Mobiltelefoni på gott och ont

Kjell Hansson Mild

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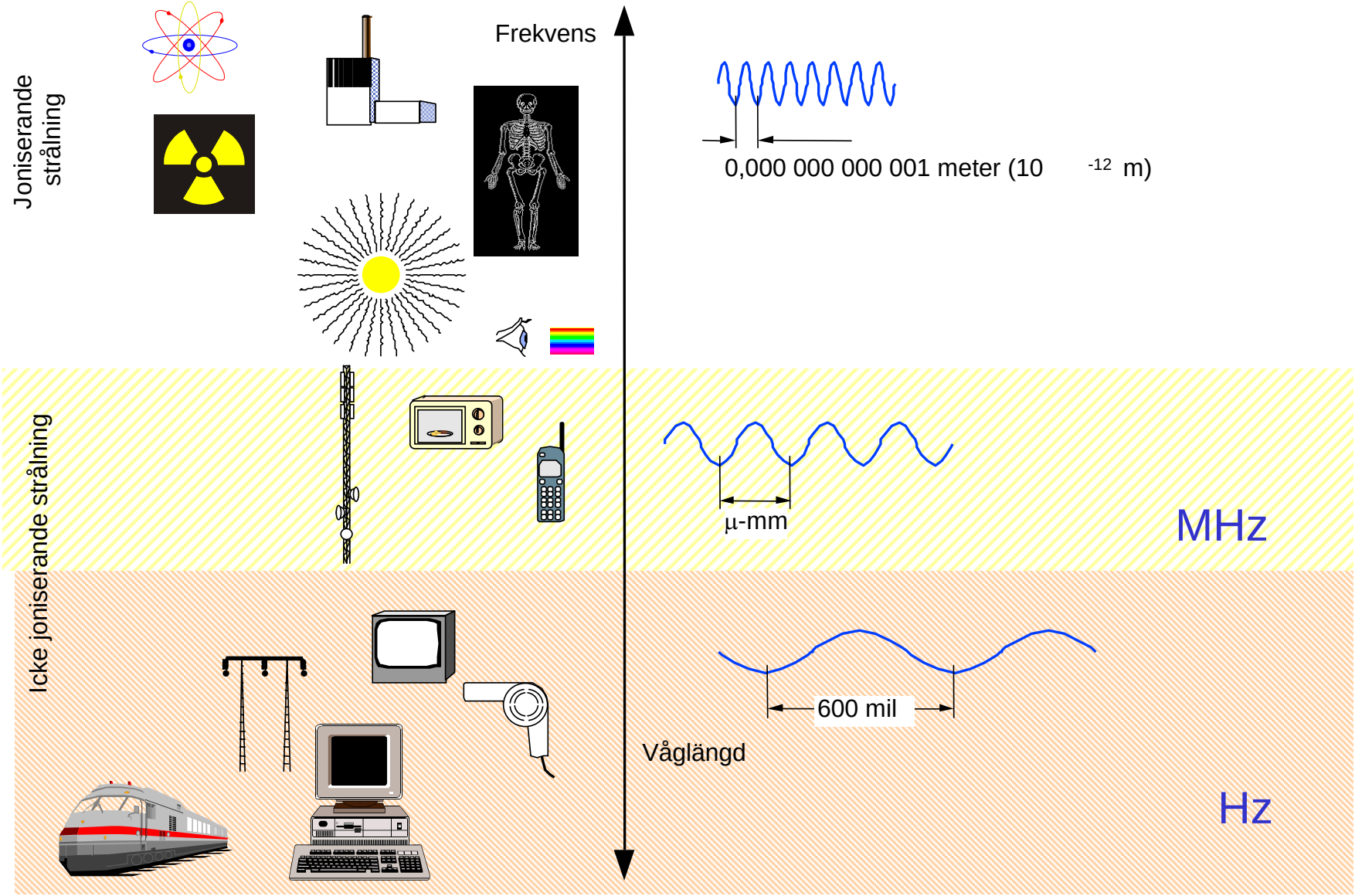
Örebro universitet
och
Arbetslivsinstitutet, Umeå

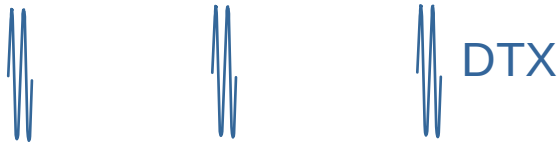
Elektromagnetiska spektrat



I dag:

GSM

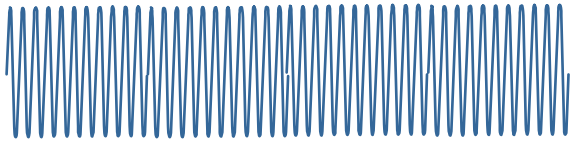
900 eller 1800 MHz



Uteffekten beror på avståndet till basstationen (0,0004- 0,25 W)

NMT

450 MHz

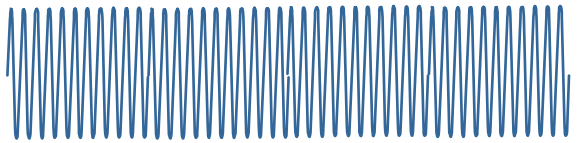


Uteffekten ca 1 W

I morgon:

UMTS

1900 MHz



Uteffekt < 0,02- 0,25 W

Snabbare effektnedreglering än GSM

GSM = Global system for Mobile Communication

UMTS = Universal Mobile Telecommunication System, även kallat 3G.

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GSM 900

890-914 MHz uplink, 935-959 MHz downlink
Pulsed output power max 2W, 217 Hz/2 Hz
Down regulation in steps to 3 mW
Duty cycle 1/8 gives max mean power 0.25 W
and low mean 0.4 mW

DCS 1800

1710-1785 MHz uplink, 1805-1880 MHz downlink
Peak pulse power max 1 W, low 2 mW
Max mean power 0.125 W, low mean 0.25 mW

With DTX system further reduction

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DECT

1880-1900 MHz up- and downlink
peak power 250 mW, 100 Hz rep. rate
Duty cycle 1/24, mean power about 10 mW

UMTS

1920-1980 MHz uplink, 2120-2170 MHz downlink
CW, Max power 0.25 W, power regulation 1500 times/s, DTX

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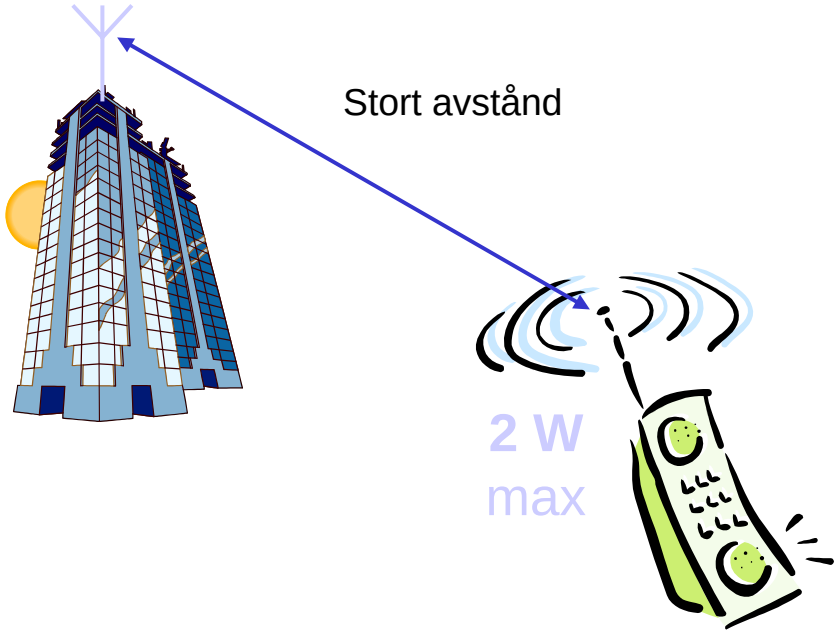
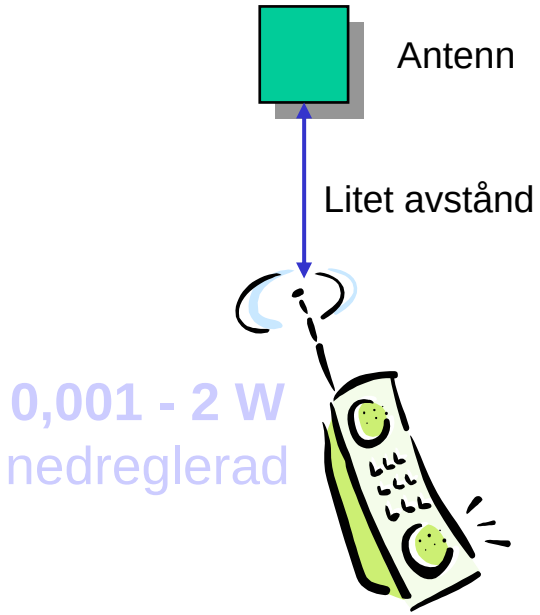
Effektkontroll

Mobilen använder inte högre effekt än vad som är nödvändigt!

