

# **Scientific Workshop**

**Do Children Represent a Special Sensitive Group for EMF-Exposure?**

## **State of Research**

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**FGF (The Research Association for Radio Applications)  
in Cooperation with  
the State Ministry of Environment, Baden-Württemberg,  
and European Coordination Action EMF-Net**

Summary

[excerpted from notes and presentations]

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### Executive summary

- **COST281/FGF** considered child sensitivity to RF in June 2004 in Istanbul, in Trondheim, Norway Oct 2005, in Graz April, 2006 and finally in Stuttgart Nov 2006 covering the State of RF Research on children and young animals. This summary covers, the medical, ethical, in vivo/vitro biological, human acute and epidemiology presentations.
- Pediatrician **Karl Ernst von Mühlendahl** gave a medical overview of children's special environmental risks as compared to adults. This included both greater resistance to, or, greater sensitivity to a toxin depending on the specific environmental toxin considered, the age of the child, and the condition of the child.
- Normal children dissipate increased heat more effectively than adults [Inbar et al., 2004] and thus normal children may be less sensitive to increased temperature produced by RF exposure than adults [less than 1 degree C within guideline limits].
- Dr **Ken Foster** gave a review of ethical considerations of child protection specifically in the USA and Europe. There is a lack of an identified RF hazard but there are ambiguous risk communications across the agencies on child exposure. The ethical issues of beneficence/ nonmaleficence and the child's right to autonomy are to be considered in the response of governments to the issue of child protection.
- Professor **M Bornhausen** presented his powerful operant-behavior design, well-established in toxicology to combine the data and to enhance the test sensitivity on CNS functions of animals to evaluate long term effects on cognition of rats from conception to death over 3 generations exposed to both GSM & UMTS signals. We await the results to be presented at BEMS June 2007 meeting in Japan.
- Dr **T Kumlin** presented preliminary results on behaviour in the development of nervous system of young rats by measuring motoric activity, fearfulness, startle response, stress, learning, & memory after GSM exposure. The only positive results were a significant slight improvement in escape latency and the time looking for the missing platform in the Morris-water-maze after GSM exposure in juvenile rats [5-10 wks].
- Professor **I Lagroye**, principle investigator, presented the 'Effect of [wifi] RF fields on the young animal' [ERYA] design 2007-2009. Previous preliminary results have shown differential HSP25 expression in the rat brain at 12 weeks after a 4-wk exposure to UMTS at 1966 MHz, 2.6 W/kg [head exposure in rockets].
- Professor **Andrew Wood** reviewed the place of human volunteer studies in health impact assessment from 1998 to present, & ongoing prospective studies involving youth < 18 years in Australia. There are no age-related findings but new research is in progress.
- Dr **Martin Röösl**i presented the Cefalo case-control study underway in Switzerland, Denmark, Sweden and Norway to investigate the risk for brain tumours in children [age range: 7-19 years] who use mobile phones over the study period 2004-2008. Also Dr **E Cardis** & collaborators in a large multi-country epidemiological study of the effect of mobile phone exposures in childhood & adolescence [INTERPHONE-Kids (7-25yr)] have a proposed application for funding submitted to the EU FP7.

## **Introduction**

COST281/FGF have considered child exposure to RF over the past 5 years in many different aspects, in June 2004 in Istanbul at the joint WHO/COST281 workshop on children's possible sensitivity to EMFs, in Trondheim, Norway Oct 2005, in regard to abdominal RF-exposure on human reproduction and the fetus, in Graz April, 20th-21st, 2006 in relation to emerging technologies and potential sensitive groups, and finally in Stuttgart covering the state of RF research on children.

Dr. Gerd Friedrich welcomed us on behalf of the hosts and chaired the first session with Pediatrician Karl Ernst von Mühlendahl explaining the nature of children's special environmental risks as compared to adults this included both greater resistance to and greater sensitivities to particular toxins. Following this medical overview Dr Ken Foster gave a review of ethical considerations of child protection specifically in the USA and Europe as well as generally, worldwide.

### **Karl Ernst von Mühlendahl - Kinderhospital Osnabrück, Why are children more susceptible to environmental influences? – What is environment?**

Karl explained why children are more susceptible to some environmental influences but this is considered as dependent on specific issues and cannot be considered as a general rule. Some children are born with special genetic deficiencies such as immune deficiency, phenylketonuria, or osteogenesis imperfecta. In these cases special precautions must be taken to avoid the related environmental condition that triggers the particular disease situation they are susceptible to.

