

News from Science

The following article refers to recent scientific original studies on effects from mobile radiofrequency fields. The publications were selected by the author Prof. Roland Glaser reflecting his personal view of what would be relevant.

Roland Glaser


Several years ago, a working group at the University of Freiburg published a study according to which the use of mobile phones would lead to a rise in blood pressure (Braune et al., *Lancet* 351, 1857. 1998). In the following, the study was criticized on methodological grounds (Reid et al., *Lancet*. 352, 576. 1998). The authors then felt compelled to withdraw the results after trying in vain to reproduce them (*Radiat. Res.* 158, 352-356. 2002. See also: „News from Science“ in 11 (1). 2003). Because of these publications and the continuing public irritation, the University Hospital in Kuopio (Finland) – in cooperation with physicists and technicians from Helsinki and Turku – recently performed thorough tests in 32 volunteers of both sexes, in the age group between 23 and 55 years old. Besides conducting sham exposures, this investigation that was designed as a double-blinded study, considered the frequencies of 900 and 1800 MHz emitted by mobile phones manufactured by Nokia. These phones were fixed to helmets. Phantom measurements showed maximum SARs of 1.58 W/kg (900 MHz) resp. 0.70 W/kg (1800 MHz). In an extensive test protocol including different breathing rhythms, blood pressure and heart rate of the volunteers were measured. With high certainty, influences of the RF fields on these parameters were excluded (Tahvanainen, K., Nino J., Halonen P., Kuusela, T., Laitinen, T., Länsimies, E., Hartikainen J., Hietanen, M., Lindholm H.: Cellular phone use does not acutely affect blood pressure or heart rate of humans. *Bioelectromagnetics* 25, 73-83. 2004).




Lai, Horita and Guy reported in 1994 on behavioral experiments performed in rats where they found that an exposure to 2450 MHz (2 ms pulses, 500 pps, 1 mW/m², mean body SAR 0.6 W/kg) led to effects on learning capacity (*Bioelectromagnetics* 15, 95-104). A series of studies of other authors could not confirm this result; however, the respective applied frequencies and intensities deviated from those used by the group around Lai. A direct comparison thus was not possible. There is now a publication where the tests of Lai et al. were replicated as exactly as possible. Using the same fields and a maze of the same design, after exposure the rats learnt to search for food. In contrast to the experiments of Lai et al., no influence from the electromagnetic field could be observed. Was this perhaps due to the fact that this study – contrary to Lai's experiments - preferred a plastic maze over a wooden one? The influence of scent marks left behind by the animals thereby was excluded (Cobb, B. L., Jauchem, J.R., and Adair, E.R.: Radial arm maze performance of rats following repeated low level microwave radiation exposure. *Bioelectromagnetics* 25, 49-57. 2004).




Two experiments performed independently from one another on the issue of potential cancer promotion by 900 MHz GSM fields do not show any effect, but



shed new light on the typical problems related to such experiments. In Sprague-Dawley rats, mammary carcinomas were induced by adding the carcinogen DMBA to the food. The question – as in various similar studies – was: Do RF fields with intensities around or above the valid limit for humans affect growth or expression of these tumors? In both subsequently conducted tests, 64 animals each were divided into groups of 16; one group served as the control, whereas the other three were exposed to a field over 9 weeks, for two hours per day. Three weeks after exposure stopped, i.e. in the twelfth week of the experiment, the animals were sacrificed and histologically examined. It was determined prior to the tests that the group size, according to the t-test, should be sufficient to prove a potential effect with a 5% error probability, if there was a >35% deviation from the control. Generally, none of the tests showed such deviation, neither over the time course of tumorigenesis nor in their number or size. It is interesting and perhaps typical for such tests, though, that the two tests did develop differently. Whereas the first experiment indicated a slight increase in tumor incidence at 1.4 W/kg, less at 2.2 W/kg and no effect at all at 3.5 W/kg, the effect was not reproduced in the second experiment. To the contrary: ignoring statistics, one could even claim a protective effect of field exposure. According to the authors, these differences are due to the utter dependency of the examined process on many biological parameters that cannot be excluded, despite all attempts to standardize tests. This should be a warning to all those who give formal statistics too much weight (apart from the question whether the t-test is really appropriate for this!). (Anane, R., Dulou, P.E., Taxile, M., Geffard, M., Crespeau, F.L., and Veyret, B.: Effects of GSM 900 microwaves on DMBA-induced mammary gland tumors in female Sprague-Dawley rats. *Radiation Research* 160, 492-497. 2003)



