-gamed the Lai-Singh issue, assuming SAG[2] and CTIA[3] have done their homework. We may want to run this by George Carlo[4] and fill him in on the contacts we've made.

ment, but offer this new, somewhat strengthened version of the second paragraph for consideration:

"While this work raises some interesting questions about possible biological effects, it is our understanding that there are too many uncertainties—related to the methodology employed, the findings that have been reported and the science that underlies them—to draw any conclusions about its significance at this time. Without additional work in this

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Media Strategy

It is not in the interest of Motorola to be out in front on this issue because the implications of this research—if any—are industrywide. Therefore, we suggest that the SAG be the primary media contact followed by the CTIA. It is critically important that third-party genetic experts, including respected authorities with no specific background in RF, be identified to speak on the following issues:

- Problems with the Lai-Singh and Sarkar studies.
- The health implications of DNA single-strand breaks.

We do not believe that Motorola should put anyone on camera. We must limit our corporate visibility and defer complex scientific issues to credible, qualified scientific experts. We have developed a list of independent experts in this field and are in the process of recruiting individuals willing and able to reassure the public on these matters. SAG will be prepared to release Munro[6]-Carlo memos, which touch on key points made in this material.

Action Planned

Since 1997 Secondary Insurers do not cover health damages from wireless

Several Lloyds of London underwriters deny coverage for health damages from wireless devices.

Swiss Re 2014 rates electromagnetic fields as of the 6 top risks businesses face today, above things like Mad Cow Disease.

"Risk from dangers linked to EMF can be classified as an emergent risk"-- the same category once occupied by asbestos

General Insurance Exclusions: Electromagnetic fields directly or indirectly arising out of, resulting from or contributed to by electromagnetic fields, electromagnetic radiation, electromagnetism, radio waves or noise.


SORRY BUT YOUR HEALTH MAY BE HAZARDOUS TO OUR PROFITS!
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COUGH, COUGH!
COUGH!
TOBACCO