BfS programme

In vivo-Experimente unter Exposition mit hochfrequenten elektromagnetischen Feldern der Mobilkommunikation- Blut-Hirn-Schranke.

Final report:
Effect of GSM-1800 and UMTS exposure

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1   Executive summary

Objectives

As part of its research recommendations, the World Health Organisation (WHO) has emphasized the need for "studies to assess the accuracy and reproducibility of published RF effects on the permeability of the blood-brain barrier and other neuropathologies (e.g., dura mater inflammation, dark neurons)", which were considered as "short-term or urgent needs" (www.who.int/peh-emf/research/agenda/en/index.html).

Among the overarching issues for animal laboratory studies, WHO stated "animal studies should, where possible, be conducted using commercially relevant RF signals, and not be scaled in frequency. Animal model systems with the potential for clear responses to RF exposures should be used in initial studies of new signals."

The present BfS project addressed specifically the rat blood-brain barrier (BBB) and the presence of dark and degenerating neurons under exposure to new mobile-phone signals: GSM-1800 and UMTS. These *in vivo* studies extended over three years, with a total of 1200 rats.

The literature reports contradictory data on the occurrence of BBB permeation after exposure to low-level radiofrequency (RF) fields[1], but the actual weight of evidence of deleterious effects of RF fields on the BBB is becoming weaker and weaker as data accumulate.

The neuronal degeneration has not been widely investigated. The occurrence of dark neurons, assumed to be degenerative neurons, was reported 50 days after a single 2-hour exposure of rats to GSM-900[2]. In that investigation, the possibility of experimental bias, leading to an overestimation in the number of dark neurons, could not be ruled out. Moreover, there is no clear evidence that "dark" neurons are, indeed, degenerating cells.

The present study was performed using animals under well-controlled conditions (age, gender, stabulation, restrainer habituation, exposure conditions), staining processes, including a dye specific to degenerating neurons (Fluoro-Jade B in comparison with Cresyl violet). Care was taken that all staining procedures and data analyses were done in a blind manner. A comprehensive statistical analysis of data was performed. Another shortcoming of many previous studies on possible health effects from electromagnetic fields was the inadequate definition and description of the exposure set-ups as well as the poorly-characterised dosimetry. In the present study, the dosimetry included precise determination of the field strength in the brains of the animals and a study of its variability.

The objective of this BfS research project was to provide key research results which, when combined with current and past studies on the effects of RF fields on living systems, would contribute to an adequate database for health risk evaluation by public health authorities including the WHO. This report gathers results on the influence of GSM-1800 and ULTS signals on the occurrence of brain damage (presence of dark and degenerating neurons) and the permeability of the blood-brain barrier in the following conditions: immediately and 50 days after a 4-week GSM-1800 or UMTS exposure (2 hours/day, 5 days/week) or immediately, one hour, and 1, 7 or 50 days after a single 2-hour GSM-1800 or UMTS exposure.

Results

Exposure systems

Exposure was done using the RFR head-only exposure system available in our group, i.e. the loop antenna. The characterisation of the SAR absorbed in the brain (BASAR[3]) had been performed at

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[1] Person et al. (1992); Fritze et al. (1997); Tsurita et al. (2000); Finnie et al. (2001); Finnie et al. (2002); Salford et al. (2003); Kuribayashi et al. (2005); Cosquer et al. (2005); Finnie et al. (2006).
[2] Salford et al. 2003.
[3] Brain-averaged SAR

900 MHz[4]. The same approach was done as part of the project at 1800 and 1960 MHz in collaboration with Dr Philippe Lévêque (X-LIM, University of Limoges, France) using experimental measurements and numerical simulations (FDTD).

In this project, four local SAR levels were to be used: 0.02, 0.2, 2.0, and 10.0 W/kg. These levels were chosen to be relevant to human exposure to mobile telephones, but since the head of the rat (50 g) is much smaller than that of humans, for which the usual definition of the local SAR is that averaged over 10 g (ICNIRP), the local SAR in the heads of rats was defined in our laboratory as the BASAR.

Following BASAR determinations done in Bordeaux (temperature measurements) and Limoges (FDTD calculations), the final values used in the actual experiments were: 0.026, 0.26, 2.6 and 13 W/kg.

Single exposure to GSM-1800 and UMTS

After a single 2-hour exposure to GSM-1800, no consistent effect was found on the "dark" and degenerating neurones, and an early, transient decrease in BBB permeability was observed at the highest level of exposure. Globally, the observed changes were limited (0 change /240 i.e. none for Cresyl violet staining, 3 changes /240 i.e. 1% for Fluoro-Jade B staining, and 2 changes /60 i.e. 3% for BBB permeability) and were not predictive of deleterious effects.

After a single 2-hour exposure to UMTS, there was no consistent effect on dark and degenerating neurones. Increases were only seen using the Cresyl violet dye, and alterations were not matched with Fluoro-Jade. In parallel, an early transient drop in the BBB permeability was observed at the highest level of exposure. On the whole, the effects observed were mostly decreases in the parameters tested.

Experimental conditions leading to significant increases in neuronal damages, at the $p = 0.05$ level, were very limited (1% for Cresyl violet staining, none for Fluoro-Jade B staining, and none for BBB permeability). Overall, no brain damage was observed up to 50 days after exposure to UMTS.

Repeated exposures to GSM-1800 and UMTS

Repeated exposures to GSM-1800 (2 hours/day; 5 days / week; 4 weeks) induced changes in the rat brain 50 days after last exposure. The effect on the occurrence of "dark" and degenerating neurons was either an increase or a decrease. Globally, the experimental conditions where the effects were seen were limited (6 changes /96 i.e. 6% for Cresyl violet staining, 2 changes /96 i.e. 2% for Fluoro-Jade B staining). On another hand, increases in the BBB permeability were seen more consistently (5 changes /24, i.e. 21 %). BBB permeation was detected at 0.026 W/kg and 13 W/kg. No dose-response was found.

Changes were also observed in the rat brain immediately and 50 days after a repeated exposure to UMTS. The effect on the occurrence of "dark" neurons was either a decrease (immediately after exposure, Cresyl violet dye) or an increase (50 days after exposure, Cresyl violet), while degenerating neurons were increased (50 days after exposure, Fluoro-Jade B dye). BBB permeation was sparse. A transient BBB permeation was observed at 0.26 (in two zones of the bain) as it vanished 50 days after the last exposure. No dose-response was found. Globally, experimental conditions showing significant increased brain damage remained limited (7 changes /96, i.e. 7% for Cresyl violet staining, 1 change /96, i.e. 1% for Fluoro-Jade B staining, 2 changes /24, i.e. 8% for endogenous albumin leakage).

Conclusion

We have studied the influence of GSM-1800 and UMTS signals on the occurrence of brain damage as evaluated by the presence of "dark" neurons, degenerating neurons and permeation of the blood-brain barrier in 1120 rats. A number of exposure conditions have been tested as single (2 hours) exposures, time kinetics after exposure (immediately to up to 50 days after last exposure) and brain averaged SAR level (0.026, 0.26, 2.6 and 13 W/kg).

Increases in dark and degenerative neurons were sporadic, and their correlation was very limited over the whole experiment (1 case for GSM-1800 and UMTS). Also, no correlation between the occurrence of dark and degenerating neurons and BBB permeation was observed.

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[4] Lévêque et al. (2004).

Increases in BBB permeability were more consistently observed, especially 50 days after exposure to GSM-1800 at the highest SAR value (13 W/kg, all brain zones with albumin leakage). The amplitude of the effect is about a doubling in the number of leaking vessels (maximum 2.4 fold), corresponding to two leaking areas in exposed animals, as compared to one in sham-exposed animals.

BBB permeation may occur as a delayed event with a BASAR threshold around 13 W/kg. Repeated exposures could gradually weaken the BBB, making the functional alterations (endogenous albumin leakages) not immediately visible. This effect could be linked to the occurrence of thermo-elastic waves (known as the cause of the "microwave hearing" effect) that may act as a mechanical stress in the rat brain and could induce gradual BBB alteration. In contrast to UMTS, GSM technology uses "pulsed" signals (1/8 duty factor). At 13 W/kg, while the steady-state temperature is unlikely to differ between GSM-1800 and UMTS, it is conceivable that the threshold for thermo-elastic waves for the rat (ca. 1 mJ/kg) is reached for each of the GSM-1800 pulses. Obviously, this cannot occur at the BASAR of 0.026 W/kg. This hypothesis needs to be tested thoroughly. However, the overall magnitude of the effect is not very large.

Therefore, the overall conclusion is that physio-pathological consequences are unlikely to be expected in the rat brain after single and repeated exposure to GSM-1800 and UMTS, at BASAR levels up to 13 W/kg. Moreover, calculations showed that the maximum SAR in the periphery of the rat brain is ca. twice that value i.e. 26 W/kg. Extrapolation to the human situation gives a SAR10 g of ca. 50 W/kg, which is much larger than the 2 W/kg SAR10 g exposure limit but twice lower than the critical effect as defined by ICNIRP.

2 Effect of single and repeated exposure to GSM-1800 and UMTS signals on brain damage in the Wistar rat

Introduction

The homeostasis of the brain microenvironment, which is essential for its normal function is maintained by the blood brain barrier (BBB). The BBB is formed by highly-specialised endothelial cells, whose tight junctions between adjacent cells restrict the paracellular diffusion of hydrophilic molecules. The tight junctions are the intricate combination of transmembrane and cytoplasmic proteins linked to an actin-based cytoskeleton system.