Generally normal children could be considered to have special susceptibility [more or less than adults] to environmental factors because of differences in specific physiologic and metabolic processes. For instance young children are more susceptible to lead, alcohol, mercury, as it lowers IQ and damages their nervous system. Differences in exposure settings of children, such as playing habits lead to differences in the spectrum of diseases (allergies, atopic dermatitis) in children. And the accumulation of some toxins [UV, DDT, PCBs, and ionizing radiation] in the body can result in over exposure during the long lifetime from childhood. Of note in this generation of children in countries with one child families, children often suffer from loneliness.

Children have developing organs, systems, and functions over the embryonic and fetal growth and this development continues to a lesser extent in infants and children. As a result, they require higher levels of energy, water and protein in their diets than adults; and children's requirements decrease variably across development to adulthood. Because of their higher metabolic rate infants are less susceptible to some drugs than adults and as a consequence are given much higher doses of antibiotics such as amoxicillin, and the heart stimulant digoxin. And the dosages of therapeutic drugs vary as the metabolic rate changes at different ages of childhood.

Neurodevelopment and Interferences:

During the three months of embryonic development and the following six months of fetal development, the human brain develops from a tiny accumulation of ectodermal cells into a very complex organ with billions of cells that are topographically exactly situated, highly specialised and interconnected into a sophisticated communicative, collaborative

neuronal network. This development is genetically determined. Each step must be accomplished on schedule and in correct sequence, which implies that there are windows of unique susceptibility to toxic interference. Many of such developmental steps and processes, if not performed with the correct timing, cannot be repaired at a later time; thus the result of disruption of growth is often permanent damage. For instance hypothyroidism slows growth, and must be corrected as soon as possible to avoid permanently stunting a child's intellectual and physical growth.

### **Discussion**

Dr. Karl Ernst von Mühlendahl did not consider possible responses to either ELF or RF EMFs. Since the question of whether children represent a special sensitive group for EMF-exposure was the main topic of the conference many comments and questions were addressed to Karl on this issue during the discussion after his presentation. Sheila Johnston mentioned that the only known mechanism of interaction of RF with the human body produces heat and it is known that children dissipate heat more effectively than adults [Inbar et al., 2004] and thus it is evident that children are less sensitive to the heat produced by RF exposure than adults. The older male with his decreasing heart strength and consequently slower blood circulation is considered the more susceptible to build up of heat and increase in body temperature as compared to adults and children and thus is more susceptible to over exposure to RFs.

Karl said, since epidemiology is expensive but a necessary method to show any effects of RF in children such as loss of IQ, only if it becomes a severe issue would such a study be feasible. Presently Karl advises pediatricians that exposure to base stations and mobile phones would have little effect on children since they raise the temperature only about 0.1 °C. Ken Foster asked what would be a toxic thermal effect and was told that raising the temperature up from 37 to 40 °C would not result in any harm to a child. Jafar Keshvari stated that dosimetric limits protect children and adults against skin burns and eye damage. The eye is the organ most susceptible to heat [Keshvari and Lang, 2005]. Joe Elder mentioned effects of whole body and tissue temperature increase over 2 °C was decided empirically, in a number of variations in dosage.

**Kenneth R. Foster** –presented ‘**Should Children Use Mobile Phones?**’ Department of Bioengineering, University of Pennsylvania. This was a summary of a recent published paper [Chau and Foster 2005]. Ken covered 4 topics: the recommendations by health agencies/expert groups about use of mobile phones by children, the rationale for recommendations, ethical issues, and non-health issues.

Several agencies have given no special recommendation in relation to child exposure namely the Australian radiation protection agency ARPANSA, the US Federal Drug Agency [FDA], the Health Council of the Netherlands and the WHO EMF Project. But at the same time some agencies have given recommendations for precaution on child exposure including the Health Protection Agency [HPA] of the UK, the Russian Ministry of Public Health, [RNCNIRP] and the French Health General Directorate [Zmirou report]. The rationale suggested that there was a higher absorption of RF energy by children than adults that they may have a higher sensitivity of children to effects of RF energy and that they will have a longer potential exposure time in children.

Dosimetrically, in comparison with the multiple sources of uncertainty, the observed differences between maximum SAR over 10 g are not significant in children as compared to adults [Wiart et al., 2004].

There is a lack of an identified hazard: “The balance of evidence to date suggests that exposures to RF radiation below NRPB and ICNIRP guidelines do not cause adverse health effects to the general population.” There are ambiguous risk communications across the agencies on child exposure. There are the ethical issues of beneficence/nonmaleficence and the child’s right to autonomy to be considered in the response of governments to the issue of child protection.