- Stort avstånd - hög effekt
- Litet avstånd - låg effekt





När sänder mobilen?

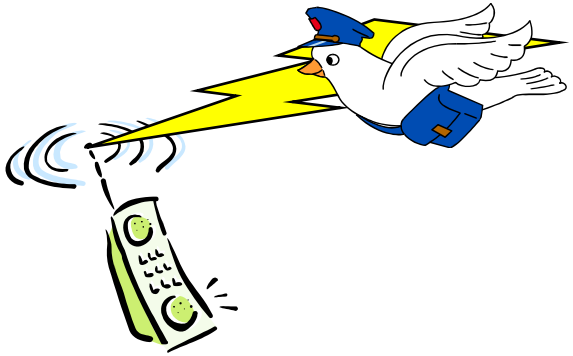
Mobilen kan sända även om inget samtal pågår!

Attach

Location Update

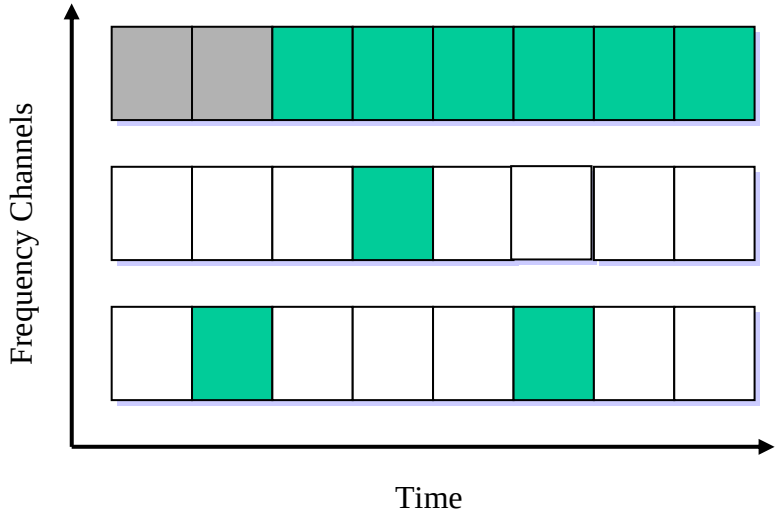
Detach

Incoming Message



Periodic Location Update

När sänder basstationen?



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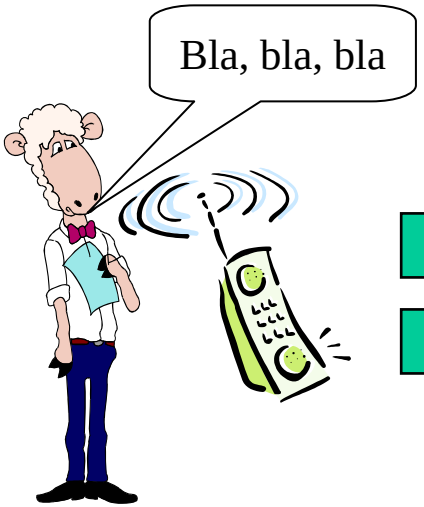
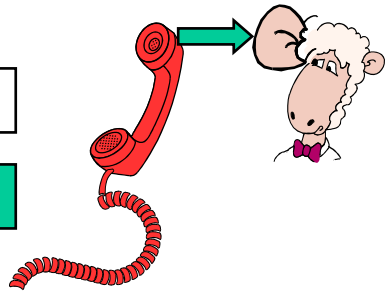
DTX

Mobilen respektive basstationen sänder bara när de har något att sända!



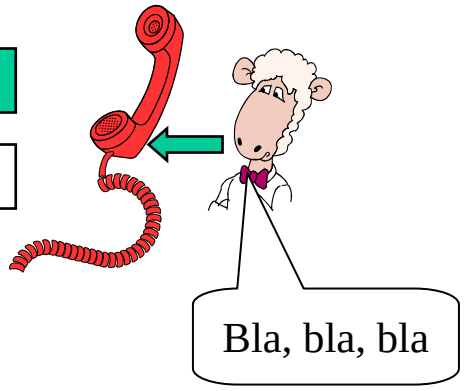
Basstation till mobil

Mobil till basstation

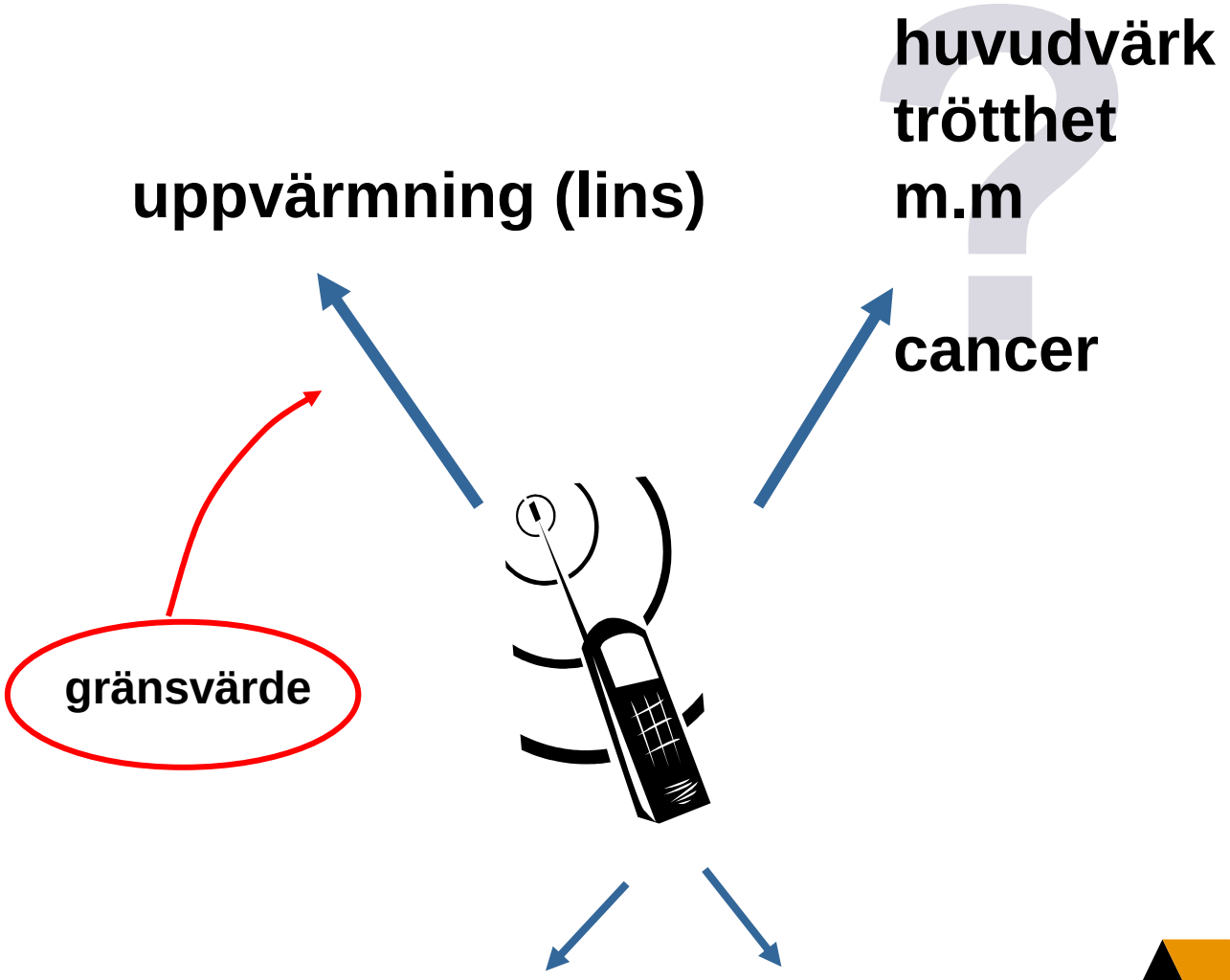


Basstation till mobil

Mobil till basstation



Risker med mobiltelefoni?



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Biologiska effekter av radiofrekventa elektromagnetiska fält

Termiska effekter – effekter pga värme

Tämligen väl undersökta, uppstår vid akut exponering, tröskelvärden. Gränsvärden finns, epidemiologi saknas i stort.