Different sources of stress such as immobilization (Belova and Jonsson 1982; Dvorska et al. 1992), cold (Ben Nathan et al. 1991), forced swim (Sharma et al. 1991), ionising radiation (Phillips et al. 1987; Bezek et al.1990; d'Avella et al. 1992; Namba et al. 1996), and heat stress (Sharma et al. 1992) are known to alter BBB permeability.

BBB breakdown has also been observed after exposure to radiofrequency (RF) fields at high specific absorption rate (SAR), where RF radiation is known to induce hyperthermia and heat stress. At 2 W/kg, the exposure limit for local exposure to RF fields, there is no heat stress in humans. While some research groups have reported an absence of BBB disruption in rodents under exposure to mobile phone in the GHz range and W/kg SAR levels (Tsurita et al., 2000; Kuribayashi et al., 2005; Finnie et al., 2001, 2002, 2006; Cosquer et al., 2005), one research group has reported significant BBB alteration and neuronal degeneration in rats exposed at 900 MHz (Person et al. 1992 ; Salford et al. 2003). In their 2003 paper, brain damage was observed up to 50 days after a single 2-hour whole-body exposure.

The World Health Organisation (WHO) has recently recommended "studies to assess the accuracy and reproducibility of published RF effects on the permeability of the BBB and other neuropathologies (e.g., dura mater inflammation, dark neurons)".

The present work addresses specifically the issue of the BBB and the presence of degenerating neurons in a rat model under exposure to mobile phone signals: GSM-1800 and UMTS. The effects of RF signals were investigated immediately, one hour, and 1, 7, or 50 days after a single 2-hour exposure, and immediately and 50 days after repeated exposures of 2 hours per day, 5 days per week for 4 weeks. Four local brain-averaged SAR (BASAR) levels were used: 0.026, 0.26, 2.6, and 13.0 W/kg. These levels were chosen to be relevant to human exposure to mobile telephones.

Material and methods

Radiofrequency field exposure setup

Signals used in the present study are GSM-1800 and UMTS.

At 1800 MHz, the applied field was an amplitude-modulated signal with GSM rectangular pulses with a repetition frequency of 217 Hz and a duty cycle of 1:8, yielding frames of a length of 4.61 ms each including a 576 µs burst. The UMTS signal was produced by a UMTS generator GUS 6960S (University of Wuppertal, Wuppertal, Germany) coupled to a RF power amplifier 14002600-10 (RFPA S.A., Artigues-près-Bordeaux, France). The signal is detailed in Ndoumbè Mbonjo-Mbonjo et al. (2004).

Head-only exposure was done using a loop antenna (Figure 1). The characterisation of the specific absorption rate (SAR) absorbed in the brain, or brain-averaged SAR (BASAR), had been performed at 900 MHz (Lévêque, et al. 2004). The same approach was used at 1800 and 1960 MHz using experimental measurements and numerical simulations. The Finite Difference Time Domain (FDTD) method was used to calculate the SAR distribution. This method is particularly well adapted to this objective and has become a very powerful and popular tool in bioelectromagnetic studies. It has been often used to analyze and design exposure setups for *in vitro* and *in vivo* biological experiments (Burkhardt et al., 1996 ; Watanabe et al., 1996 ; Laval et al., 2000).

Since the computational volume is limited, Absorbing Boundary Conditions (ABC) are needed to simulate free space and avoid spurious reflections from the edges. Large efforts have been carried out to improve the ABC used in FDTD. In this study, the Perfectly Matched Layer (PML) ABC were used (Gedney,1996 ; Bérenger, 1994); these ABC are able to limit to less than 40 dB the spurious reflections induced by the restriction of the computational domain.

Four local brain-averaged SAR (BASAR) levels were used: 0.026, 0.26, 2.6, and 13.0 W/kg. These levels were chosen to be relevant to human exposure to mobile telephones, but since the head of the rat (50 g) is much smaller than that of humans, for which the usual definition of the local SAR is averaged over 10 g (ICNIRP), the local SAR in the heads of rats was defined in this study as the BASAR.

BASAR determination

BASAR determination

Temperature measurements were done on a gel phantom using a Vitek probe and gave 6.0 ± 0.6 W/kg/W for both GSM-1800 and UMTS, at 1.3 cm from the inner side of the rocket directly below the loop.

At the location of these measurements, the FDTD calculations gave 8.2 ± 0.3 and 10.9±0.3 W/kg/W for a homogeneous numerical phantom, for GSM-1800 and UMTS, respectively. Calculation of the BASAR using the 7-tissue numerical phantom gave 11.5 and 14.3 W/kg/W, for GSM-1800 and UMTS, respectively. For 350-500 g rat,

medium rocket was used and BASAR are similar to those obtained for 250 g or 700 g rat models placed in small or big rockets.

The temperature method was considered most realistic. It was chosen to calibrate the FDTD BASAR considering the change in SAR obtained by temperature measurements (homogeneous phantom) and FDTD calculations (homogeneous and multi-tissue phantom). The final BASAR estimations are 8.4 ± 0.3 W/kg/W and 7.9 ± 0.3 W/kg/W for GSM-1800 and UMTS, respectively (Figure 2). If the BASAR is considered as the "local" SAR level, as some authors have done, then the levels set in this set of experiments were 0.026, 0.26, 2.6, and 13 W/kg.

Rat local and core temperature recording

To characterize the rat body temperature when exposed to the higher SAR value (13 W/kg) for 2 hours (as in the experimental procedure), two temperature probes were used. One was placed just below the loop antenna, between the inner face of the rocket and the rat's scalp, to record local temperature variations. The other probe was placed inside the rectum of the animal to measure the core temperature.

One rat was tested for each signal. At the rat head level, just below the loop antenna, we observed a small temperature increase of 0.5-1.2°C, under GSM-1800 and UMTS exposure at 13 W/kg (Figure 3). However, no change in core temperature was recorded.

Given the above results obtained using the highest SAR value (13 W/kg) tested in our experiments, only modest temperature changes are expected at the brain level under exposure to the GSM-1800 and UMTS signals.

Animals

To make possible a comparison between single- and repeated-exposure experiments, the animals' sex and age at sacrifice time were matched as much as possible. Thus, 10-week-old (300-325 g) male Wistar-Han rats were used in the single exposure experiments and six-week-old male Wistar-Han rats (200-225 g) in the repeated-exposure series. Rats were purchased from Janvier (Le Genest Saint Isle, France), housed under controlled temperature (22°C) and lighting conditions (monitored light-dark cycles 08:00-20:00), and supplied with water and UAR 04 food (Safe, Augy France) *ad libitum*.

Animals were kept for one week in the animal facility before starting the experimental procedure. Cages were cleaned twice a week. All French national regulations were implemented in housing and handling of animals.

During the experiment, animals were weighted at least once a week for monitoring the physiological development.

Rat exposure to radiofrequency fields

After a one-week acclimation, rats were trained over one week, so that rats were enrolled in GSM-1800 and UMTS exposure experiments when they were 12 and 8 weeks old for single and repeated exposure schemes, respectively. Rats were

randomly distributed in each experimental group and progressively trained over one week (0.5, 1, 1.5, and 2 hours/day) to the rocket-type exposure setup.

Rats were divided into 5 groups of 16 rats: sham-exposed group, and 4 groups exposed to the GSM-1800 and UMTS mobile telephony-related signals. Four SAR levels were used: 0.026 W/kg (very low), 0.26 W/kg (low), 2.6 W/kg (in the range of ICNIRP limits for public local exposure), and 13 W/kg (in the range of ICNIRP limits for occupational local exposure).

Single exposure

Twelve-week-old rats were exposed or sham-exposed to RF using a single 2-hour exposure scheme. Series of experiments were done according to the time elapsed after exposure (0 and 1 hour, 1, 7, and 50 days), and 2 independent series were performed for each exposure condition.

Repeated exposures

Eight-week-old rats were randomly exposed or sham-exposed to RF using a repetitive scheme of 2 hours per day, 5 days per week, during 4 weeks.

Series of experiments were done according to the time elapsed after exposure (0 and 50 days), and 2 independent series were performed for each exposure condition.

Samples

At the time of sacrifice, rats were euthanized using isoflurane (TEM, Bordeaux, France) inhalation. Using intracardiac perfusion, rats were perfused with PBS (8 minutes) and fixed for 8 minutes with 4% paraformaldehyde in 0.1 M phosphate buffer (Sigma Aldricht, Saint Quentin Fallavier, France). The brains were removed and kept in the fixative solution overnight at 4°C. They were then cryo-preserved in 20 % sucrose in phosphate buffer for 48 hours at 4°C and frozen to –80°C using isopentane. To ensure blinding of the experiments, brains were coded before slicing and analysis.

Serial 10-µm brain sections were prepared from 3 brain zones named Z1 (bregma –0.30 to –0.80 mm), Z2 (bregma –3.30 to –4.50 mm), and Z3 (bregma –7.30 to –8.00 mm) for frontal, median and posterior zones, respectively (Figure 4a). Different regions in the cortex and the hippocampus, for a total of 12 regions, were then considered in each slice (Figure 4 b). The regions selected were:

- In Z1: the motor cortex (F1) and the medial forebrain bundle (F4),
- In Z2: the retrosplenial cortex (M1); the auditory cortex (M3), the cortical amygdaloid nucleus (M4), the Cornu Ammonis field 1 (CA1), the Cornu Ammonis field 2 (CA2), the Cornu Ammonis field 3 (CA3), and the Dentate Gyrus (DG)
- in Z3: the dorsomedial periaqueducal gray (P1), the retrosplenial cortex (P2), and the Pontine nuclei (P3)

Controls

Negative controls

As mentioned above, the sham-exposed group was used as a control group for handling and restraining in a rocket (0 W/kg). Cage controls were also included in the protocol for each time-point after the last exposure, except for a common cage-control group (16 rats) assigned to match the 0- and 1-hour post-exposure condition in the single exposure scheme.