We are advised by child experts that ‘the general public is easily scared and when scared, they form pressure groups to push governmental agencies into action. These agencies are scientifically naive and have to rely on our advice. We should be very careful not to give advice based on oversimplified tests and facile interpretations [Auerbach 1971 quoted by Brent June 2004, at the Child sensitivity conference, in Istanbul]

Presently there was a European Commission public consultation on mobile phone risks to children. Contributions were received from 25 July to 16 October 2006. An overview of the results was published in December 2006

[[http://ec.europa.eu/information\\_society/activities/sip/docs/public\\_consultation/public\\_consultation\\_results\\_en.pdf](http://ec.europa.eu/information_society/activities/sip/docs/public_consultation/public_consultation_results_en.pdf)]. Some issues include access to harmful or illegal content (i.e. violent or sexually explicit images), bullying grooming (e.g. strangers "making friends" with children with a view to meeting them), risks to the privacy of children and the risk of unexpectedly high expense.

### **In Vivo and Volunteer Studies** Young Animal Research

**Michael Bornhausen** presented ‘**Analysis of serial properties of operant-behavior tests in rats after exposure to cell-phone EMFs**’. LM-University of Munich, Germany. This research project is just recently completed and the data are not yet analyzed. Michael presented the features of the design of his study. They carried out baseline testing of the first generation of animals, to eliminate outliers who were too dumb to learn or were too bright at the operant tasks, to increase the statistical power.

Their general aim is to assess the dynamics of changes of CNS functions resulting from RF exposure. Their specific aim is to detect cognitive effects eventually induced by chronic exposure to GSM or UMTS RF fields in three consecutive generations of rats. Part of this work was supported by the German Federal Office of Radiation Protection (Bundesamt für Strahlenschutz, BfS) and done in cooperation with Dr. H. Scheingraber, of the Max-Planck-Institute of Extra-terrestrial Physics (MPE), Garching, Germany. The rationale for experimental studies of cognition after chronic exposure to environmental hazards (e.g. GSM- or UMTS-electromagnetic fields [EMFs]) in three generations of animals is that: changes of function are precursors of structural changes; functions of the central nervous system (CNS) are more sensitive than functions of other organs and CNS functions are most sensitive during prenatal development.

They used automated operant-behavior tests run in a battery of 10 standardized test chambers (“Skinner boxes“). Subjects are required to press a lever for food reinforcement (pellets of 45 mg). The 15h-nocturnal test sessions (16:00-07:00 CET) are subdivided by

alternating 30 min on- and 60 min off-cycles. Differential Reinforcement of Zero Rate (**DR0**), Differential Reinforcement of High Rate (**DRH**) and Differential Reinforcement of Low Rate (**DRL**) tests were used. The final tests require the subjects to respect a blocking interval of 16 sec after a reinforcement.

Operant-behavior contingencies are useful in the assessment of potential health risks, in toxicology, and environmental protection [Ferster and Skinner 1957; Jensch 1983; Weiss et al., 1989; Bornhausen & Scheingraber 2000]. The analysis of the microstructures of operant-behavior test performance is a powerful tool to demonstrate changes of CNS functions. And the dynamics of test acquisition (i.e. "learning") can be combined and measured by S-curve fits and used to enhance test sensitivity of CNS functions in situations of potential health hazards [Levenberg-Marquardt algorithm].

This is a well-designed, powerful study using a traditional and well-established protocol in toxicology and environmental protection. Historically these operant-behavior designs have been used in published studies for health risk assessment by expert guideline and standards committees and by IARC expert committees for cancer classification. It has the potential to combine the data and to enhance the test sensitivity on CNS functions of animals to give an evaluation of long term effects on cognition of rats from conception to death over 3 generations exposed to both GSM and UMTS signals.

#### **Discussion**

We look forward to the analyses of the results and the publication of the paper.

#### **Timo Kumlin U Kuopio, Finland, *Mobile Phone Radiation and Developing Brain: Behavioural and Morphological Effects in Juvenile Rats***

There is little relevant data about effects on the developing rat nervous system of juvenile rats over 5-10 weeks old. The aim of the study was to test whether mobile phone radiation affects behaviour in the development of nervous system of young rats by measuring motoric activity, fearfulness, startle response, stress, learning, and memory.