Possible influences of radiofrequency fields on the immune system can be investigated both in vitro, in lymphocyte cultures, and in vivo, in animal tests. Experiments performed in isolated lymphocytes naturally eliminate various possible repair mechanisms that are inherent to the whole organism. That is why an Italian group of toxicologists investigated possible changes in the immune system of mice after 1, 2 and 4 weeks exposure (900 MHz GSM, 2 hours/day, whole body SAR: 1 resp. 2 W/kg). Neither the number of spleen cells nor the ratio of B- to T-lymphocytes changed during this treatment. Both at 1 and at 2 W/kg, after one-week exposure a small, albeit significant (t-test: $p > 0.01$) increase in cytokin production (Itng) could be determined, but not after 2 to 4 weeks exposure. This reaction is comparable to that occurring after a shock; its disappearance could indicate that the animals had grown accustomed to the effect. The cause of the shock is unclear, for also the control animals were subject to the spatial constraints of a sham exposure (could it be perhaps that heat receptors of the animals had been activated at field exposure?). The toxicologists saw this effect not as health-damaging, however, and reached the conclusion that the exposure overall had no clinical relevance (Gatta, L., Pinto, R., Ubaldi, V., Pace, L., Galloni, P., Lovisolo, G.A., Marino, C., and Pioli, C.: Effects of in vivo exposure to GSM-modulated 900 MHz radiation on mouse peripheral lymphocytes. *Radiation Research* 160, 600-605. 2003).



Recently, millimeter waves and their potential biological effects have increasingly been examined from a medical perspective and on radiological protection grounds. A Chinese working group dealt with the question of the extent of effects at an exposure to 30.16 GHz (1 and 3.5 mW/cm²) on cell-cell communication

by so-called gap junctions. We know that the uninhibited multiplication of cancer cells, among other things, is based on the disturbance of this communication between adjacent cells. It is assumed that cancer-initiating substances, such as TPA (tetradecano-ylphorbol-acetate) become effective when this intercellular contact is blocked. The experiments done in cultures of skin cells (keratinocytes) showed no field influence on the distribution of fluorescent dye across the culture, but seem to be able to alleviate the inhibition of the cell-cell communication caused by TPA to a certain extent. Thus, the authors see the possibility to apply millimeter waves in cancer therapy (Chen, Q., Zeng, Q.L., Lu, D.Q., and Chiang, H.: Millimeter wave exposure reverses TPA suppression of gap junction intercellular communication in HaCaT human keratinocytes. *Bioelectromagnetics* 25, 1-4. 2004).



In 2000, news came from the University of Turku (Finland) that radiofrequency fields of a mobile phone would significantly change the EEG signals in the alpha frequency range during task performance in a psychological test with volunteers (Krause et al.: *Neuroreport* 11, 761; *Intern. J. Rad. Biol.* 76, 1659). The authors tried to reproduce these results in a recent study conducting double-blinded experiments in contrast to the previous investigation. The volunteers (24 persons of both sexes, average age: 24.3 +/- 8.1 years) were exposed to a mobile phone with 902 MHz fixed to their head (Nokia 6110, 217 Hz pulsed, 0.25 W, SAR 0.878 W/kg averaged over 1 g). Within 1.5 seconds, the test volunteers heard 4 Finnish verbs. After a break of 1 s, another verb followed. They had to decide whether the last verb was included in the list of the four verbs they had heard before. During the approx. 1-hour test period, the volunteers had to endure 192 such tests; the field was on half of the time in each test. A general increase in wrong answers could be detected at field exposure (19.1 +/- 4.2 versus 6.3 +/- 3.1, $p < 0.001$), in contrast to


previous tests where an increase in vigilance was measured during field exposure. EEG effects could not be reproduced, either. A slight change was found only in the theta band. The authors conclude that the influence of radiofrequency fields on the EEG and psychological tests varies and, due to unknown reasons, is not easy to reproduce (Krause, C.M., Haara-la, C., Sillanmaki, L., Koivisto, M., Alanko, K., Revonsuo, A., Laine, M., and Hamalainen, H.: Effects of electromagnetic field emitted by cellular phones on the EEG during an auditory memory task. A double blind replication study. *Bioelectromagnetics* 25, 33-40. 2004).