Icke termiska effekter- ingen temperaturhöjning

Svårbedömt, finns data som tyder på förekomst av dylika effekter, mer forskning behövs

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Specific Absorbtion Rate, SAR

Anger hur mycket energi som absorberas per tidsenhet och massenhet

SAR ges i enheten watt/kg, W/kg

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Exempel på biologiska effekter

	SAR (W/kg)
Missbildning på foster	15
Låg fostervikt	10 - 15
Funktionella störning hos foster	2 - 3
Temporär sterilitet	5 - 6
Beteendeförändringar	1 - 2
Hormonella ändringar	1
ELF mod signal Ca-utflöde	0.001
Cancer promotion ?	2 - 3
Komb. effekt med droger	1 - 2

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Klara icke önskvärda effekter vid SAR > 4 W/kg

ICNIRP: Säkerhetsfaktor 10 för yrkesverksamma, ger gränsvärde för helkroppsexponering på

SAR < 0.4 W/kg

För allmänheten ytterligare faktor 5,

SAR < 0.08 W/kg

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ICNIRP: Exponering av del av kropp:

Grumling av linsen (katarakt) behövs ca 100 W/kg

Ögongloben ca 10 gr, Säkerhetsfaktor 10 ger gräns:

SAR 10 W/kg över 10 g

Allmänheten lägg på ytterligare säkerhetsfaktor 5

vilket ger lokal SAR = 2 W/kg.

Detta har blivit ”mobiltelefongränsvärdet” .

ANSI C95.1, USA: Delkroppsexponering

max 1:20, ger 20 x 0,08 W/kg = 1,6 W/kg

över 1 g.

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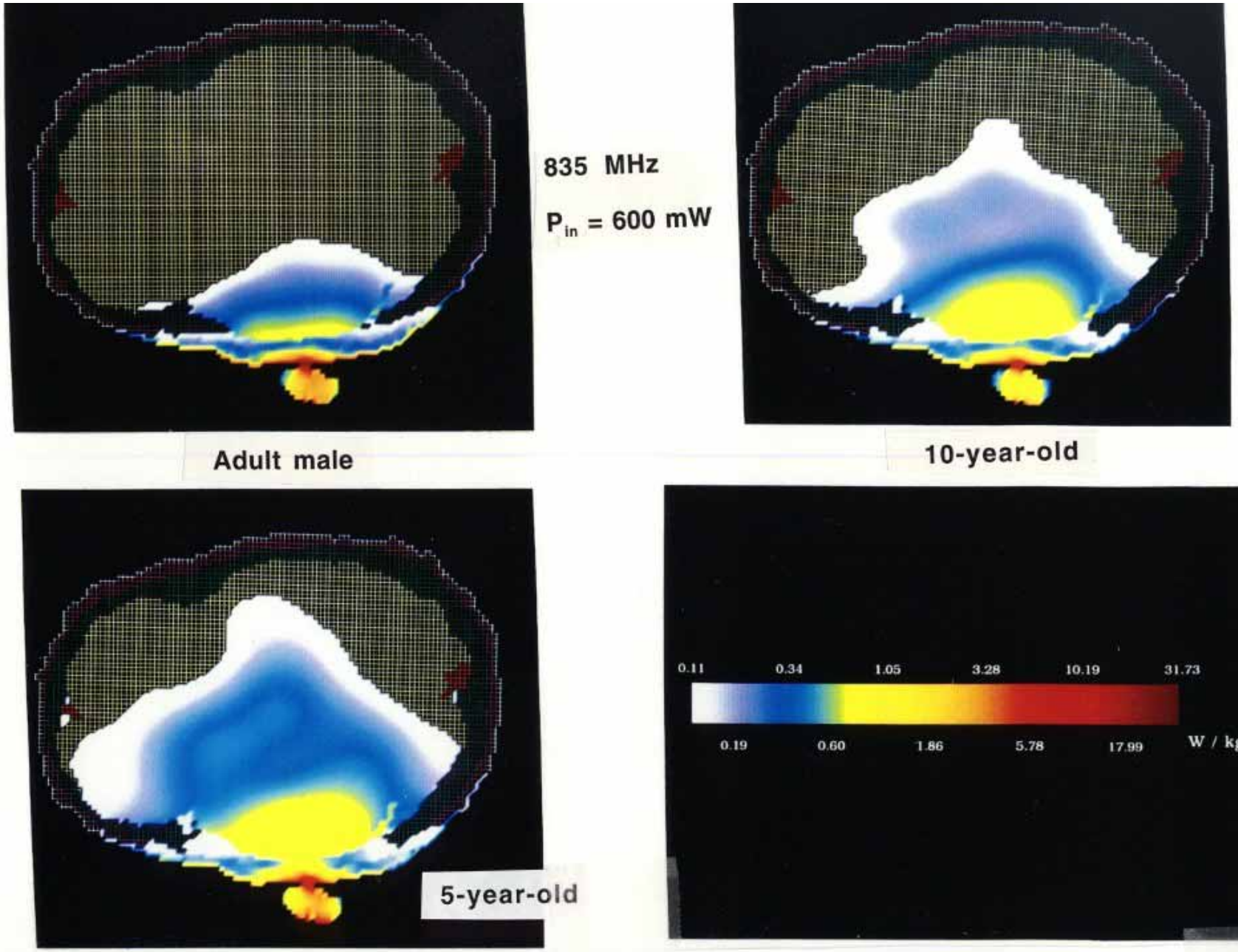
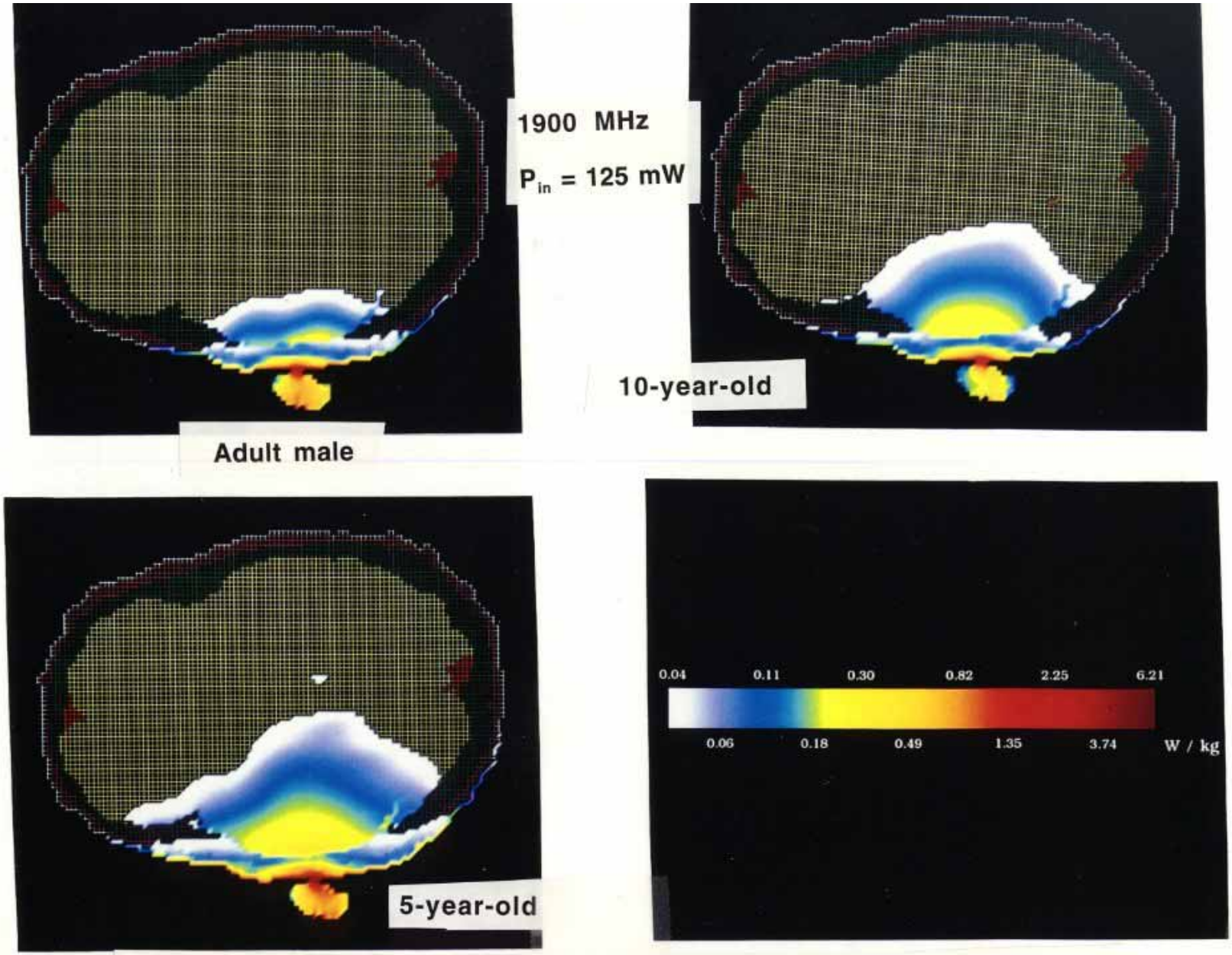
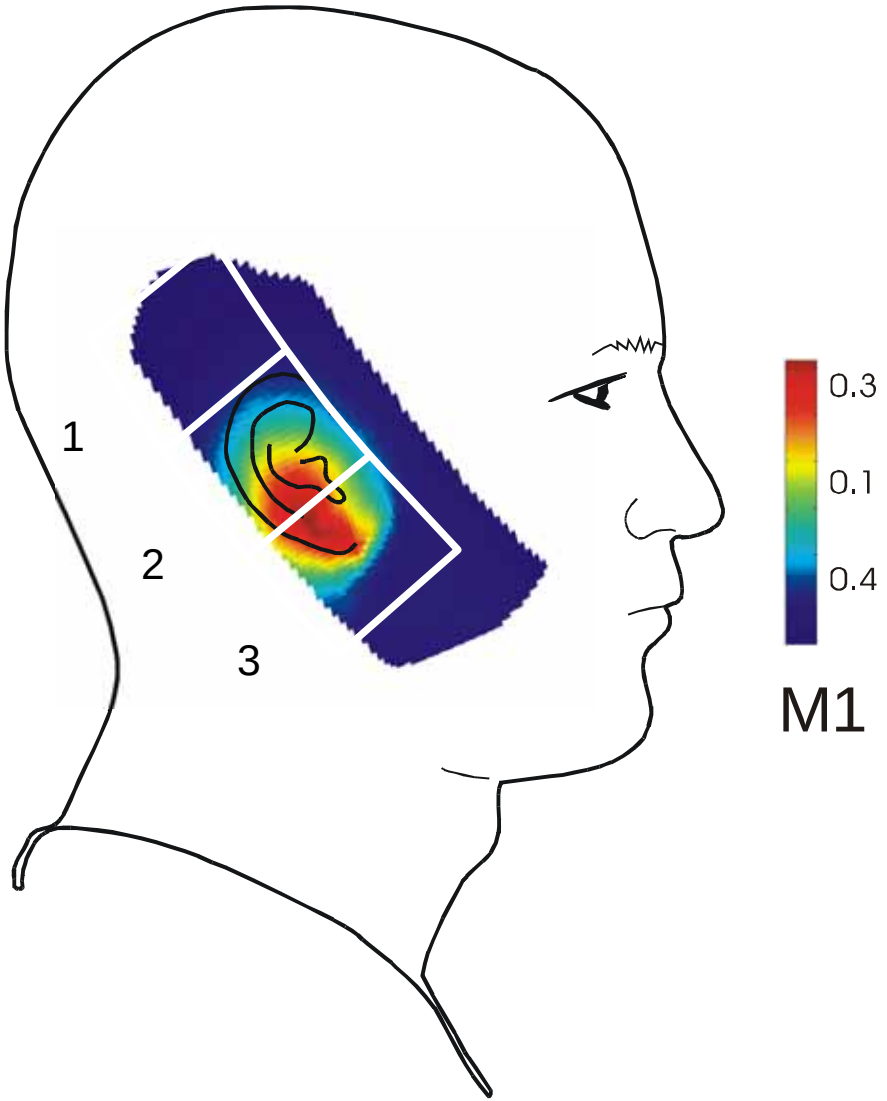