And to examine whether neuronal damage occurred (Salford et al., 2003) using histopathological analyses of the brain tissue after a long-term exposure (5 weeks).

Juvenile male Wistar rats weaned at the age of 21 days (24 rats/group) and individually exposed to RF were tested after 3 days of familiarization to the experimental environment. Individual exposure was 2 h/day, 5 days/wk, over 5 weeks. At other times there were two rats per cage in normal steel cages. There was a high [1.5 W/kg], a low [0.15 W/kg] GSM signal and a sham exposure. Exposures started in three phases.

Eighteen rats out of each exposure group were randomly chosen for behavioural tests right after the last exposures: They used an open field test for locomotor and exploratory activity, the plus maze test for anxiety, the prepulse inhibition of the startle reflex to test general reactivity and attention and the Morris water maze to test for spatial learning and memory.

The results of the 4 behavioural tests right after exposures of 5 weeks showed no differences on 3 behaviour tests: the open field test, the plus maze test and the prepulse inhibition of the startle reflex. On the Morris water maze there were some differences. On both doses, there was a significant slight improvement in escape latency. And on the high dose, there was a significant; slight improvement on the time looking for the missing platform.

**In the brain histology they found no differences among exposed and non exposed results.** These included cresyl violet for general morphology of the brain, fluoro jade for detection of possible dying cells, doublecortin and PCNA for detecting newly generating cells, pCREB as a marker of transcription regulation, and leakage of IgG into brain parenchyma and spread of Evans Blue as markers for BBB breaks. They speculated that there may be a delay in the normal development of brain due to RF radiation that appeared to improve spatial learning and memory of the juvenile rats.

### **Discussion**

At the end of the presentation **commentors suggested** that there have been studies on development and learning in juvenile rats with the weight of evidence suggesting no effects of RF within guideline limits [Joe Elder, SAJ: See C95.1-2005; Dubreuil 2002; Heynick and Merritt 2003; Jensh et al., 1979; Jensh et al., 1983].

Of note are the advanced brain histology techniques such as doublecortin and PCNA for detecting newly generating cells, and pCREB as a marker of transcription regulation. If increased learning occurred could we expect histological support such as detectable increase in pCREB transcription or increase in doublecortin and PCNA to indicate newly generating synapses or cells in the hippocampus? If so then the lack of effects would be an indication for a lack of support for the spatial memory effect reported in the water maze [SAJ]. There is no indication that the animals were tested to eliminate the outliers such as the very bright or the non-learners. This is a procedure that was followed by Bornhausen, above. Also it would be useful to be able to combine the data to get an overall score such as Bornhausen has done above [Levenberg-Marquardt algorithm]. Both of these techniques increase the sensitivity and statistical power of the tests. If Bornhausen in his future publication reports no effects then that would be further weight of evidence to suggest no effects on the developing nervous system, over 3 generations, however if he found effects that might support these preliminary results on the water maze. No mention is given of any statistical controls for multiple comparisons or tests of normalcy of their data [see Dubreuil 2002: Check the normality of the distribution of each analysed variable with the Kolmogoroff-Smirnoff test]. Normality or non-normality has an impact of the statistical method used for data analysis. It is presently unknown if a slight difference in score on the water maze would have any biological significance.

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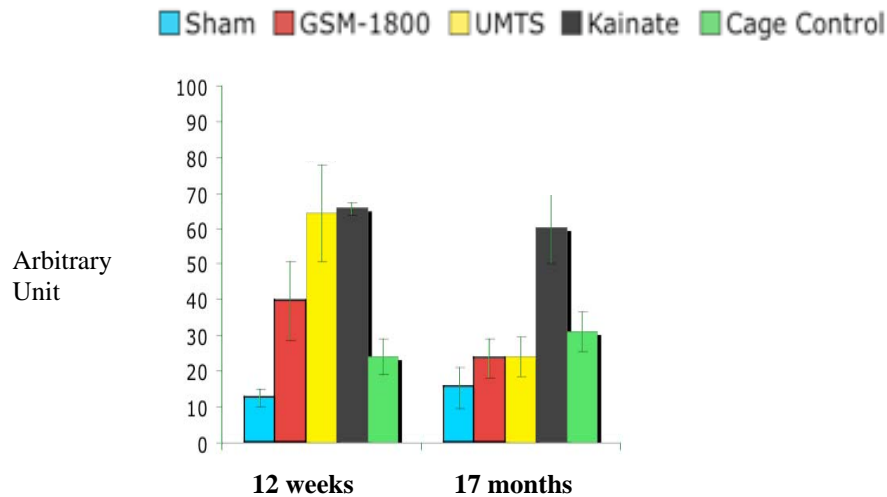
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Jensh RP, Vogel WH, Brent RL. An evaluation of teratogenic potential of protracted exposure of pregnant rats to 2450 MHz microwave radiation: II. Postnatal psychophysiological analysis. *J. Toxicol. Environ. Hlth.*, 11:37-59, 1983.