Does exposure to GSM modulated 900 MHz resp. 1800 MHz fields affect the hormone production in the hypophysis? Does melatonin production in the pineal glands alter? This much discussed question was revisited by a group of Hungarian colleagues performing, several times over, experiments in rats. The animals were exposed over two weeks, for 2 hours a day each. Intensities used were the limits valid in Hungary (0.1 mW/cm² for 900 MHz and 0.02 mW/cm² for 1800 MHz). Except for a distinct increase in melatonin concentration in the urine after the first day of tests, as well in exposed as in sham-exposed animals, and probably due to stress, no differences could be found (Bakos, J., Kubinyi, G., Sinay, H., and Thuroczy, G.: GSM modulated radiofrequency radiation does not affect 6-sulfatoxymelatonin excretion of rats. *Bioelectromagnetics* 24, 531-534. 2003).



Gingko leaf extracts offering protection against damages due to mobile phones? A Turkish working group seems to think so from their experiments performed in groups of 9-11 rats that were exposed to mobile phones (900 MHz, estimated SAR at the head 2 W/gk, one hour/day, seven days). Different substances inherent in Gingko leaves allegedly bind reactive oxy-




gen radicals (ROS) developed by the fields (Ilhan, A., Gurel, A., Armutcu, F., Kamisli, S., Iraz, M., Akyol, O., and Ozen, S.: *Gingko biloba* prevents mobile phone-induced oxidative stress in rat brain. *Clinica Chimica Acta* 340, 153-162. 2004).



A group of immunologists, geneticists, cell physiologists and molecular biologists from Institutes in Bologna, Pisa and Rome has published a first report on still ongoing experiments sponsored by several projects. They deal with the effects of weak continuous 900 MHz fields on growth, proliferation and apoptosis of cultivated leukemia cells (CCRF-CEM). These were exposed inside a TEM cell to a field of 24 mW/m² leading to a SAR of <1 mW/kg across the cultures. Temperature measurements as well as control experiments involving comparisons between the outside and the inside of the non-operated TEM cell ensured that the results were not falsified by heat and other undesired effects. After 24 hours cultivation in the field there was a significant decrease in proliferation resp. viability (an unclear parameter, unfortunately resulting from the contradiction between the coordinate labelling „cell viability“ and the legend „proliferation index“ in fig. 3). More exact analyses show that the onset of the increase in apoptotic activity already occurs after 2 hours of exposure leading to DNA degradation. The subsequent occurrence of DNA fragments in turn seems to be the signal for growth inhibition and the activation of pro-apoptosis genes. The study therefore offers interesting insights into the course of cell regulatory processes at exposure to relatively weak RF fields. One may be curious what other results this project will bring, and especially about the attempts to independently reproduce results that will certainly follow (Marinelli, F., LaSala, D., Ciccioiti, G., Cattini, L., Trimarchi, C., Putti, S., Zamparelli, A., Giuliani, L., Tomassetti, G., and Cinti, C.: Exposure to 900 Mhz electromagnetic field induces an unbalance between pro-apoptotic and pro-sur-

vival signals in T-lymphoblastoid leukemia CCRF-CEM cells. *J. Cell. Physiol.* 198, 324-332. 2004; correction for one page in the same issue, p. 479).