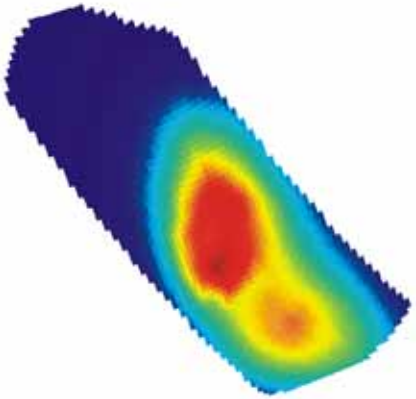
Energy deposition for models of an adult and 10- and 5-year old children for a cellular telephone at 835 MHz. Radiated power = 600 mW [from O. P. Gandhi et al., *IEEE Trans. Microwave Theory & Techniques,* 44, p. 1893, 1996]

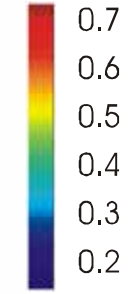


Energy deposition for models of an adult and 10- and 5-year old children for a cellular telephone at 1900 MHz. Radiated power = 125 mW [from O. P. Gandhi et al., *IEEE Trans. Microwave Theory & Techniques,* 44, p. 1894, 1996]

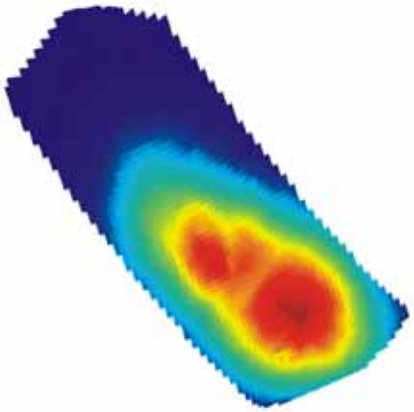


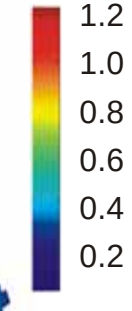
M1



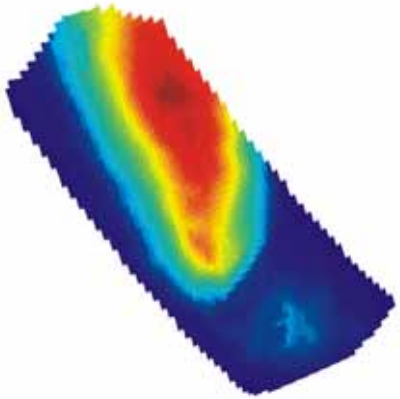


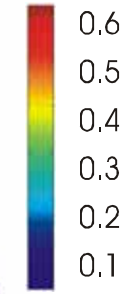
M2





M3





M4

Mild

Gert Anger, Sthm: SAR and transmitted power for 21 mobile phones

The Bioelectromagnetics Society 25th Annual Meeting
Wailea, Maui, Hawaii, June 22-27, 2003

Highest SAR values ranged from 0.49 to 1.7 W/kg.

Emitted power (TCP) 900 ranged from 0.19 to 0.49 W
1800 MHz: range 0.056 to 0.26 W

Ratio SAR/TCP for 900 MHz phones: 0.24 - 2.9 W/kg/W
1800 MHz: 0.76 - 5.4 W/kg/W

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Biologiska effekter vid låga nivåer

Finns flera undersökningar som visar på biologiska effekter vid låga SAR värden, sk icke termiska nivåer:

Repacholi – transgenic mice och lymfom,

Kwee cellprofilering,

Litovitz heat shock protein aktivering,

dePomerai hsp hos rundmask,

dePomerai amyloid fibril formation

Salford-Persson blod-hjärnbarriären

Ny genomgång av data behövs.

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Cancer och djurförsök (I)

Repacholi et al. Rad Res 147: 631-640, 1997
Transgena möss (Eμ-pim1), predisponerade för lymfom ca. 15% på 18 mån.

Exp. i fjärrfält för 900 MHz, 217 Hz pulser med 0.6 ms, SAR 0.008 - 4.2 W/kg, 30 min på morgon och kväll, 18 mån.

Risken för lymfom var sign förhöjd hos exp vs kontroll:
OR = 2.4 , 95% KI 1.3 - 4.5.

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Rudiger Group, Vienna: Genotoxic effects of ELF-EMF on human cells in vitro.

The Bioelectromagnetics Society 25th Annual Meeting
Wailea, Maui, Hawaii, June 22-27, 2003

Exp to 1800 MHz, 2 W/kg, intermittent 5´on/10´off,
neutral comet assay:
Continuous no effect, pulse and talk modulated no effect after 4 h, but sign. effect after 16 and 20 h on DNA strand breaks.

GSM 1950 MHz 1 W/kg, 5´on/ 10´off: effect on chromosome aberrations; dicentric, acentric fragments, and breaks.

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Tauber group, Berlin: Genotoxic effects of RF-EMF on cultured cells in vitro

The Bioelectromagnetics Society 25th Annual Meeting
Wailea, Maui, Hawaii, June 22-27, 2003

HL60 cells, 1800 MHz, 24 h, Micronuclei, DNA strand breaks

MN: No effect at 1 W/kg, sign. max at 1.3 W/kg, lower at 1.6 and 2.0 W/kg, and no effect at 3 W/kg.
Both CW, intermittent and "talk" modulated.