**Isabelle Lagroye** CNRS, CPB, EPHE. Centre National de Recherche Scientifique presented the ‘**Effect of radiofrequency fields on the young animal: the ERYA programme**’. Research on the effect of RF on young animals is a priority in the WHO research agenda: “Studies investigating the effects from exposure of immature animals to RF fields on the development and maturation of the CNS, and on the development of immune systems using functional, morphological and molecular endpoints are needed. Experimental protocols should include prenatal and/or early postnatal exposure to RF”.

Their preliminary results have shown differential HSP25 expression in the rat brain at 12 weeks but not at 17 months in the hippocampus after a 4-week exposure, to UMTS at 1966 MHz, brain average SAR of 2.6 W/kg [head exposure in rockets], 2 hours a day for 5 days a week [Laclau et al., 2006, BEMS meeting].

Hippocampus : HSP25 Expression



Kainate –induced microglial colonization of the hippocampus is significantly decreased on the old animals [17 months] compared to the young ones [juvenile, 12 weeks -3 months, ~350g]. This is in line with a diminished immune response in older animals compared to young animals and may contribute to the lack of response to GSM 1800 and UMTS in the older animals [Laclau et al., 2006]. There is a large amount of error variance [indicated by error bars in the bar graph above] in the GSM1800 and UMTS results of the 12-week old rats. The sample is n = 8. Replication in another laboratory and a larger sample of animals and tests in two species and tests over a broader number of ages and tests over other signals and power levels including Wifi may help to resolve the questions raised here. Do different RF signals have different effects at different ages on the immune system? Is there any biological significance to the differences if they are found? The study design below will address these questions to some extent.

The ERYA is a toxicology program of 5 research projects over 3 years beginning in January 2007 [See bar graph below] funded by the French foundation ‘Health and

radiofrequency fields'. The signal investigated is WiFi, a new signal, a source of environmental exposure at home, at school and in the workplace. The 2450 MHz signal is WiFi-like based on the "dialog" between two computers equipped with WiFi cards.

The exposure setup designed by 'Antennessa' uses 6 dipole antennas, activated at random, in a reverberation chamber with 5 paddles for mode mixing of whole-body exposure of free-moving animals from day 7 to day 20 in utero, until birth, and from day 1 to day 35, postnatally, until weaning. In the exposed rat brain slices of 10 young rats per group they will be investigating levels of apoptosis (TUNEL), stress proteins (HSP 25 and 70), radical stress (3-nitrotyrosine) and gliosis (GFAP).

The ERYA experiments on mice investigate effects of exposure on mouse spleen and peripheral blood with 12 young mice per group. The parameters considered are B- & T-cell populations (phenotyping), B- & T- cell proliferation (mitogens), B- & T- cell activation responses (cytokines), natural killer cells activity, and autoimmunity (neo-antigens). The PIOM team are Dr Isabelle Lagroye, Principle Investigator, biology, Dr Gilles Ruffié, physicist, Dr Bernard Billaudel, biology, Dr Michel Geffard, immunologist, Dr Bernard Veyret, physicist, Emmanuelle Haro, engineer and biology, Annabelle Hurtier, technical biologist and a doctoral student, in biology.

**The ERYA 3-Year Calendar:**

Months 1-6	Months 7-12	Months 13-18	Months 19-24	Months 25-30	Months 31-36
Exposure set-up building, characterisation, installation (WP1)					
	Doctoral student hired				
	Exposure of rats (WP2) Biological assays in brain(WP3)				
	Exposure of mice (WP2) Immunological biological assays (WP4)				
			Autoimmunity biological assays (WP5)		
	Reporting (WP6)				

France Telecom R&D and ENEA Italy [C. Marino, C. Pioli & G. Lovisolo] are collaborators. Their study will involve exposure to WiFi in utero [in rats and mice] - and postnatally only [in mice].

Laclau M, Billaudel B, Taxile M, Haro E, Ruffi G, Lagroye I, Veyret B. Effect of GSM-1800 and UMTS exposures on microglial activation and heat shock proteins induction in brain: a comparative study of young adult and elderly rats. S1-7 BEMS June 2006, Dublin 166-170.