Preliminary results of an Australian study on EEG measurements during mobile phoning are available now. A pilot study with 12 volunteers examined the extent of changes in acoustically evoked potentials in the EEG that are measurable after 30 to 60 minutes exposure to the field of a Nokia 6110 phone fixed to the right side of the head (estimated SAR in the head 0.87 W/kg). At the same time, the response time to acoustic signals was measured. The test persons were provided with the numbers 0 to 9, stochastically cubed and in quick succession. At „six“, they had to push a button. The potentials evoked by the stimulus, derived at different sites of the head, were evaluated regarding amplitude and time after the stimulus was exerted. An acceleration of stimulus reception (corresponding with the 100 ms signal) was shown, but also an obviously slowed processing of the stimulus (300 ms-signal). However, these changes only occurred at the derivations at the side of the skull where the mobile phone was fixed, and more weakly still at the derivations at the middle of the head. According to the authors, these reactions are not dangerous to the normal mobile phone user, since exposure duration and intensity were above average in the study. They thoroughly discuss why their data obviously contradict those of other authors (Hladký, Freude, Jech, Koivisto). On the one side, they think that the exposure period in most experiments done by their colleagues was too small, possibly also the intensity; moreover, biological variability could be the cause of the differences. In this context, they point out that their study continues (Hamblin, D.L., Wood, A.W., Croft, J.R.m and Stough, C.: Examining the effects of electromagnetic fields emitted by GSM mobile phones on human event-related potentials and performance during an auditory task. *Clinical Neurophysiology* 115, 171-178. 2004).



International NIR workshop & symposium in Sevilla

More than 200 internationally acknowledged experts of all disciplines dealing with non-ionizing radiation met on May 20 to 22, 2004, for the workshop performed by the ICNIRP and WHO in cooperation with the URSI (Union Radio Scientifique Internationale) and the ICOH (International Commission on Occupational Health). Topic foci were, among others, dosimetry, interaction mechanisms, biological and health effects, standards and protective measures from all areas of non-ionizing radiation, from the static field to ultraviolet radiation. Highlights were the discussions of the ICNIRP philosophy regarding on NIR protection, the programs of the WHO, the precautionary principle, as well as medical aspects of non-ionizing radiation. The abstract book on CD-ROM can be requested at info@icnirp.org.

“miniWatt“ presents concept for minimizing exposure

The project “miniWatt“ commissioned by the Federal Ministry for Education and Research (Bundesministerium für Bildung und Forschung – BMBF) provides advice on how to keep electromagnetic exposure at the present level, even despite future growth of mobile communications. Accordingly, alternative radio systems with minimum radiation power density for broadcasting that is becoming increasingly mobile, for mobile radio and other wireless networks were examined. Due to the participation of eight universities, three industries, four medium-sized companies,

as well as one of the Fraunhofer Institutes, the topic “radiation reduction“ for the first time was intensely examined by a nationwide group of experts.

The German Center for Air and Space Technology (Deutsches Zentrum für Luft- und Raumfahrt e.V. – DLR) as the project holder has issued a brochure accompanying the project that can be ordered (free of charge) or downloaded on the internet (http://www.pt-dlr.de/PT-DLR/kt/miniwatt_broschuere.pdf).

IEE publishes positional paper 2004 on weak electromagnetic fields

In its recent positional paper, May 2004, the IEEE, Europe’s largest association of engineers, concludes that there is no proof of health damaging effects from weak electromagnetic fields in the frequency range up to 300 GHz after more than 800 studies from the years 2002 to 2003 were evaluated. The knowledge accumulated over the past 20 years indicates that the existence of adverse health effects is not probable. Despite the small risk, the IEE proposes further research in order to resolve present or future open issues.

<http://www.iee.org/Policy/Areas/BioEffects/POSTATO2final.pdf>

Television program „Ratgeber Technik“ informs about protection against electro smog

In the ARD (German public television network) program broadcast on April 18, 2004, and prepared by the NDR channel (North German Broadcasting), a school class (physics course) tested different protective devices that allegedly help to distinctly reduce mobile phone radiation. They were supported by Dr. Cornelia Baldermann of the Federal Office for Radiation Protection (Bundesamt für Strahlenschutz) and by Professor Jürgen Detlefsen from the Chair of Radiofrequency Technology, TU Munich. Using a phantom head for measurement, the students tested the promised protective effects of various chips, felts, ferrite nuclei, etc. Overall, the results were very discouraging: A reduction of the measured SARs was (almost) never found, in one case the measured val-

ue even increased. Detlefsen concludes: "If there was any device that would at least have a minimum effect, argumentation used would perhaps be more respectable – that radiation can be reduced instead of fully neutralized. But they always say negative components will be transformed into positive ones, and such assertions do not only appear to be highly irresponsible, they are."