Positive controls

A positive control is intended to show that the technique used is efficient to detect the endpoint of interest. This is of outmost importance in the field of bioelectromagnetics, where the amplitude of the reported effects, if any, is small. Cold shock has been shown in our laboratory to induce a variety of lesions in the brain, i.e. degenerative neurons and BBB leakage. Because cold shock gives more reproducible results and less mortality as compared to a variety of treatments (kainic acid, ischemia, etc), cold shock was used as a positive control treatment in the present study (Figure 5). A total of 16 rats were submitted to cold shock.

After anaesthesia (Isoflurane), the head skin was incised in the parietal region and the skull surface exposed. A small block of dry ice was maintained on one side of the hemisphere for 5 minutes. When the dry ice was removed, a purplish area showed the cold-shock injured region. Then the rat was left without treatment and kept warm for 25 minutes, before it was anaesthetized for brain removal.

Detection of dark and degenerative neurons

Cresyl violet staining

In this programme, Cresyl violet staining was intended to detect "dark" neurons as reported by Salford et al. (2003).

Cresyl violet staining was adapted from Luna (1968). Briefly, cresyl violet stain (1 g in 1000 ml distilled water and 30 ml acetic acid) was applied on the tissue sections (1-5 min) and rinsed with distilled water. Tissue slices were then treated in successive baths (95% ethanol, 100% ethanol; 50% ethanol and 50% xylene, 100% xylene). Coverslips were mounted on slides before microscopy observation, and analysis performed using visual quantification. In each brain region of interest, one X400 representative microscopic photograph was taken using a camera on a microscope (Zeiss). From these photographs, dark neurons were identified as strongly stained-, usually shrunken cells, with no visible nucleus. The results are expressed as the number (or count) of dark neurons.

Two slices per rat were analysed and the mean value taken in account for each brain region. The results were expressed as the mean ± SEM and the median of the values from rats of a given group. The mean and the median of the three zones (Z1, Z2, Z3) were then given as representative of the dark neurons population within the whole brain.

Fluoro-Jade B staining

Cresyl violet, as used in Salford et al. (2003), is not reported a specific marker of degenerative neurons. Therefore, the fluorescent Fluoro-jade B, shown to be a specific marker of degenerative neurons (Schmued et al., 1997; 2000), was used in the present work. Briefly, tissue slices were treated with successive baths (1% NaOH and 80 % ethanol, 5 min; 70% ethanol, 2 min; 0.06% potassium permanganate, 10 min), rinsed and stained using a 0.001% Fluoro-jade B solution (30 min, gentle agitation). Slices were rinsed in distilled water and immersed in xylene. Coverslips were mounted on slides before microscopy observation (Axiovert 40C Zeiss), and analysis performed using visual analysis. In each brain region of interest, one X100 representative microscopic photograph was taken using a black and white camera. From these photographs, degenerating neurons were identified as bright, white cells. False-colour treatment allowed the restitution of the real staining, i.e. bright cells on a green-coloured background tissue. Fluorescence intensity was scored on the following scale: 0 for no fluorescence labelling (0), 1 for medium fluorescence labelling (+) and 2 for high fluorescence labelling (++).
Two slices per rat were analysed and the mean value taken in account for each brain region. Therefore, for each brain region and each rat, the final score could be 0, 0.5, 1, 1.5, and 2. The results were then expressed as the mean ± SEM and the median of the values of rats from a given group. The mean and the median of the three zones (Z1, Z2, Z3) were given as representative of the degenerating neuronal population within the whole brain.

Detection of endogenous albumin

The permeation of the blood-brain barrier was assessed by the presence of endogenous albumin in the brain tissue. Briefly, quenching of endogenous peroxidase was done with 0.3% H_2O_2 in 0.3% horse serum (HS) in PBS. Non-specific binding sites were saturated with PBS-HS (5%, 10 min).

Tissue sections were incubated during 1 hour with an anti-human albumin antibody (Dakocytomation, France) diluted in PBS/HS (1/2000) and the first antibody revealed using an indirect immunoperoxydase method (Vectastain ABC kit) (Vector SA, France). Coverslips were mounted on slides before microscopy observation, and analysis performed on the whole brain sections using visual quantification.

Endogenous albumin leakage around the vessels was carefully identified (versus staining artefacts) and counted; it appeared as brown spots that where recorded.
For each brain zone (frontal Z1, median Z2 and posterior Z3) and each rat, two slices were analysed and the mean value taken in account. The results were expressed as the mean ± SEM and the median and the median of the values of rats from a given group. The mean and the median of the three zones were given as representative of the endogenous albumin leakage within the whole brain.

Statistical analysis

For each condition, the statistical power was such that the use of 16 rats per group allowed the detection of a statistically significant (p < 0.05) variation of 35% based on historical controls.

Statistical analysis is computed automatically using a software developped by Pr Le Pape (bio-statistician, France, http://www.viesanimales.org/stats/StatsIndex.htm) on the Statview software (SAS Institute Inc., Cary, NC, USA).

For each parameter studied, a p value < 0.05 was considered as significant.

Statistical analysis was performed between sham-exposure and exposed groups (all SAR levels) for each brain zone (albumin leakage) or region (dark neurons) and each time after exposure using the Kruskall Wallis test. Correction for multiple comparisons was then applied according to the software and formulae given by Siegel and Castellan, 1988[5]. Whenever the analysis showed significant variation, Kruskall Wallis test was performed for the comparison to the sham exposure condition.
Comparison between cage controls and positive controls were done using the Mann-Whitney test. The cage-control group considered for this statistical analysis is the single exposure/0-1 hour group, which matched the best the positive control group.
Figures are either presented as in-box graphs allowing the comparison of samples distribution or as mean ± sem graphs. In the former case, a box corresponds to 50 % of the sample size and the bars correspond to 95% of the confidence interval.

Results

Raw data and statistical significances can be found in the "tables" of the annexes.

Rat body weights

Rat body weights were not found statistically different among all groups, including cage control group, up to 50 days after the single and repeated exposures (data not shown).

Control rats

The distribution of the means is reported for each parameter in Figures 6a (Cresyl violet), 8a (Fluoro-Jade B), and 9a (endogenous albumin).
Other results are expressed as medians.
In cage control rats (total of 109 rats), the presence of dark and degenerating neurons varied over the twelve brain regions. Using cresyl violet, the median for the number of dark neurons ranged from 1.5 to 12.5. Of interest is the finding that this

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[5] Siegel, S. & Castellan, N. J. 1988. *Nonparametric Statistics for the Behavioural Sciences.* New York: McGraw-Hill, pp128-137.

number was highest in the F4 region. In Salford et al. (2003), the "occurrence of 'dark neurons' was judged semi-quantitatively by [a] neuropathologist as 0 (no or occasional dark neurons), 1 (moderate occurrence of dark neurons), or 2 (abundant occurrence)." The comparison with the present data is thus difficult.

Using fluoro-jade B, fluorescence intensity medians scored from 0 to 0.5 i.e. no to weak amount (− to +/−) of degenerating neurons were detected. Regarding this background, comparison with Hellmich et al. (2005) for instance, indicate about 10 Fluoro-Jade positive cells against 700 positive cells 24 hours after traumatic brain injury. This correlates with the present finding indicating no to very low Fluoro-Jade B staining in cage control rat brains.

A background level of endogenous albumin leakage was observed in most animals (about 60% of rats with ≥ 1 spot). The median values were 0.5 spots for Z1, 1.5 spots for Z2, and 0.5 spots for Z3. Evaluation of the number of endogenous albumin spots took into account the presence of staining artefacts that can be found using immunohistochemistry. Thus, all such artefacts were discarded in this study.

Short-time perfusion (1 minute) has also been demonstrated to yield aberrant BBB leakage using Evans blue (Ovadia et al., 2001). This could also be the case of endogenous albumin. Here however, perfusion time was 8 minutes with PBS with a further 8 minutes for brain fixation, so that this cannot account for the background level. In any case, the background level should be constant in any given zone and should not affect the detection of induced BBB leakage.

However, it has to be mentioned that some circumventricular organs (CVO's), i.e. the subfornical organ, the median eminence and the subcommissural organ, were present in the slices studied. The CVO's are midline structures bordering the 3rd and 4th ventricles and are unique areas of the brain that are outside the BBB[6].

Comparison with the existent literature is not easy as results are differently expressed. However, Finnie et al. (2002) showed that background endogenous albumin spots in mice were present in up to 50% of the animals and the mean number of spots was up to 0.6. The mean background was found to be 1.7 spots in rats. Thus, we consider that the background reported in the present work is fairly comparable to that reported by Finnie et al. (2002). In summary, the background level of albumin leakage was very small (< 2 spots).

After exposure to cold shock, dark neurons were detected in the brain slices using either cresyl violet (Figure 6b) or Fluoro-Jade B (Figure 8b). The location of dark neurons was mainly recorded in the brain region located below the cold-shock (F1, M1, and P2), whereas the other brain regions were less affected.

Using cresyl violet, the maximum number of dark neurons was observed in the F1 region with a median at 14.5 vs 4.5 (p<0.05, cold-shock vs. cage control rats, Figure 7).