DNA strand breaks doubled at 1.3 and 1.6 W/kg, less at 2 W/kg

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Nerve Cell Damage in Mammalian Brain after Exposure to Microwaves from GSM Mobile Phones

Leif G. Salford, Arne E. Brun, Jacob L. Eberhardt,
Lars Malmgren, Bertil R.R. Persson
doi:10.1289/ehp.6039 (available at http://dx.doi.org/)
Online 29 January 2003

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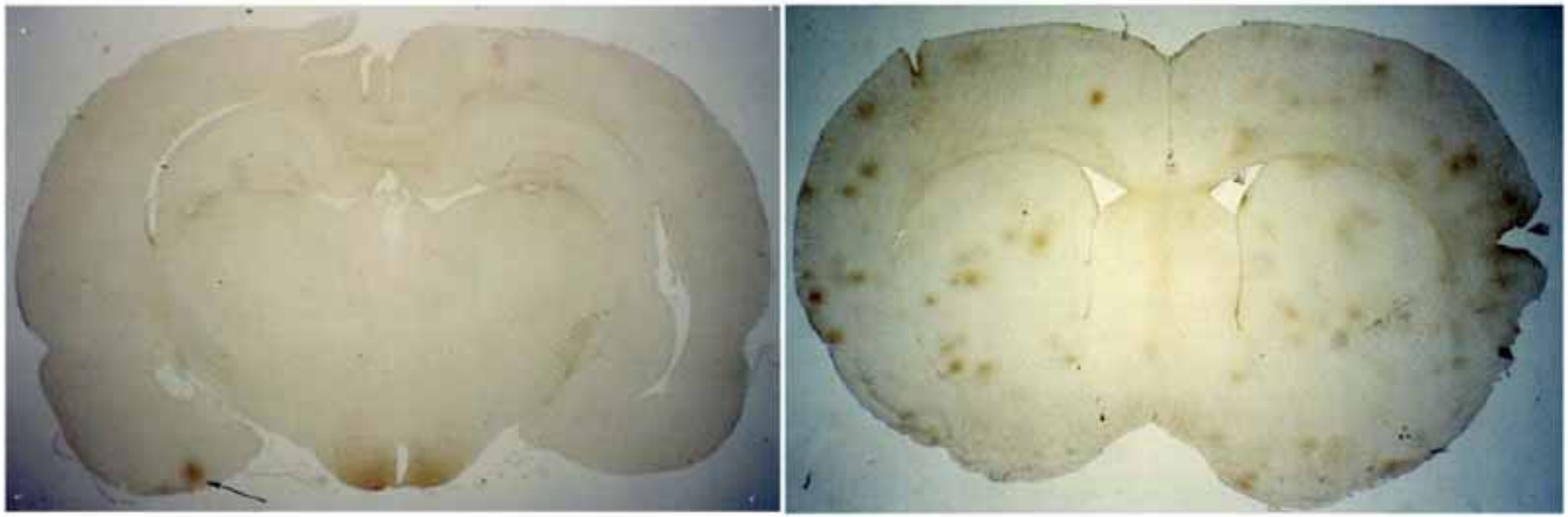

(a) (b)

Figure 1

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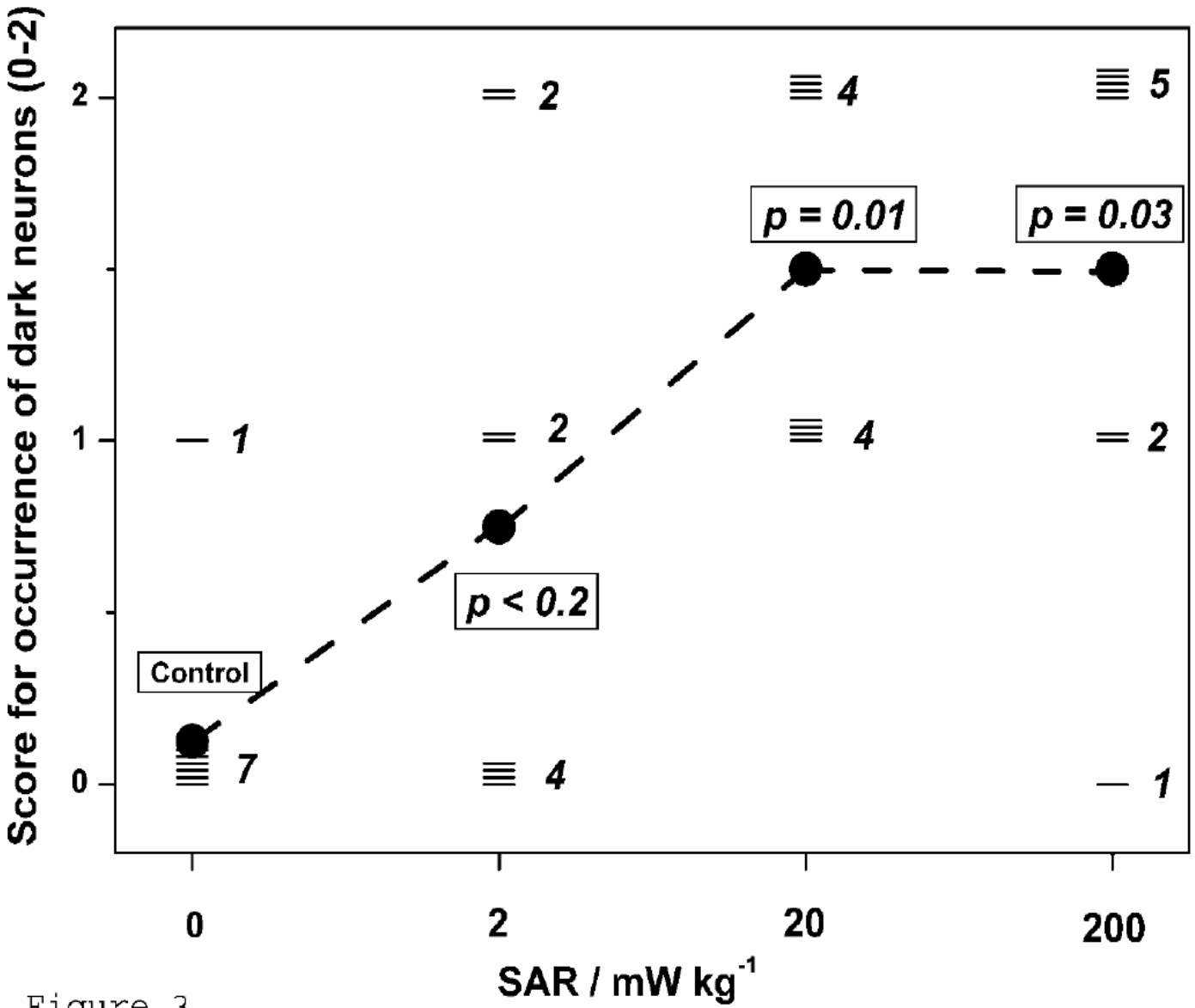
Score for occurrence of dark neurons (0-2)
2
1
0
2
4
5
1
2
4
2
7
4
1
p = 0.01
p = 0.03
p < 0.2
Control
0
2
20
200
SAR / mW kg-1

Figure 3

Kliniska studier

Finns ett flertal studier med exponering av frivilliga friska försökspersoner (oftast män 20-25 år!)

De flesta har exponerat för en mobiltelefon mot ena örat, angett SAR till 0,5 till 1,5 W/kg, tid ca 30 min.

Mätningar av EEG, reaktionstid, blodtryck, hjärtfrekvens, minnestester.

Enda upprepbara effekter man sett är EEG förändringar. Någon studie har visat på blod-flödesförändring.

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Huber et al, 2002. Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG. J. Sleep Res. (2002) 11, 289

16 unga män, 20-25 år, Exponering för 900 MHz GSM liknande signal, 1 W/kg över 10 g, 30 min., vänster sida.

Undersökning med PET kamera 10 min efter exponeringen.

Sömnundersökning: Exp kl 22.20 i 30 min, släckt lyse 23.00, EEG mätning under 8 h.