http://www.ndrtv.de/ratgebertechnik/themen/20040418_elektrosmog.htm

NRPB supports the introduction of international guidelines

In its press bulletin released in March 2004, the British National Radiological Protection Board (NRPB) supports the introduction of the ICNIRP guidelines on the limitation of electromagnetic fields between 0 and 300 GHz in Great Britain, and thus of lower than today valid exposure limits. This decision was made based on the evaluation of the independent Advisory Group on Non-Ionising Radiation (AG-NIR). In its last statement of January 2004, the group emphasizes that there are no health impairments to be expected either from mobile phones or from mobile radio stations. With this recommendation, the NRPB intends to harmonize British limits with international recommendations and to account for the precautionary principle.

In practice, the introduction of the ICNIRP guidelines has no consequences, since a corresponding recommendation has already been issued in 2002 and was voluntarily complied with.

http://nrpb.org/press/press_releases/2004/press_release_5_04.htm

Mobile radio operators publish report on voluntary commitment

In March 2004, the mobile radio operators have published their second report. The experts of the consulting firm B.A.U.M. Consult and the German Institute of Urban Development (Deutsches Institut für Urbanistik) reach positive results in their report. The expertise examined all aspects of voluntary commitment – communication and participation, consumer

protection, research promotion and EMF monitoring. The experts stated that the network operators were again true to their commitment in 2003, too. Regarding the issue of mobile radio base station sites, the experts see a high degree of cooperation and consent-seeking on the part of mobile radio operators and municipalities.

The 2003 report is available at <http://www.izmf.de>; the press release of the Federal Ministry for Economy and Labor (Bundeswirtschaftsministerium) is found at <http://www.bmwi.de>.

IZMF launches school project „Mobile Radio“

How can mobile radio-relevant topics be prepared for school in order to provide students with important skills in handling media and other influences in their surrounding? This question is answered by the learning material prepared by the Information Center Mobile Radio (Informationszentrum Mobilfunk – IZMF) specifically for the classes 5 to 8. The foci are „Digital text“, „Humans and Mobile Radio“, as well as „Humans, Media, Environment“. 40 pages each provide expert information, stimulations for the work done



in the classroom, didactic advice, as well as task- and worksheets.

The material can be ordered free at the IZMF and can be downloaded at www.schulprojekt-mobilfunk.de on the internet (in German only).

Roundtable provides more transparency

What are the effects of mobile radio on humans and the environment? Since 2002, this question is examined under the direction of the Federal Office for Radiation Protection (Bundesamt für Strahlenschutz – BfS) and within the German Mobile Radio Research Program (Deutsches Mobilfunk-Forschungsprogramm – DMF). Now, the BfS has instigated an additional independent body with the “Roundtable on the German Mobile Radio Research Program” (RTDMF) which shall advise and support the DMF. The RTDMF shall provide the possibility to different social groups and institutions to obtain information on the state of the program and stimulate research themselves. “By this, we want to make ongoing research on the effects of mobile radio more transparent and comprehensible for the citizens“, the President of the BfS, Wolfram König, says.

From 2002 to 2006, the DMF itself will commission research projects for the investigation of different aspects of mobile radio, supervised by the Federal Office for Radio Protection. Among other things, the program supports the International EMF Project (investigation of electromagnetic fields) of the World-Health Organization (WHO); it is financed in part by the Federal Government, in part by network operators.

Research foci of the DMF are interaction mechanisms of radiofrequency fields, effects on humans and animals, exposure dosimetry, as well as risk communication.

www.bfs.de

www.deutsches-mobilfunk-forschungsprogramm.de

Events

Current events are found on the internet at: <http://www.fgf.de/english/aktuell/events/index.html>

Imprint

Newsletter of the FGF e.V.

Editor:

Forschungsgemeinschaft Funk e.V.

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Concept and Editorial Staff:

Gerd Friedrich (respon.),

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Design:

Kurt Günther, Dortmund

Layout, Graphics:

setz it. Richert GmbH,

Sankt Augustin

Photographs:

S. 2 – Gollnick, S. 34, 35, 36,

37, 39 – Liesenkötter, S. 31 –

Müller, all others – archiv

Publication Dates:

4 times a year

Number of copies:

4,500

Reprinting and requests

for copies

ISSN 0949-8745