Increase in Fluoro-Jade B fluorescence was found to be maximum in the F1 region where the median for the score was 1.25 vs. 0 (p<0.05, cold-shock vs. cage control rats). Increased fluorescence was also observed in deeper parts of the brain (F4,

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[6] CVO's include the pineal gland, median eminence, subfornical organ, area postrema, subcommissural organ, and organum vasculosum of the lamina terminalis.

DG, P1, and P3). When the averaged values over all the brain regions were considered, the difference with respect to control animals was found statistically significant (Figure 9).

In all cold-shocked rats, endogenous albumin leakages were observed. Most animals (n=9) showed distinct albumin leakage (spots) located in the upper part of the brain, where the underlying vessels could be observed with a clear leakage around them and the spots were counted under the microscope (Figure 10b). However, in some animals (n=6), a largely diffused albumin leakage was observed under the cold shock area that made counting vessels showing albumin leakage and comparison with control animals not possible. Therefore, this staining was re-evaluated on a 0 to 10 scale, according to the staining intensity and the area of albumin leakage. This number was then added to the number of isolated leaking vessels.

Positive control animals exhibited a statistically significant increase in BBB permeation in the Z1 and Z2 brain zones (Figure 11) as compared to cage-control rats (median Z1: 4.5, median Z2: 3.9, $p<0.001$, cold-shock vs. cage control). In the Z3 brain zone, the increase was not found significant due to a higher inter-individual dispersion (median Z3: 1, $p>0.05$, cold-shock vs. cage control). Based on the mean values, the amplitude of the effect was found to be a 6.9 fold in Z1, a 3.7 fold in Z2 and a 4.0 fold in Z3, with an overall effect was a 4.4 fold increase in endogenous albumin spots. Moreover, the maximal count of spots was 26 in the Z3 zone.

Effect of a single 2-hour exposure to GSM-1800 and UMTS

Sham-exposure
No significant variation was found between cage controls and sham-exposed animals at any time-point.

Detection of dark and degenerative neurons
After a single 2-hour exposure, cresyl violet staining showed a significant increased in the number of dark neurons, 1 hour and 50 days after exposure to UMTS at 0.26 W/kg in the P1 and F4 regions, respectively ($p<0.05$ UMTS vs sham). This was however not correlated to the number of degenerating neurons as detected using Fluoro-Jade B staining (Figures 12 and 14).

Both staining methods also showed significant decreases in the amount of dark and degenerating neurons after exposure to both GSM-1800 and UMTS signals ($p<0.05$ vs sham), while no matching for the brain regions could be observed (Figures 13, 15 and 16).

Detection of endogenous albumin
Changes observed after exposure to either RF signals were found to be decreases in the amount of albumin leakage after exposure to 13 W/kg. The effect was mainly found immediately after exposure (Figures 17-19).

False positives are significant changes by "statistical chance", i.e. found within 5% of total experimental conditions. For single experiments, the total number of experimental cases is 480 for Cresyl violet and Fluoro Jade B staining, and 120 for albumin staining. The % of "statistically significant" increases or decreases after GSM and UMTS exposures was never superior to the range of 5%, and thus were all possible false positives.

Effect of repeated 2-hour exposures to GSM-1800 and UMTS

Sham-exposure
No significant variation was found between cage controls and sham-exposed animals at any time-point.

Detection of dark and degenerative neurons
Immediately after exposure, significant decreases in the amount of dark neurons were found using Cresyl violet staining for the UMTS signals ($p < 0.05$ vs sham, Figures 20 and 21).
Fifty days after repeated exposure to GSM-1800 and UMTS (Figures 20 and 22), increases in the number of dark neurons were observed. Cresyl violet staining showed a significant increase in the number of these neurons after exposure to 0.026 W/kg GSM-1800 (F4, CA1, DG, P1 and P3 regions) and UMTS (F4, CA1, CA3, DG, P1 and P3 regions). Increase was also found in the F4 region after exposure to UMTS at 13 W/kg. Regarding degenerating neurons, Fluoro-jade B staining showed a significant increased fluorescence for exposure to GSM-1800 at 0.026 W/kg in the F4 and M1 regions and to UMTS at 0.026 W/kg in the F4 region (Figure 23).
Both staining were found correlated at 0.026 W/kg in the F4 region.

Detection of endogenous albumin
Changes observed after exposure to GSM-1800 signal were increases in the amount of albumin leakage, 50 days after repeated exposure. GSM-1800 induced increases in albumin leakage 50 days after exposure at 0.026 W/kg (Z1 zone) and 13 W/kg (all zones, Figure 24). At 13 W/kg, median values ranged from 1.5 to 3 in the brain zones, as compared to 0 as the median in any brain zone of sham-exposed animals ($p < 0.05$, Figure 25). A 3-fold increase was calculated from the means in 13 W/kg GSM-1800 versus sham exposure. While the mean spot numbers were quite similar at 0.026 and 13 W/kg (2.19 ±0.69 Z1 and 2.03 ±0.36 to 3.03 ±0.61, respectively), the mean values distribution was different (data not shown). We found that 50% of the rats exposed at 0.026 W/kg, as compared to 5% of the rats exposed at 13 W/kg, exhibited between 0 and 1.5 spots. Accordingly, at 0.026 W/kg, 20% of the rats had a spot number between 4 and 5.5, as compared to 45% for the rats exposed at 13 W/kg. Thus, the effect was much stronger at 13 W/kg than at 0.026 W/kg.
However, the overall magnitude of this effect is not very large. This is exemplified by the fact that the largest number of albumin spots in the brains of rats exposed to GSM-1800 at 13 W/kg is 3.0±0.6 (Z3, 50 days) is of the same order of magnitude as the maximum observed in cage control rats (2.9±0.6 spots in Z3, at 0 hour), while it is 6.4±2.2 for the positive control group (Z3).

UMTS increased albumin leakage immediately after exposure at 0.26 W/kg (Z1 and Z2 zones, Figures 24 and 25), and the effect was found reversible.

False positives are significant changes by "statistical chance", i.e. found within 5% of total experimental conditions. For repeated experiments, the total number of experimental cases is 192 for Cresyl violet and Fluoro Jade B staining. The % of "statistically significant" increases or decreases after GSM and UMTS exposures was never superior to the range of 5%, and thus were all possible false positives. On the other hand, the total number of experimental cases was 48 for albumin staining. The % of "statistically significant" increases after GSM and UMTS exposures was 12.5%, superior to the range of 5% (17% for GSM, and 8.3% for UMTS). Therefore, these increases are unlikely to be false positives.

Discussion

In the present work, we investigated the influence of the GSM-1800 and UMTS signals on the permeability of the blood-brain barrier and the occurrence of brain damage (presence of dark and degenerating neurons) under the following conditions: immediately and 50 days after a 4-week exposure (2 hours/day, 5 days/week) or immediately, one hour, and 1, 7, or 50 days after a single 2-hour exposure. These *in vivo* studies extended over three years, with a total of 1120 rats.

Contradictory data have been reported on the occurrence of BBB permeation after exposure to low-level RF fields (for review, see d'Andrea et al., 2003; Hossman and Hermann, 2003).
BBB permeation under RF exposure was reported by two groups : Fritze et al. (1997) showed that some BBB leakage occurred in the rat brain with a SAR threshold of 7.5 W/kg. The authors attributed this effect to the perception of temperature associated with this SAR level.
Salford and colleagues (Salford et al. 1993, 1994, 2003; Persson et al., 1997) reported consistently BBB leakage in the brains of rats exposed at whole-body SAR as low as 0.002 W/kg. The effect was found up to 50 days after a single 2-hour exposure and was dependent on the whole-body SAR level up to 0.2 W/kg.
By contrast, different groups have found no significant effect on BBB leakage in animals (mice and rats) exposed to RF (Tsurita et al., 2000; Finnie et al., 2001, 2002, 2006; Kuribayashi et al., 2005; Cosquer et al., 2005). The signal frequency ranged from 898 to 2450 MHz, the whole-body SAR from 0.25 to 4 W/kg and the BASAR from 0.3 to 6 W/kg (animals were exposed either whole-body or locally). In these studies, not only were animals submitted to single exposures for 45 min to 4 hours but also to repeated exposures up to 90 minutes/day and up to 104 weeks.

In the present study, no increase in BBB leakage was observed in animals exposed to either GSM-1800 or UMTS for 2 hours, as compared to sham-exposed rats, whatever time elapsed after exposure. Therefore, our results are in agreement with those suggesting that short-term exposure to mobile phone-related RFR does not

alter the BBB in rodents.

Fritze et al. (1997) saw an altered BBB permeation in the brains of rats locally exposed to 7.5 W/kg for 4 hours. The effect was found to be reversible 7 days after the exposure. In this study, the animals were restrained for 4 hours, and in the absence of training, this could have caused an immobilisation stress, which, combined to the perception of temperature at the BASAR of 7.5 W/kg, could have induced BBB leakage. Salford et al. observed inconsistent BBB leakage after a 2-hour exposure to GSM-900-like signals (modulation at 200-217 Hz) as the threshold for the effect was found at 2 W/kg (range tested 0.016 to 5 W/kg) and 0.002 W/kg (range tested 0.002 to 0.2 W/kg), whole-body exposure in the 1994 and 2003 papers, respectively. The reasons for such inconsistency are unclear, as the technique used to reveal endogenous albumin leakage was the same.

We observed, however, significant decreases in BBB leakage early after exposure to GSM-1800 and UMTS at 13 W/kg. The effect was transient, as it vanished 7 days after exposure. The physiological meaning of such a decrease is not clear. It is hardly conceivable that high-level RF exposure has a protective effect on BBB permeability, but this could be tested with concomitant treatment using a BBB leakage-inducer. These results could also be due to chance since they were found when the background level of BBB leakage in sham-exposed animals was at its highest (in the range given above). This background was however comparable to that found in cage control rats.