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Huber et al, 2002

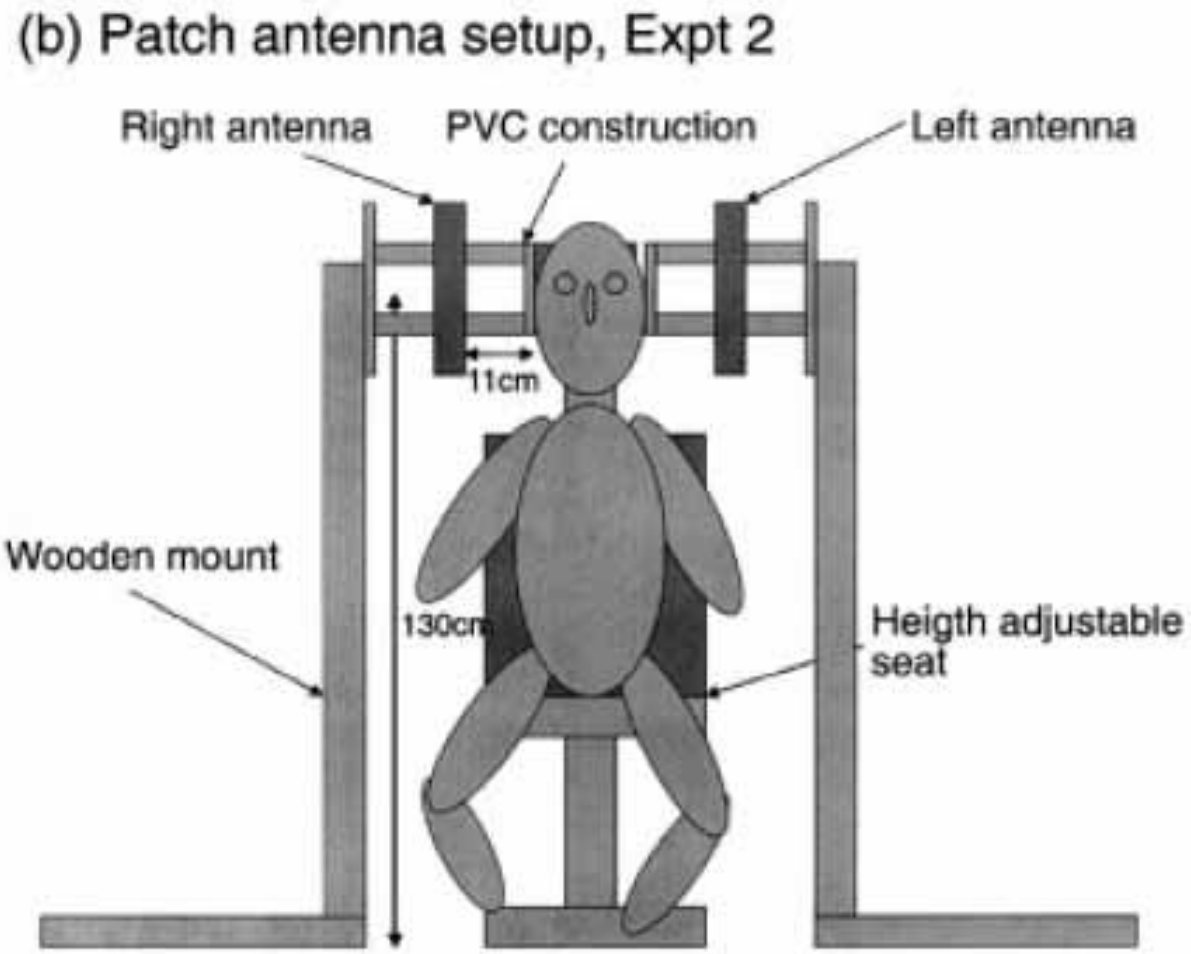
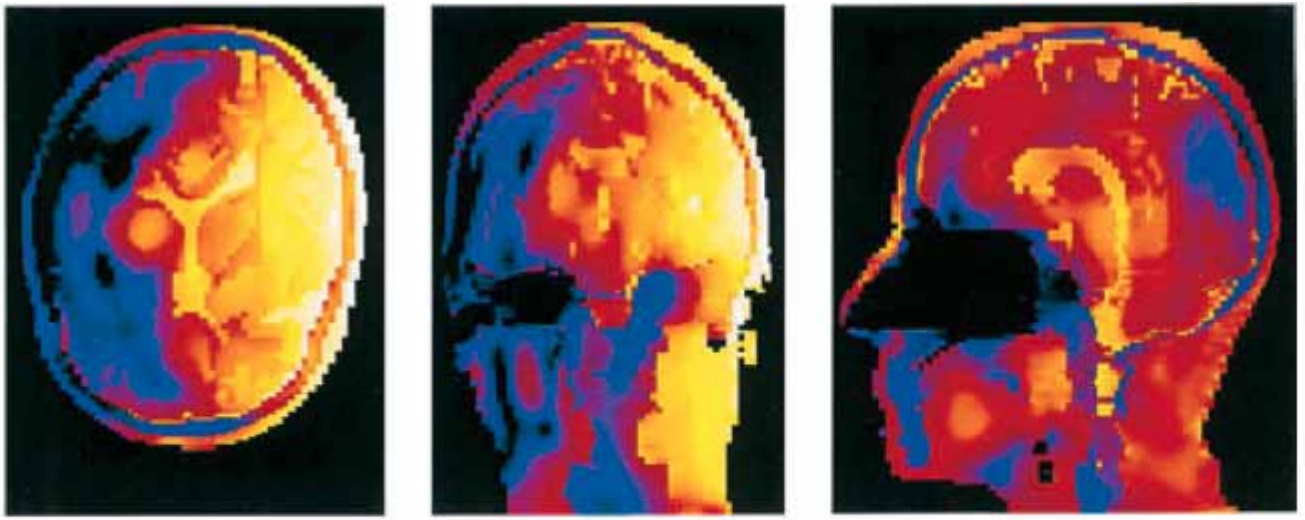


Fig. 1. Schematic diagrams of the exposure setups used in experiments 1 (Expt 1) and 2 (Expt 2).

Huber et al, 2002

Patch setup
(Expt 2)



0 dB = 1 W/kg

Fig. 2.

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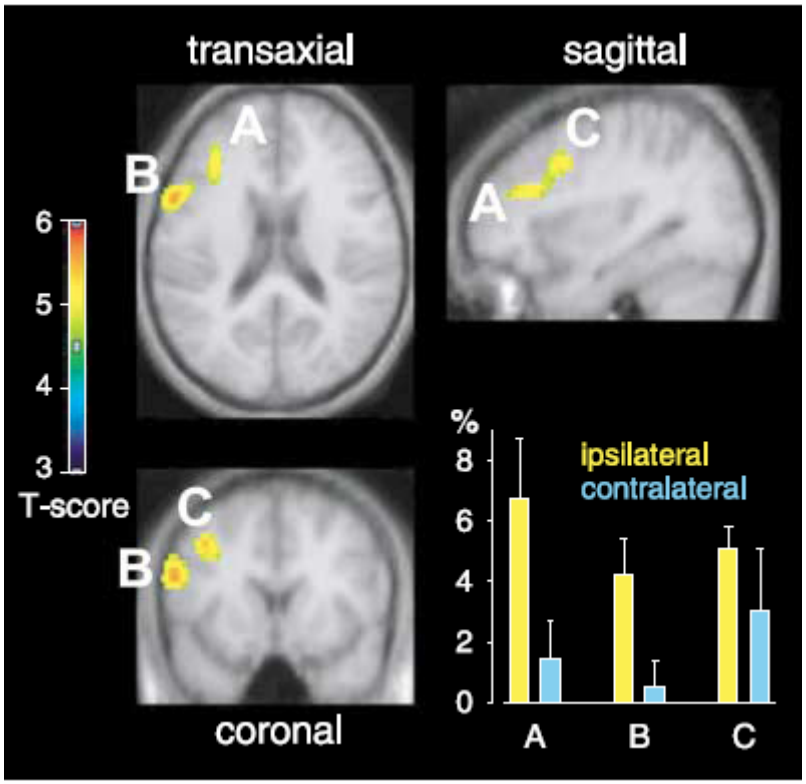
Huber et al, 2002. PET och blodflöde



Increased regional cerebral blood flow after EMF exposure. Regions showing higher relative regional cerebral blood flow (rCBF) after pulse modulated. A significant increase of rCBF was observed in all three regions on the ipsilateral side ($P < 0.01$, two-tailed paired t-test) but not on the contralateral side.

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Huber et al, 2002

EEG förändringar noterade före sömn i alfabandet (ökning), och vid ca 12-13 Hz under sömnen.

Förändringarna endast då pulsat fält användes, ej vid CW.

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TNO-studien

Effects of GSM and UMTS fields on cognitive functions and well-being

Eric van Rongen

A. Peter M. Zwamborn

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Experimental design

- Double blind crossover study
- Conditions:
  - 900 MHz GSM-fields
  - 1800 MHz GSM-fields
  - 2100 MHz UMTS-like fields
  - sham
- 4 sessions of max 30 min, 20 min interval:
  - 1 training session (no exposure)
  - 3 exposure sessions, randomized
    - 1 sham
    - 2 actual exposure

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Subjects

- Volunteers with subjective complaints (36; group A)
  - recruited through *Monitoring Network on Health and Environment*
  - very reluctant to participate
- Volunteers without subjective complaints (36; group B)
  - own network
  - local newspaper ad: very low efficiency: 5 volunteers for € 2300
  - Internet
- Result: unbalanced groups

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Exposure conditions

- Exposure in shielded (anechoic) room
- Field strengths chosen: maximum value measured occasionally in a real environment (1 V/m)
- Peak field strength is maximized
- Effective field strength:
  - GSM: 1.0 V/m
  - UMTS: 0.7 V/m

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Tests used

- Cognitive functions:
  Taskomat (TNO-developed test set)
  - reaction time
  - memory comparison
  - visual selective attention
  - dual tasking: general reaction
  - dual tasking: filtering irrelevant information

- Well-being:
  subset of Bulpitt questionnaire
  - full questionnaire validated for hypertension
  - contains for present study irrelevant questions
  - Ethical Committee demanded use of subset