**Andrew W. Wood presented ‘Human Volunteer Studies of Physiological and Psychological Responses to Mobile Phone Emissions: How consistent are they? Are Children Different?’**

He reviewed the place of human volunteer studies in health impact assessment in Australia from 1998 to present, and ongoing prospective studies involving people below 18 years in Australia. He ended with the question; ‘Are these reported mobile phone effects age related?’ The issue today is that young children use phones to contact parents, but the use increases in the teenage years (texting as well as voice). Is there evidence at present that children show greater responses in human volunteer studies and are especially sensitive to RF?

**Human Volunteer Studies** are useful for identifying immediate effects (minutes to hours) to single exposures. Researchers are able to control exposure parameters and many sources of variability in human laboratory studies. They are able to compare results of ‘real’ with ‘sham’ exposure, and carry out ‘double-blind’ investigations [i.e. Hamblin et al 2006; Haarala et al., 2005]. A large sample size is required to identify small effects ( $n \sim 20$  for 1 SD change): power varies with  $\sqrt{n}$ . Studies with larger sample sizes are possible [i.e. Hamblin et al 2006;  $n=120$ ; Russo et al 2006;  $n=168$ ].

**A Child as Human Volunteer** must be distinguished as either a ‘young person’ understood to be a minor with the maturity to decide whether or not to participate or as, a ‘child’, a person lacking the maturity to decide whether or not to participate. Research Ethics Committees need to be satisfied that the research question is sufficiently important to children and young people to justify the study; that their participation is indispensable to the research; that the circumstances of research provide for the child’s emotional safety; that the parent or guardian has provided consent in addition to the child; and that the exposure is not greater than experienced in day-to-day life (‘minimal risk’).

**How consistent are the reported effects for adult volunteers? Is the research question sufficiently supported to justify subjecting minors to the possible discomforts and inconvenience of a laboratory study?** There is now quite a large body of literature to examine. Do the emissions from mobile phone handsets lead to an immediate change in ability to react to stimuli, recall information, perform tasks accurately, get a good night’s sleep?

**Australian Studies (n > 300; ages 18 – 70)**

1. **Cognitive performance:** ‘This study compares the performance of 120 volunteers on 8 neuropsychological tests during real or sham exposure to a digital mobile phone [DMP] set to maximum permissible radiofrequency power output. ...simple and choice reaction times (CRT) showed strong evidence of impairment. Further, performance on the Trail Making Task (TMT) improved, supporting the hypothesis that DMP radiofrequency emissions improve the speed of processing of information held in working memory (Keetley et al., 2006).

2. **The event related potentials [ERP]** main study of auditory and visual ‘oddball’ stimuli is published [Hamblin et al. 2006; Croft et al. submitted]. Hamblin reported:

'There was no significant difference between exposure conditions for any auditory or visual event related potential (ERP) component or RT'.

**3. Sleep stages & EEG:** 'Results showed a decrease in rapid eye movement sleep latency & increased electroencephalogram spectral power in the 11.5-12.25 Hz frequency range during the initial part of sleep following exposure [Loughran et al. 2005].

**4. Melatonin output:** 'Total nighttime melatonin output is unchanged by mobile phone handset emissions, but there could be an effect on melatonin onset time' (Wood et al., 06).

**Conclusions on consistency:** Their reaction time findings are inconsistent with other groups. Their alpha power findings are inconsistent across studies, but they report a preponderance of alpha power increases in the sleep studies. There is no convincing mechanism to account for the effects. Two possibilities Wood suggests are increased blood flow or increased tympanic membrane temperature. Some effects are reported to persist several hours after exposure.

**Why the inconsistency?** Possible reasons include: differences in exposure conditions; differences between tasks; statistical artefact due to 'multiple comparisons'; and the changes from RF exposure are more subtle and more specific than the comparisons are able to identify.

### **CHILDREN Studies**

The Australian Centre for RF Bioeffects Research [ACRBR] has funded the participants – Swinburne, Monash & RMIT Universities (Melbourne); IMVS (Adelaide) and Telstra Corp.- to conduct ongoing studies on children; research started in 2004.

**1. Mobile Radiofrequency Phone Exposed Users Study (MoRPhEUS)** aims to assess exposure to RF energy from mobile telephones in a cohort of 300-12/13 year-old students. \* Investigators aim to determine whether there are any associations between RF exposure and cognitive function (via computer + paper & pencil tests) and blood pressure or hearing (via pure tone audiometry). [\* Michael Abramson, Geza Benke, Jill Blackman, Malcolm Sim, and Rodney Croft].