In the repeated exposures series, different exposure conditions were found to significantly increase BBB permeability, as compared to sham exposure.

Immediately after the last exposure, UMTS signal, at one of the BASAR levels (0.26 W/kg), increased BBB leakage in two zones of the rat brains (Z1 and Z2). However, the effect was reversible as no difference was seen any more 50 days later between exposed and sham-exposed rats. The effect of UMTS exposure was thus found at a single SAR level and did not depend on SAR level, which weakens the finding. No significant effect was measured immediately after repeated exposure to GSM-1800.

Thus, the data obtained immediately after a 4-week exposure using BASAR levels up to 13 W/kg, on the whole negative, are in agreement with the data published previously.

50 days after repeated exposures, GSM-1800 increased endogenous albumin extravasation, especially at the highest BASAR of 13 W/kg. A much modest effect was found at 0.026 W/kg with only one brain zone (Z1) affected, as compared to all brain zones affected at 13 W/kg. In all cases, the significance was also found at the 1% level. Moreover, false positive are unlikely as albumin leakage was found significantly increased in 33% of the cases. However, it should be noted that the most pronounced effect after exposure to 13 W/kg GSM-1800 was comparable to the highest background level found in cage control rats.

Finnie et al. (2002) found no effects on BBB permeation in the mice repeatedly exposed for 26 months at a whole-body SAR of 4 W/kg. Although the BASAR level was not given in this paper, it was probably of the same order of magnitude. It thus

can be hypothesised that BASAR level is more important than exposure duration for the occurrence of the BBB alteration in rodents.

In the present work, the BBB permeation was found significant 50 days after the 4-week exposure at 13 W/kg. Although performed on a single rat, the temperature measurement under GSM-1800 exposure at 13 W/kg showed that temperature increased of about 0.5°C at the scalp level without measurable increase in core temperature. Interestingly however, we noted a rapid decrease in the local temperature as the exposure stopped. This is probably linked to the "perception" of temperature as mentioned by Fritze et al. (1997) and is indicative for the thermoregulation to be triggered by exposure at such BASAR level. When repeated, this temperature "perception" could be considered as a stress. It could be interesting to investigate the stress response, for instance looking at HSPs expression. Some papers suggested that stress was eliciting BBB alteration and some HSP expression (Richmon et al., 1995 ; Sharma et al.,1997, 2006 ; Martinez et al., 1999).

Moreover, the delayed effect observed suggests the involvement of indirect mechanisms. Different hypotheses can be made.

On one hand, defective or decreased amount of BBB proteins may gradually induce BBB permeability not immediately visible. However, we do not have any indication of the time needed for the physiological consequences to be observed, as the protocol was intended to allow the detection of a persistent biological effect.

On another hand, the occurrence of thermo-elastic waves (known as the cause of the "microwave hearing" effect) may act as a mechanical stress in the rat brain and could induce gradual BBB alteration. In contrast to UMTS, GSM technology uses "pulsed" signals (1/8 duty factor). At 13 W/kg, while the steady-state temperature is unlikely to differ between GSM-1800 and UMTS, it is conceivable that the threshold for thermo-elastic waves for the rat (ca. 1 mJ/kg) is reached for each of the GSM-1800 pulses (Lin and Wang, 2007). In humans at least, the numerical computation had provided the values of 2.63 kW/m^2 and 80 W/kg for the peak incident power density and peak SAR, respectively, to reach the 20 mPa auditory sound pressure threshold at the cochlea for a 20-ms pulse at 915 MHz. The maximum SAR reachable in the present study was 13 W/kg x 8 (GSM modulation) x 2 (X 2 factor between averaged and peak SAR in the brain), i.e. 200 W/kg, which is above 80 W/kg. Obviously, this cannot occur at the BASAR of 0.026 W/kg. This hypothesis needs to be tested thoroughly.

This is the first time that the occurrence of BBB leakage in rodents is investigated 50 days after repeated exposures at high SAR levels. These findings need to be confirmed and mechanistic hypotheses further investigated.

In contrast to BBB permeation, dark neurons and neuronal degeneration after exposure to mobile phone-related RF has not been widely investigated and the occurrence of dark neurons was reported in a single paper (Salford et al., 2003). In that paper, the authors showed the presence of the so-called "dark neurons" 50 days after a single 2-hour exposure of rats to GSM-900. Rats were exposed whole-body at 0.002, 0.02, and 0.2 W/kg, and there was a SAR-dependent increase in the occurrence of dark neurons. Salford et al. (2003) made the assumption that these dark neurons were degenerative neurons. The dye cresyl violet is a conventional

Nissl stain for cytoplasm. Nissl is a term used by classical cytologists for the endoplasmic reticulum (ER). Since all cells contain ER, cresyl violet will stain both neurons and glia in brain slices. The special feature of "dark neurons" however occurs after ischemia for instance (as shown in our laboratory) and can be defined as very strongly stained and shrunken cells with no distinguishable nucleus. This feature is not specific of neuronal degeneration; it can be reversible or irreversible, and artefacts can occur during tissues handling that can lead to false positives (Jortner, 2006. Kövesdi et al., 2007). Therefore, the fate of dark neurons is not necessarily neuronal degeneration.

In the present study, we used Fluoro-Jade B in parallel with Cresyl Violet, since Fluoro-jade derivatives are considered to be reliable markers of degenerating neurons (Schmued et al., 1997; 2000). Fluoro-Jade B staining gave a much smaller number of statistical differences than Cresyl Violet, which is agreement with a higher specificity of Fluoro-Jade B. We also noted a very weak correlation between the two staining methods (R^2 = 0.032).

After a single exposure to either signal, only decreases in the amount of degenerating neurons could be observed using Fluoro-Jade B.

Fluoro-Jade B exhibited significant increased fluorescence intensity in the cortex of rats, 50 days after repeated exposure to GSM-1800 and UMTS at the lowest SAR (0.026 W/kg; GSM: F4 and M1 regions, UMTS: F4 region) as compared to sham-exposed rats. Although we found a correlation between Cresyl Violet and Fluoro-Jade B staining in the F4 region, it is unlikely to add significance, as this was a single observation over the whole experiment. The effect was found to be independent of SAR level.

In conclusion, considering Fluoro-Jade B as a specific marker for degenerating neurons, a significant increase was found in only 1% of the cases (for both GSM and UTMS signals), which may lay in the false positive cases. Moreover, while increases found using cresyl violet (up to 7% of the cases) probably reflect real morphological changes, the specificity for degenerating neurons is not obvious and whether these cells will recover or not is unknown.

In summary, a single 2-hour exposure to GSM-1800 and UMTS did not increase BBB permeability nor induce dark neurons and neuronal degeneration in the rat brains.

Immediately after repeated exposures (2 hours/day, 5 days/week, 4 weeks), no increase in the number of dark and degenerating neurons could be detected and sparse and reversible BBB permeation was detected (UMTS at 0.26 W/kg only, 2 over 3 zones).

Regarding BBB permeation, the most pronounced effect was found 50 days after the last exposure to GSM-1800 at a BASAR of 13 W/kg (X3 vs. sham exposure). Although statistically different from the corresponding sham-exposed animals, the spot number at 13 W/kg was of the same order of magnitude as the maximum spot number found in cage control rats.

Therefore, the overall conclusion is that physio-pathological consequences are unlikely to be expected in the rat brain after single and repeated exposure to GSM-1800 and UMTS, at BASAR levels up to 13 W/kg. Moreover, calculations showed that the maximum SAR in the periphery of the rat brain is ca. twice that value i.e. 26 W/kg. Extrapolation to the human situation gives a $SAR_{10\,g}$ of ca. 50 W/kg, which

is much larger than the 2 W/kg $SAR_{10\,g}$ exposure limit but twice lower than the critical effect as defined by ICNIRP.

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3   Annex 1: Figures

Dosimetry
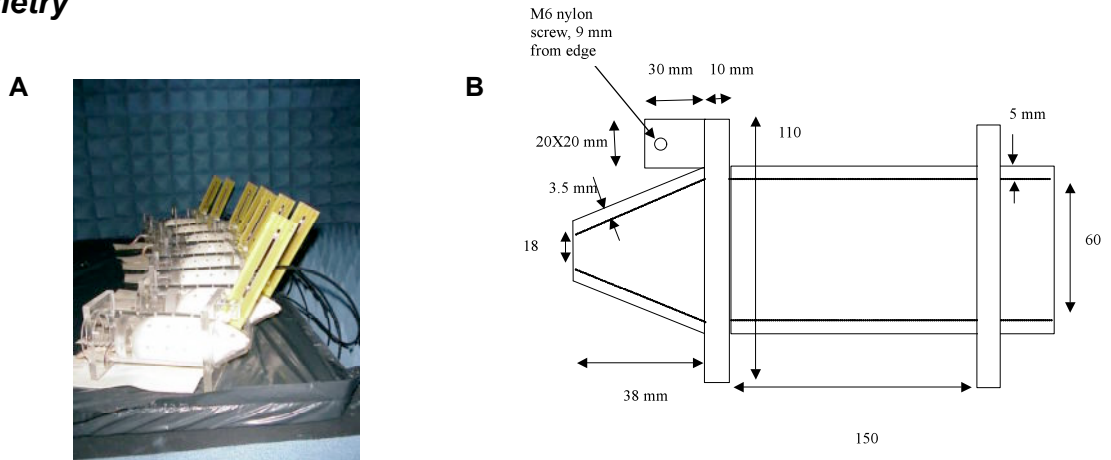
Figure 1: Rat exposure to GSM-1800 or UMTS.
A: Rats are restrained within the rocket and the loop antennas operate at 1800 or 1960 MHz;
B: Schematic view of the rat restrainer (for rats of 250 to 450 g).