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Well-being questionnaire

- Questions (first 11 out of 23)
  - Nervous
  - Feeling dizzy or faint
  - Feelings of pressure or tightness in head or body
  - Scared or frightened
  - Poor appetite
  - Heart beating quickly or strongly without reason (throbbing or pounding)
  - Feeling that there was no hope
  - Restless or jumpy
  - Poor memory
  - Chest pains or breathing difficulties or feeling of not having enough air
- Answers possible
  - Not at all score: 0
  - Feeling tired or a lack of energy
  - A little, slightly score: 1
  - A great deal, quite a bit score: 2
  - Extremely, could not have been worse score: 3

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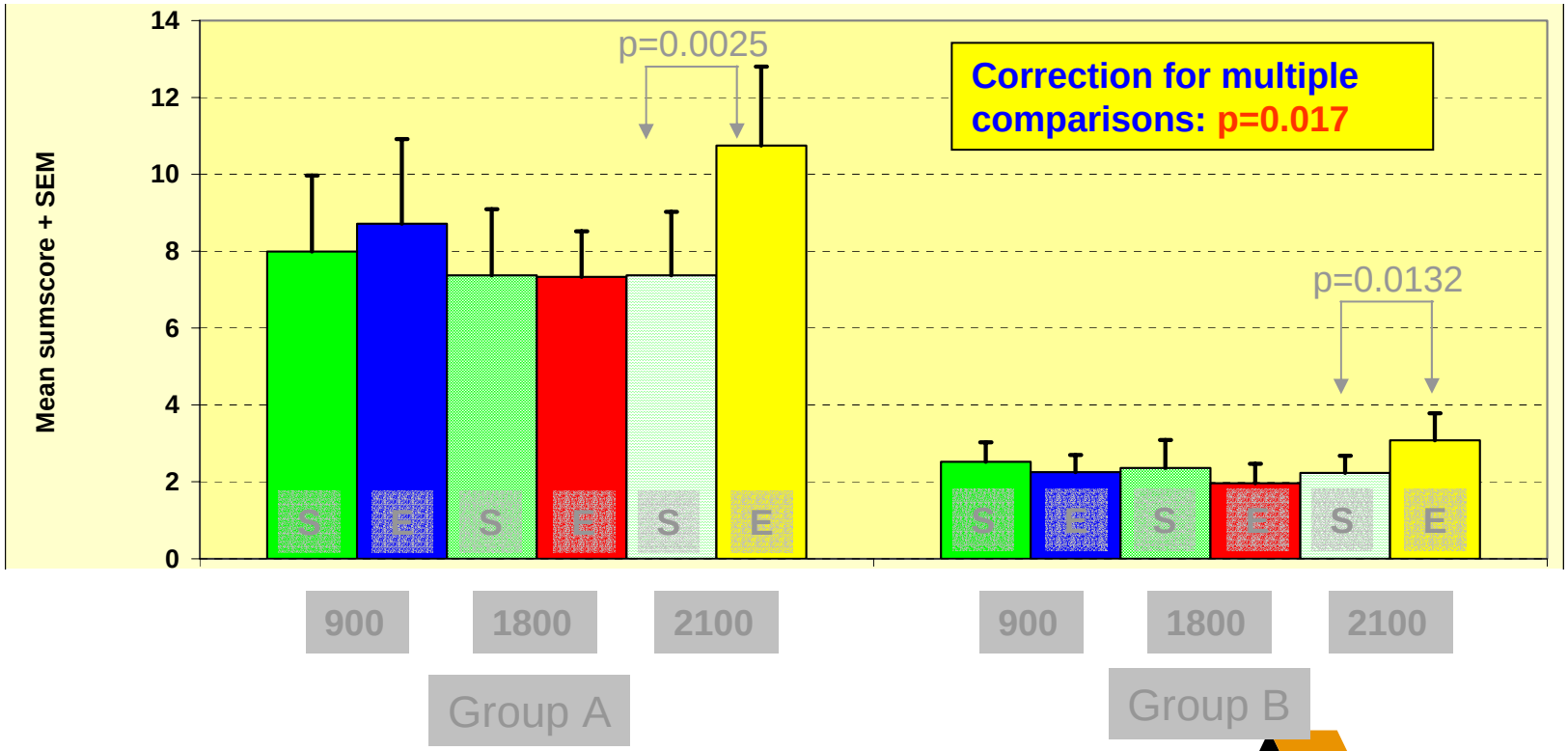
Well-being: sumscores



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Overview of cognitive function tests

	Group A			Group B		
	GSM900	GSM1800	UMTS-like	GSM900	GSM1800	UMTS-like
Cognitive function test						
Reaction time	0.014	0.55	0.44	0.49	0.42	0.36
Memory comparison	0.90	0.52	0.79	0.061	0.26	0.0034
Visual selective attention	0.55	0.69	0.046	0.081	0.84	0.049
Dual tasking, reaction time	0.60	0.82	0.56	0.80	0.041	0.27
Filtering irrelevant information	0.037	0.46	0.68	0.53	0.75	0.44

No correction for multiple comparisons: p = 0.05

Correction for multiple comparisons, (correlation 0.4): p = 0.01

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Conclusions

- Null hypothesis (“no relation”) is rejected
- Statistically significant relations are found between RF-exposure and measured parameters
- Consistent effect only on well-being
- Thermal effects seem highly unlikely to explain results
- WHO definition of health includes well-being: effect on well-being = effect on health

Conclusions (2)

- Present study: the first one with this setup
- Replication necessary
- Many different analyses of data possible
  - restricted to approved Study Protocol
- Follow-up studies necessary
  - many parameters can be varied
  - study design can be improved

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Mobiltelefoner och hjärntumörer

Hardell et al, 1999, 2000

Användning av mobiltelefon på samma sida som tumörer (bara vissa lober) ger sign. riskökning OR =2.62 (95%CI: 1.02 -6.71)

Muscat et al, 2000: Tumörer vanligare på samma sida: 26 vs 15

Inskip et al, 2001: Endast 17 pat med >15 min/dag mer än 3 år

Stang et al, 2001: Ögoncancer, men bara 6 fall med > 3 år

Auvinen et al 2002: 398 fall, 5 kontroller per fall, diagnosår 1996
användningstid 2-3 år NMT, < 1 år GSM
Gliom NMT OR= 2,1 (1,3-3,4)
GSM OR=1,0 (0,5-2,0)
OR för trend 1,2 per år (1,1 - 1,5)

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Some further aspects on cellular and cordless telephones and brain tumours

Hardell et al, 2003. Internat J Oncol 22: 399-408

Number of cases aged 20-80 years reported from regional oncology centers.

Total reported 2 561

- Metastasis or other localization than brain 133
- Other localization or diagnosis than brain based on neuroradiology records 99
- Other year than study period for diagnosis 58
- Histopathology missing 4
- Deceased 540
- Refused by treating physician to be included 35
- Unknown address 2, Not resident in study area 14
- Not capable to participate for medical reasons 59

Total included in study 1 617

Some further aspects on cellular and cordless telephones and brain tumours. **Hardell et al, 2003. Internat J Oncol 22: 399-408**

Number of cases aged 20-80 years reported from regional oncology centers. Total included in study 1 617.

1 year latency	
Analogue phones:	OR 1.3, 95% KI 1.04-1.6
Digital	OR 1.0, 95% KI 0.9-1,2
Cordless phones	OR 1.1, 95% KI 0.9-1.3
5 year latency	
Analogue phones:	OR 1.4, 95% KI 1.01-1.9
Digital	OR 1.1, 95% KI 0.8-1.6
Cordless phones	OR 1.4, 95% KI 1.1-1.8
10 year latency	
Analogue phones:	OR 1.6 95% KI 1.1-2.4
Digital	-
Cordless phones	OR 1.1, 95% KI 0.5-2.6

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Table 4. Laterality of exposure in relation to tumour localisation.