The dosimetry is collected by a 'Dosephone', a hardware modified phone, that functions as a phone and a dosimeter and allows for more direct quantification of RF exposure from mobile phones. It is designed to measure transmitted power and orientation of the phone in relation to the head and to transmit data automatically via e-mail to a computer. The dosephone requires calibration for measuring the SAR to the head. It is used to validate the subject's report of personal phone usage.

2. At Swinburne U they\* are investigating **2nd & 3rd generation mobile phone emissions in relation to consequent age related effects in children**, adults, and the elderly, in self reported hypersensitives, and in previous study participants to investigate the consistency in reported effects by repeat testing. [\* Rodney Croft, Denise Hamblin, Sarah Loughran, Ray McKenzie Jessica Dyson, Andrew Wood]

### **Are there any age-related findings in the Australian published results?**

There are a large proportion of students in their study population. In sleep study, the median age is 24. For endpoints for which change was significant, they found no difference when they split the subjects into 2 groups around the median: i.e. effects are not more marked for the younger group. In Study 2 they will investigate whether older individuals (and females) are more vulnerable.

### **Comments SAJ**

The report from Australia that effects are not more marked for the younger group are supported by child study results from Finland, by Haarala et al., 2005

‘The statistical analyses showed no significant differences between the mobile phone off and on conditions in reaction times and accuracy over all tests or in any single test. It was concluded that a standard mobile phone has no effect on children's cognitive function as measured by response speed and accuracy. The present results challenge some earlier findings suggesting that the electromagnetic field (EMF) created by an active mobile phone would facilitate cognitive functioning.’ Haarala et al., 2005.

and by child study results from the UK by Preece et al., 2005:

‘In view of the study by Haarala et al. [2004], which also found no effect even with a larger number of subjects, and the study reported here, there is no evidence that children present a more sensitive group than adults, either developmentally or physically by virtue of size, as was considered to be a possibility in the Stewart report [IEGMP, 2000].’ Preece et al., 2005.

In reference to the inconsistencies in the cognitive adult results a recent paper by Lewis, 2007 points out what others at the conference also stated: ‘Bonferroni correction of this multi-hypothesis exploratory research, ..reveals that none of the findings reach normally accepted levels of significance. The results of the study remain interesting in suggesting hypotheses for further research, however, care must be taken if making conclusions based on this research.’ [Lewis 2007].

Due to RF conductance around the electrodes increased temperature ‘artefacts’ could explain the changes in recorded characteristics of nerve potentials [as demonstrated by Chou and Guy, 1979; Moser et al 1996; Tattersall et al; IEEE ICES March 2, 2007, paper in press]. This could account for the great variability in the recorded EEGs.

### **In conclusion**

- How consistent are the reported effects for adult volunteers? **Is the research question sufficiently supported to justify subjecting minors to the possible discomforts and inconvenience of a laboratory study?** The answer so far appears to be NO.
- **Are there any age-related findings in the published results?** The answer here so far is also NO.

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## **Epidemiological Studies**

**Martin Röösl**i Department of Social and Preventive Medicine, University of Bern, Switzerland presented the slides of Elisabeth Cardis on the 'Interphone study' due to her absence and then his own presentation '**An international case-control study on mobile phone use and the risk of brain tumors in children and adolescents (Cefalo study): study design and first experiences from the field work.**' Martin presented a brief summary compiled by E Cardis of the Adult [persons aged 30-59 years] Interphone Study, run from 1 September 2000 until mid 2004 to assess whether RF radiations emitted by mobile phones are tumorigenic [glioma and meningioma, acoustic neuroma, and parotid gland tumours]. The common core protocol was carried out in 13 countries\*. The IARC INTERPHONE combined analysis of the complex set of data is underway to fully evaluate the evidence – across study centres, by level of use, by laterality, and the anatomical location of tumours. Simultaneously, it is important to assess carefully the effect of potential biases and errors.

\*[Australia, Canada, Denmark, Finland, France, Germany, Israel, Italy, Japan, NewZealand, Norway, Sweden, UK; plus an International Exposure Assessment Team and the IARC Group].