	BASAR (for one Watt incident power)	
	GSM 1800 MHz	UMTS 1960 MHz
Mean	8.4 W/kg	7.9 W/kg
Standard deviation	3.7 W/kg	2.9 W/kg
Maximum	0.6 W/kg	1.3 W/kg
Minimum	21.3 W/kg	17.4 W/kg
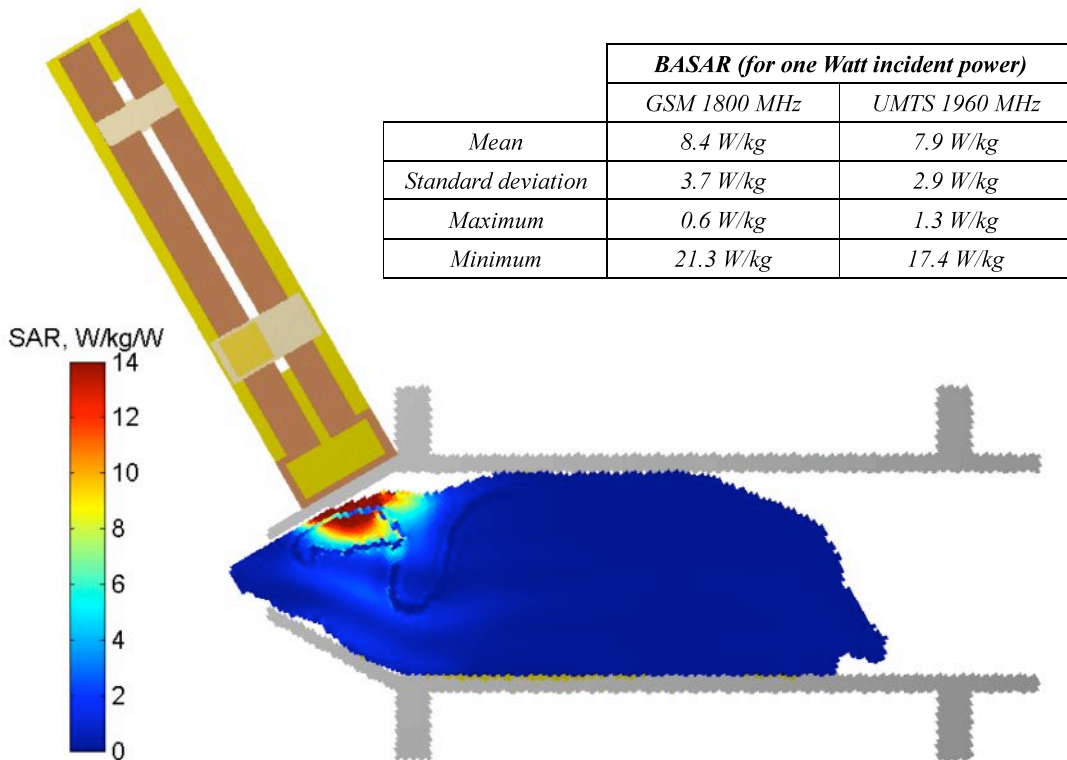
Figure 2: Exposure system with the loop antenna and SAR distribution at 1800 MHz.
Values of BASAR for GSM 1800 MHz and UMTS for a one Watt incident power are given in the inserted table.
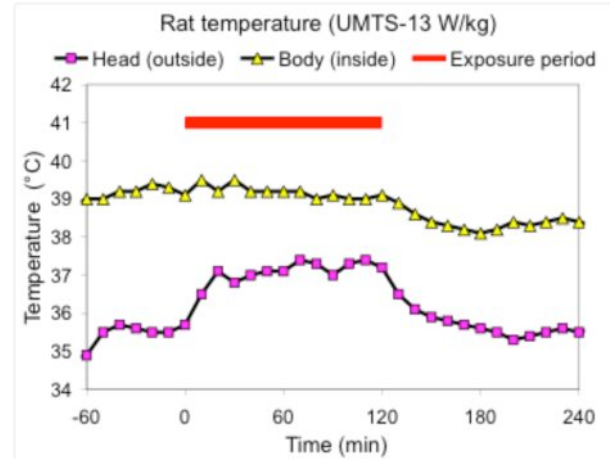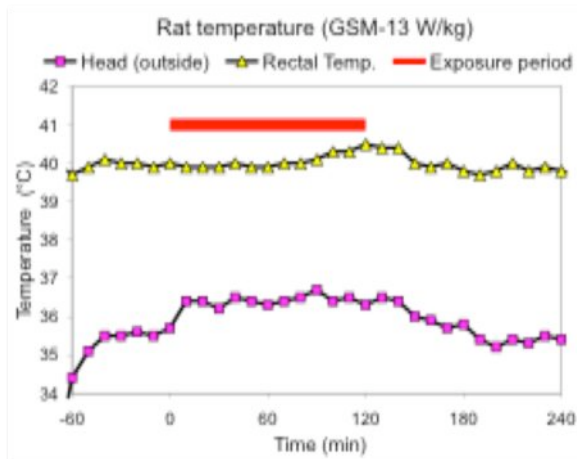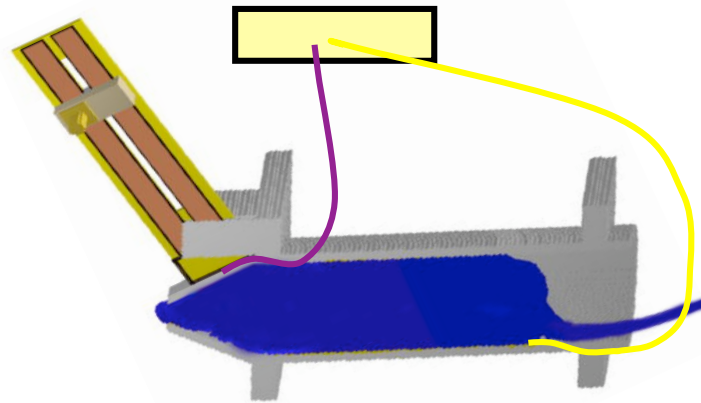
Figure 3: Rat body temperature variations using the higher SAR value (13 W/kg)
Temperature was measured during exposure to GSM-1800 or UMTS signal for 2 hours (as during the experimental procedure).

Biology
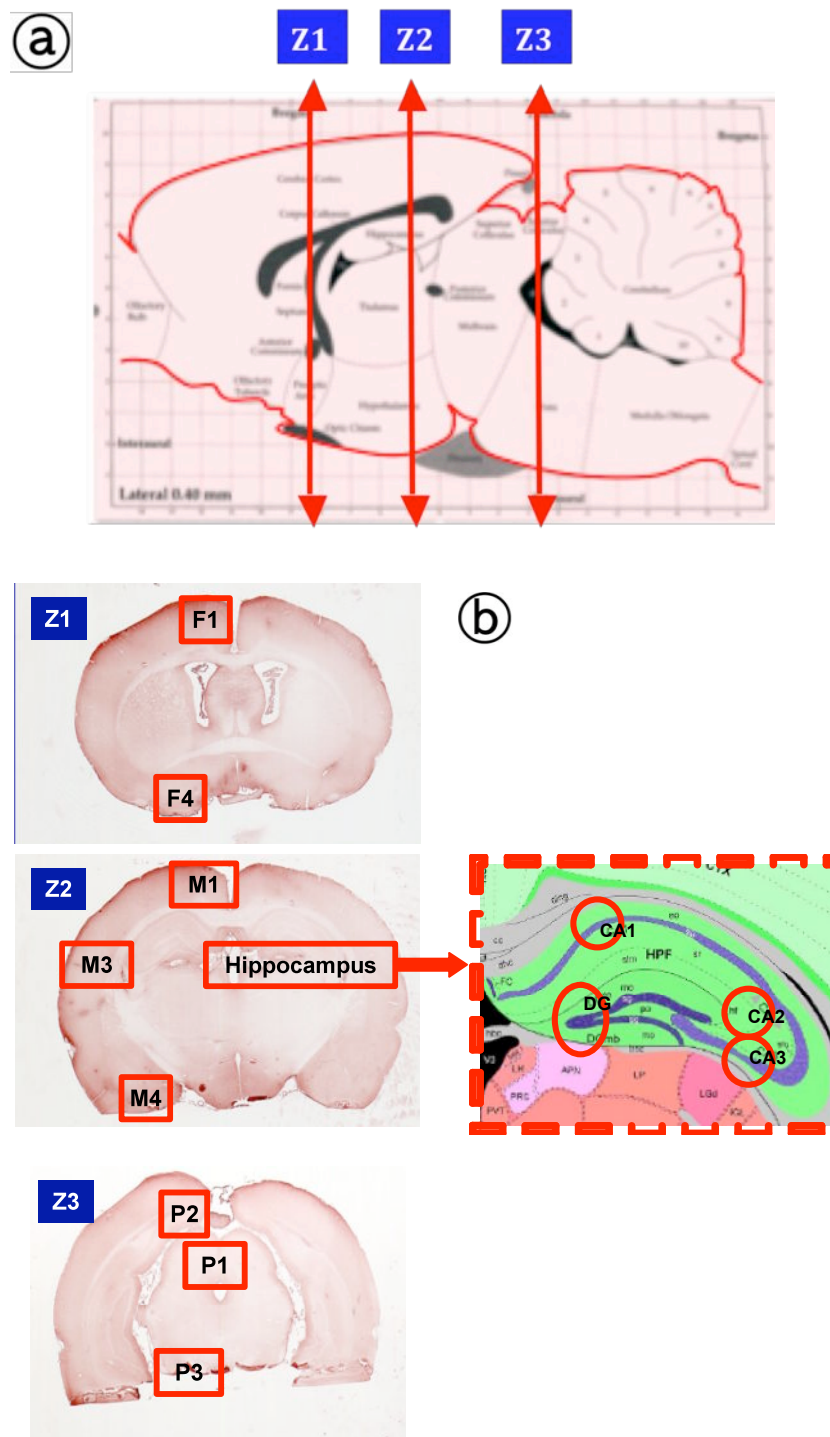
Figure 4: Rat brain zones (A) and regions (B) considered in the study.