Ipsilateral=same side, contralateral= opposite side

Localisation/Type of telephone	All Ca/Co OR (95 % CI)	Ipsilateral Ca/Co OR (95 % CI)	Contra-lateral Ca/Co OR (95 %CI)	Ipsi-/contralateral Ca/Co OR (95 % CI)
Temporal area				
Analogue phone	84/45 2.1 1.3-3.3	41/20 2.2 1.2-4.0	30/21 1.6 0.8-2.9	12/4 3.2 0.99-10.3
Digital phone	113/104 1.1 0.8-1.6	50/37 1.4 0.8-2.3	50/48 1.1 0.7-1.7	13/19 0.7 0.3-1.4
Cordless phone	111/100 1.1 0.7-1.5	58/44 1.3 0.8-2.0	38/43 0.9 0.5-1.4	14/12 1.1 0.5-2.6

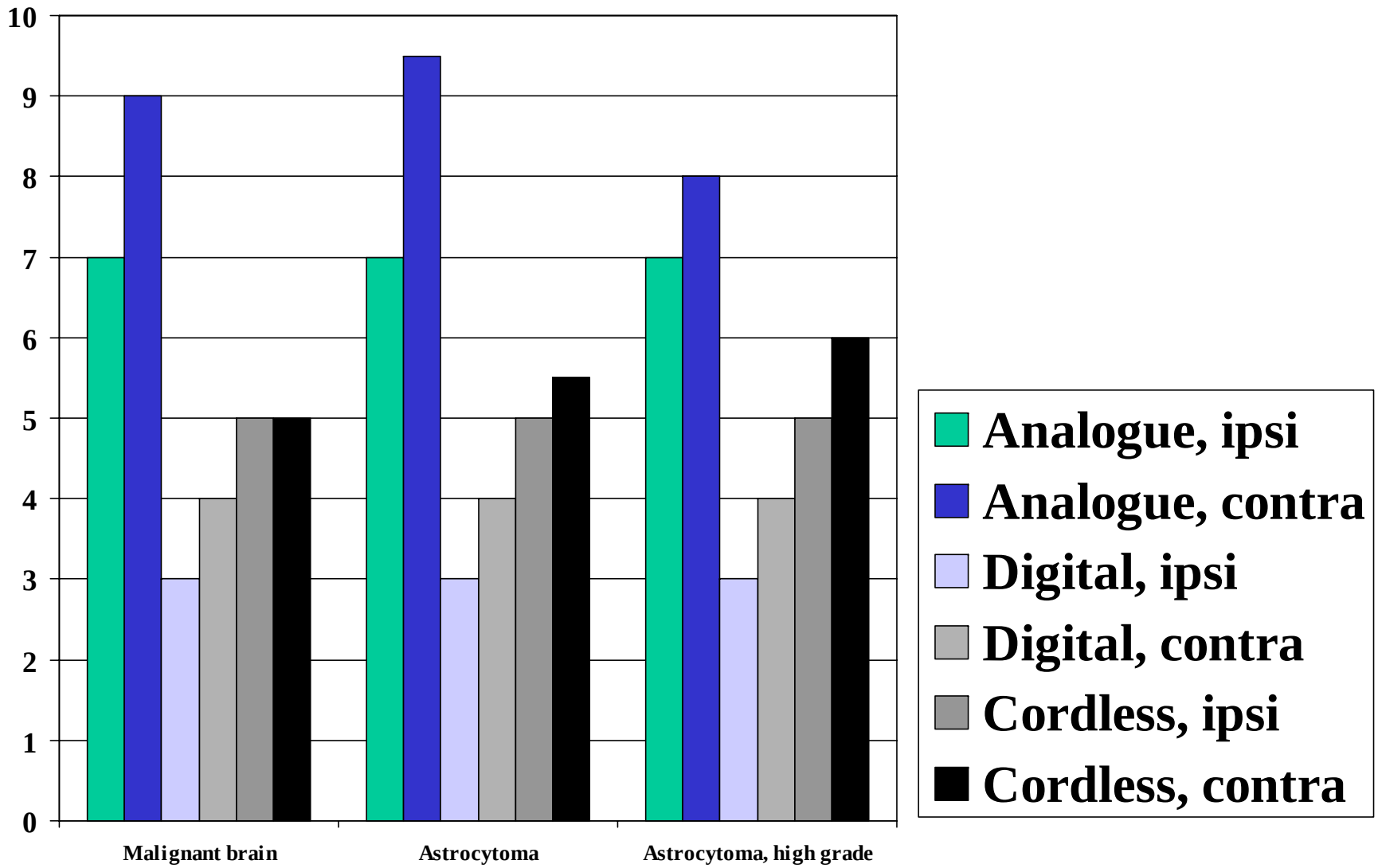
Table 6. Trend in OR per year when duration is used as a continous variable.

	All OR (95 % CI)	Temporal area, ipsilateral OR (95 % CI)
Analogue	1.04 1.01-1.08	1.19 1.06-1.32
Digital	1.01 0.97-1.05	1.09 0.96-1.24
Cordless	1.03 0.995-1.06	1.08 0.9999-1.17

Table 6. Trend in OR per year when duration is used as a continous variable.

	Acoustic neurinoma, all OR (95 % CI)	Acoustic neurinoma, ipsilateral OR (95 % CI)
Analogue	1.29 1.11-1.49	1.38 1.10-1.73
Digital	1.05 0.91-1.20	1.13 0.94-1.36
Cordless	1.10 0.9999-1.20	1.10 0.99-1.22

Median latency periods (years) for ipsilateral and contralateral use of cellular and cordless phones.



To read more:

Hansson Mild K, Hardell L, Kundi M, and Mattsson M-O. Mobile telephone and cancer: Is there really no evidence of an association? (Review). Internat J Mol Medicine, 12, pp 67-72, 2003

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The material was divided into different age groups with ten years span. Analys was done as unmatched to non-exposed controls.

Material first presented as overall OR for brain tumours, and then for ipsilateral use.

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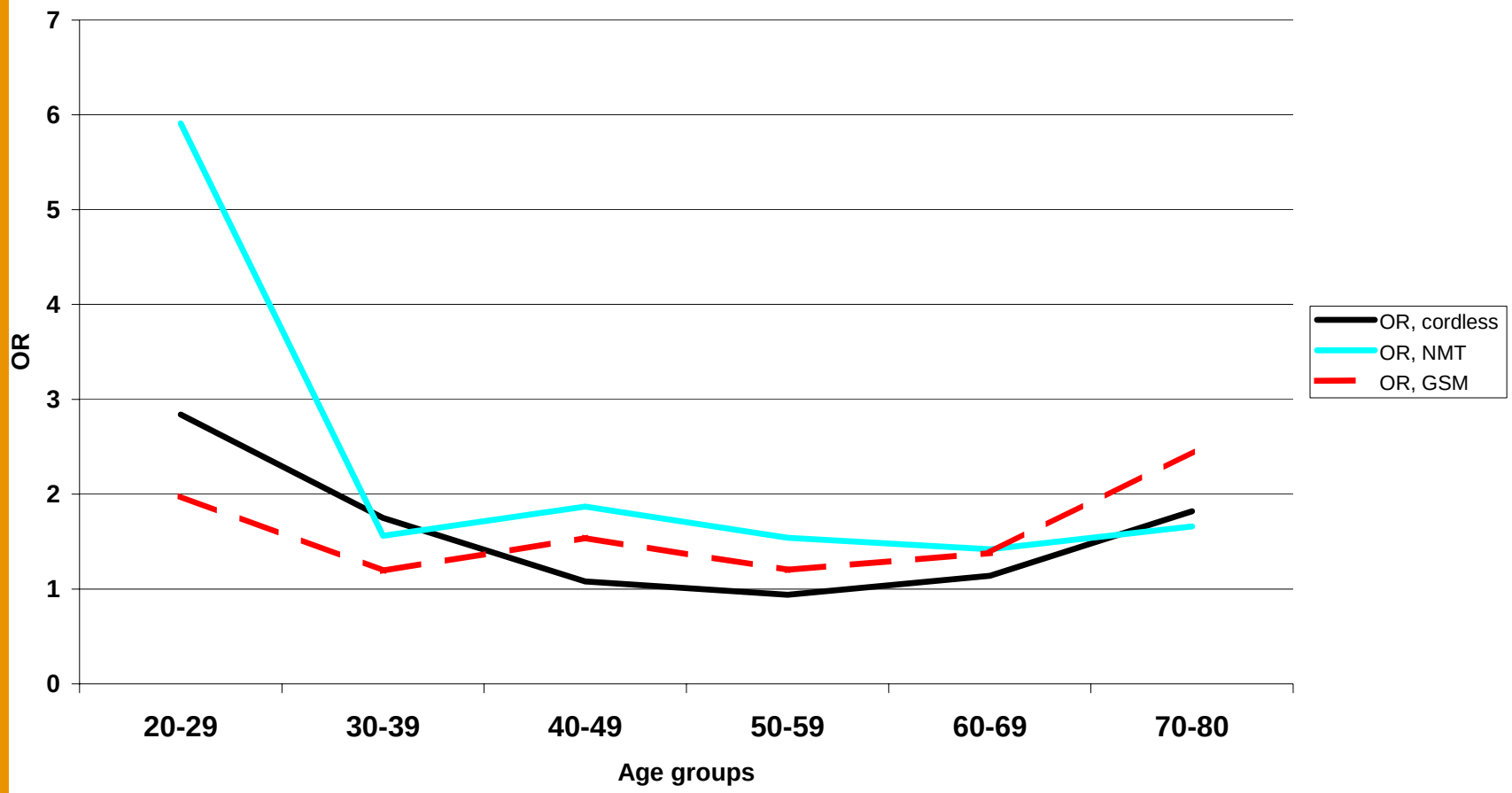
Different age groups, NMT, GSM, cordless phone, ipsilateral exp.



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Är det farligt att prata i mobiltelefonen?

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