## **Preparations for INTERPHONE-Kids**

The WHO and EMF-Net have a brain tumour study in children as a high priority in their research recommendations. Presently the lack of data causes conflicting recommendations from decision-makers. A representative survey in Switzerland, (Schreier et al, 2006) showed that the use of mobile phones in adolescents (14-20 years) was more prevalent than in adults. Since the study of cranial tumours in children and adolescents was not included in the INTERPHONE study 2000-2004; and since over 90% of adolescents now use the mobile phones (Schreier et al., 2006), the feasibility of a large multi-country epidemiological study of the effect of mobile phone exposures in childhood and adolescence [INTERPHONE-Kids (7-25yr)] is underway. The research collaborators have a proposed application for funding submitted to the EU FP7

programme (Environment – 2nd call ) starting in 2008 (with more countries than INTERPHONE) to ensure sufficient statistical power to investigate tumour incidence in young people over an extended period of their young lives [18yrs].

### **CEFALO**

A preliminary 4-country case-control study called ‘Cefalo’ is currently underway in Denmark, Norway, Sweden, Switzerland. Data collection will be complete in 2008. Cefalo could contribute to the development of a larger INTERPHONE-Kids study and could extend the data collection prospectively under INTERPHONE-Kids, in the 4/5 countries involved.

**The purpose of Cefalo** is to investigate the risk for childhood brain tumours in children [age range: 7-19 years] who use mobile phones over the study period 2004-2008 in the countries Denmark, Norway, Sweden, and Switzerland (and possibly the UK). The head is the most exposed part of the body when using a mobile phone and head tumours are the most common solid tumour in children (~25% of all childhood tumours, although very rare). Other potential risk factors for brain tumours in children included in the study are: the child’s medical history (head injuries, medications and scans), pregnancy and birth related factors, social contacts with other children, contact with animals and allergies in the child or the family.

The 4/5 countries included in Cefalo, listing the country, the principal investigator, and funding sources respectively are: Denmark, Joachim Schüz- Danish Strategic Research Council; Norway, Tore Tynes, Norwegian Research Council; Sweden, Maria Feychting, Swedish council for working life and social research; Switzerland, Martin Rösli, Swiss Federal Office of Public Health, Swiss Research Foundation on Mobile Communication; and the UK: pilot study, Patricia McKinney, Samantha Dickson Brain Tumour Trust. The pilot questionnaire will inform about multiple “subscription periods”.

**The Cefalo design is a case-control study.** This method is more efficient for rare diseases such as childhood brain tumour that has a very low incidence (age group 7-19 years: ~3 cases per 100,000 person years). The cases are identified and a control group is randomly selected from the same source population. Their extent of exposure is compared with the cases. In Cefalo there will be 550 cases and ~1100 controls in Nordic countries and Switzerland. The pilot study in UK includes 50 cases and 50 controls, and may be expanded.

**The data collection** will be by Computer Assisted Personal Interviews (CAPI) with the child and parent(s). The statistical power of the study would equal 80% if we assume there are 550 cases, and 1100 controls.

**DNA-analyses** include the collection of saliva samples for DNA analyses. The DNA hypotheses include polymorphism in genes related to: the DNA repair mechanism (base [XRCC1, OGG1]; the nucleotide [XPA, XPC, XPD, ERCC1]; the double-strand break [XRCC]); oxidative metabolisms; detoxification of carcinogenic substances and the immune system. Could the gene-environment interaction be considered an explanation

for inter individual differences? Would it be helpful to separate spurious from true associations?

**Time schedule:** The questionnaire has been developed; the pilot interviews were conducted in the spring 2006; data collection started in June 2006 and will be finalized in 2008; the results will be available during 2009.

**First experiences** from the field phase include a willingness to participate – that was high in all countries. Organizing the interview is demanding because at least the child and mother have to be there. The questionnaire is well accepted; most study participants allow them to obtain their data from the mobile phone operator; and DNA analyses are generally well accepted.

### **Comments**

One weaknesses of this study is the rarity of brain cancers in children, and the different kinds of cancer are in very small numbers [i.e.30] not 500; and the various cancers are very different diseases and it does not make medical sense to group them together. And tumors may be widespread not localized in the brain. Very little is known about the etiology of childhood brain tumours. [Karl EvM]. This weakens the power of the study to predict effects; odds ratio less than 2 would be very difficult to interpret.

There were dosimetry limitations such as how would they monitor wifi phone calls on Skype for instance. This cannot be monitored by operator records. There is a need to see the image of the child talking to see how the mobile phone is held to estimate exposure. What are the systematic biases? Where is the tumour? What is exposure? What is the SAR distribution? These are very difficult problems [J Wiart].

The end

Source Sheila Johnston PhD