A: Z1: frontal zone (bregma –0.30 to –0.80 mm); Z2: median zone (bregma –3.30 to –4.50 mm) ; Z3: posterior zone (bregma –7.30 to –8.00 mm)

B: F1: Motor cortex; F4: Medial forebrain bundle; M1: Retrosplenial cortex; M3: Auditory cortex ; M4: Cortical amygdaloid nucleus ; CA1: Cornu Ammonis field 1 ; CA2: Cornu Ammonis field 2, CA3: Cornu Ammonis field 3 ; DG: Dentate Gyrus ; P1: Dorsomedial periaqueducal gray ; P2: Retrosplenial cortex ; P3: Pontine nuclei
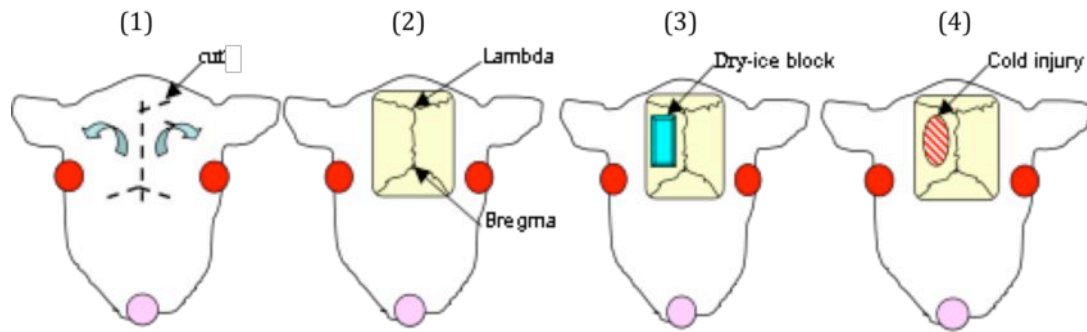
Figure 5: Schematic description of protocol for Cold-shock experiments.

A

Histogramme

Mean : 4.4
Std Dev. : 4.8

B

Cage Control

Positive Control
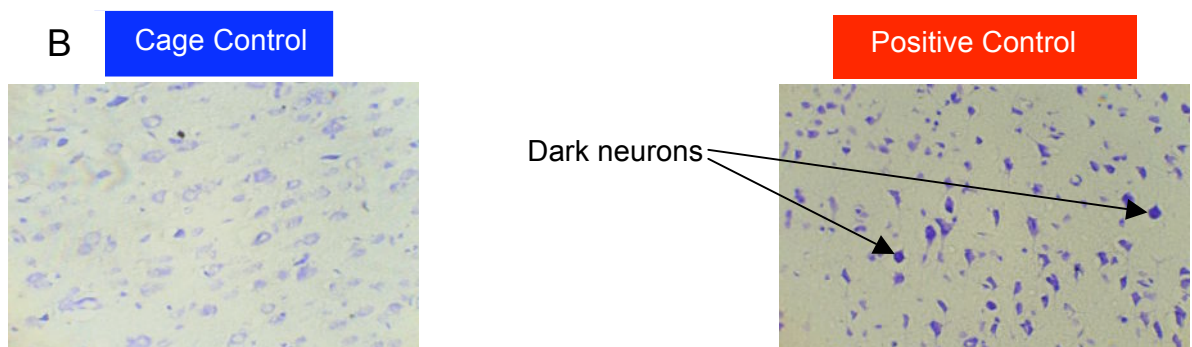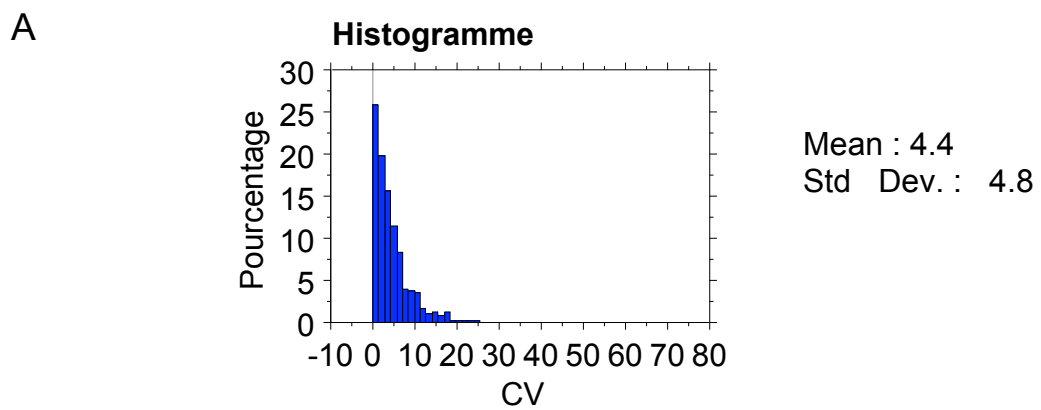
Dark neurons

Figure 6: Dark neurons as stained using cresyl violet.
A: Distribution of the means for dark neurons' counts in cage control rat brains (12 regions in 109 rats, i.e. 1307 measures). B: Representative images of "dark" neurons as identified by the cresyl-violet dye. Typical "dark" neurons are shown with an arrow.
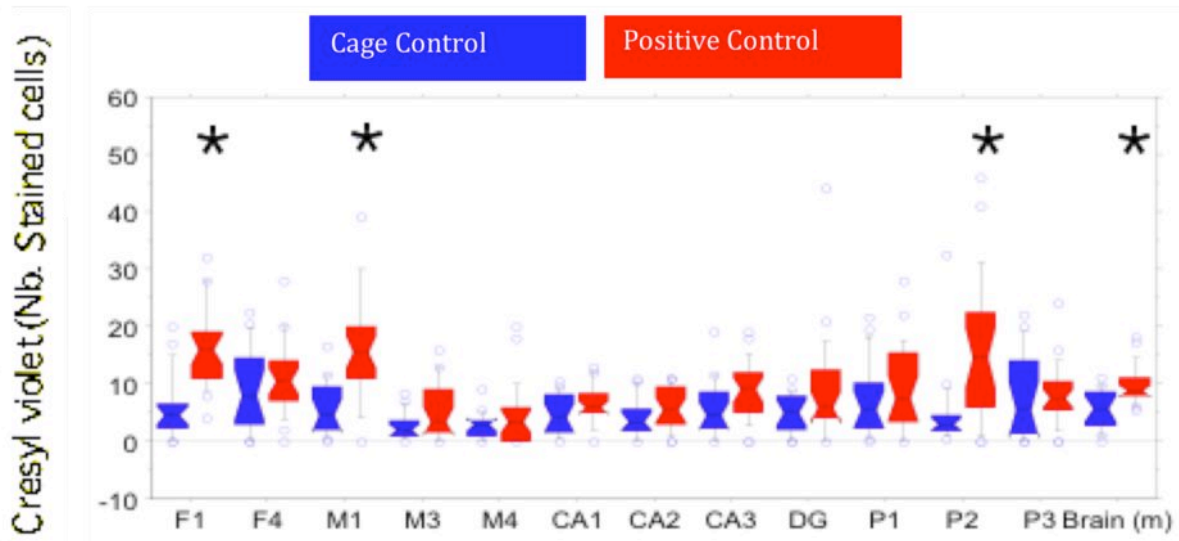
Figure 7 : Cold-shock positive control rats.
In-box graph of the amount of "dark" neurons as identified using Cresyl violet.
* p<0.05 cold-shock versus cage control rats.

Mean : 0.35
Std Dev. : 0.43
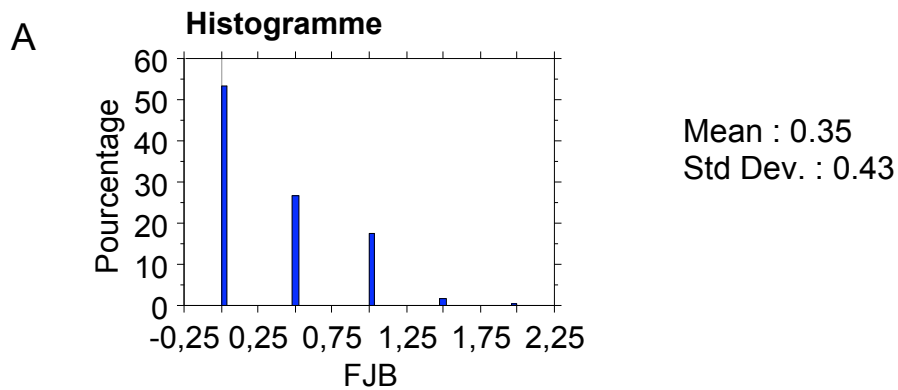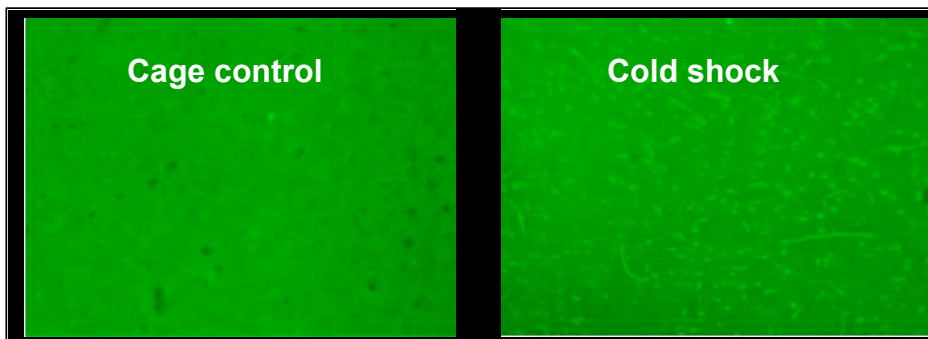
Figure 8: Degenerating neurons as identified using the Fluoro-Jade B dye
A: Distribution of the means for degenerating neurons' scores in cage control rat brains (12 regions in 109 rats, i.e. 1307 measures). B: Representative images of degenerating neurons as identified using the Fluoro-Jade B dye. Typical degenerating neurons appear bright on a green-coloured tissue. Images are obtained after false-colours treatment (X 200 magnification)
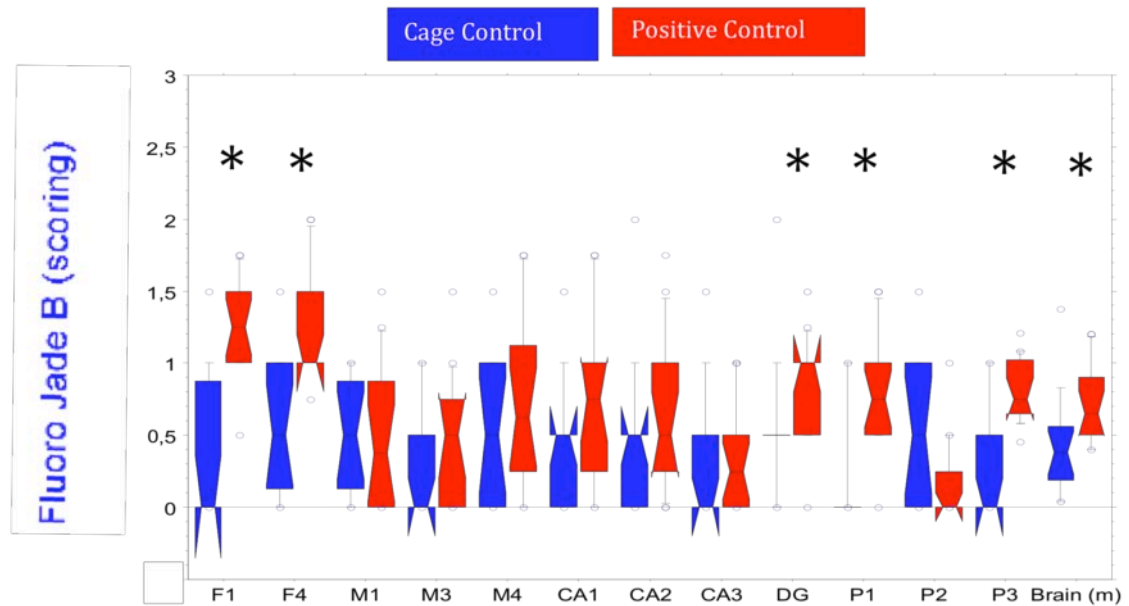
Figure 9 : Cold-shock positive control rats.
In-box graph of the amount of degenerating neurons as identified using Fluoro-Jade B. * p<0.05 cold-shock vs cage control rats.

Cage Control · Positive Control

Histogramme

Mean : 1.76
Std Dev. : 2.13
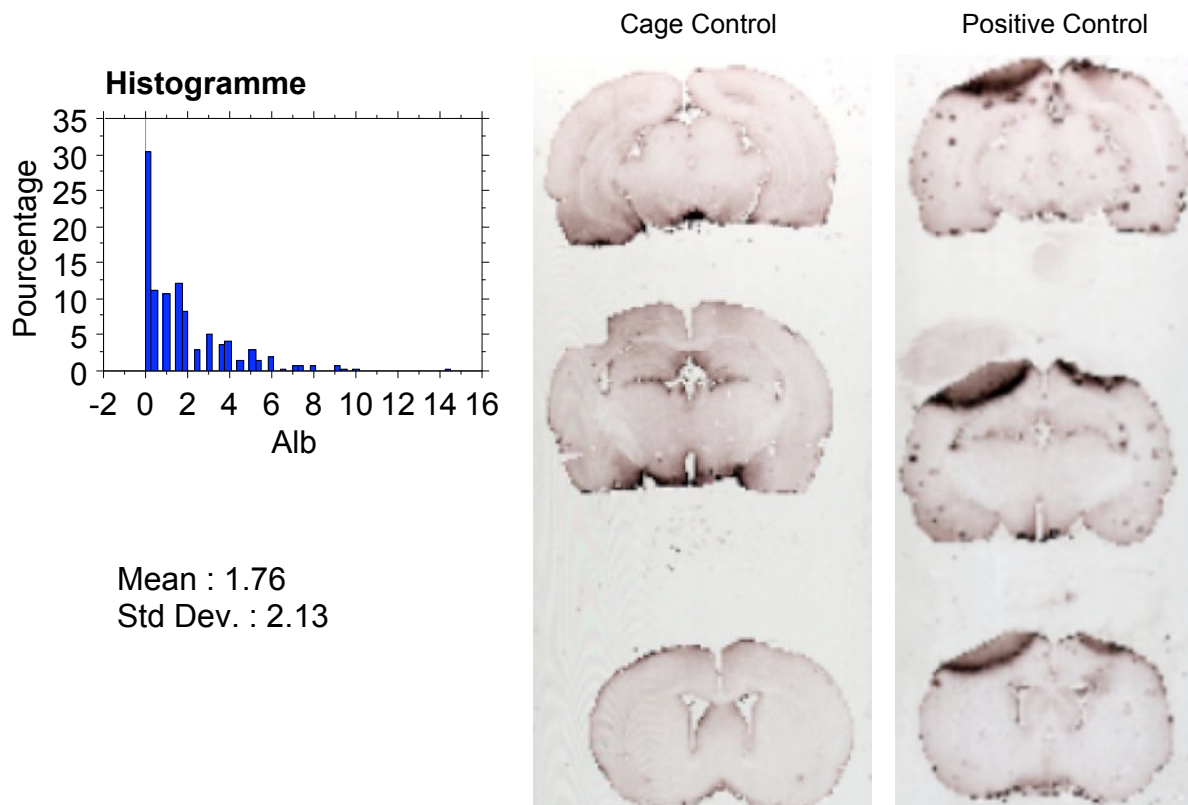
Figure 10: Endogenous albumin leakage as identified using immunohistochemistry. A: Distribution of the means for albumin spots in cage control rat brains (3 zones in 106 rats, i.e. 319 measures). B: Representative images of endogenous albumin leakage; typical leakages appear as brown area and dots.
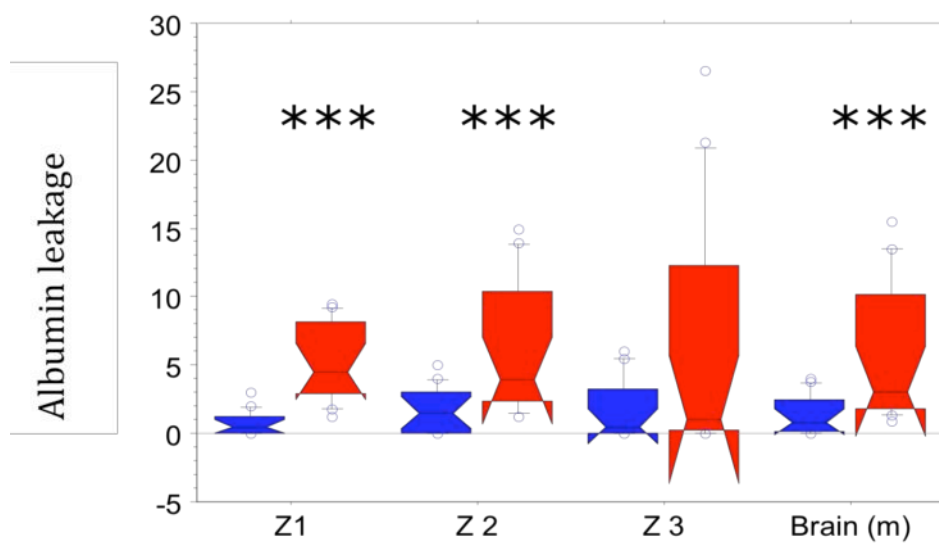
Figure 11 : Cold-shock positive control rats.
In-box graph of the amount of endogenous albumin leakage; *** $p < 0.001$, cold-shock versus cage control rats.

Figure 12: Single 2-hour exposure to GSM-1800 or UMTS (Cresyl violet staining).
Mean ± SEM and sample (n) for the amount of "dark" neurons as identified using cresyl violet in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different times after exposure. The brain regions where statistically significant differences were observed are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the SAR value. Statistical analysis was performed using Kruskall-Wallis test between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant (*).
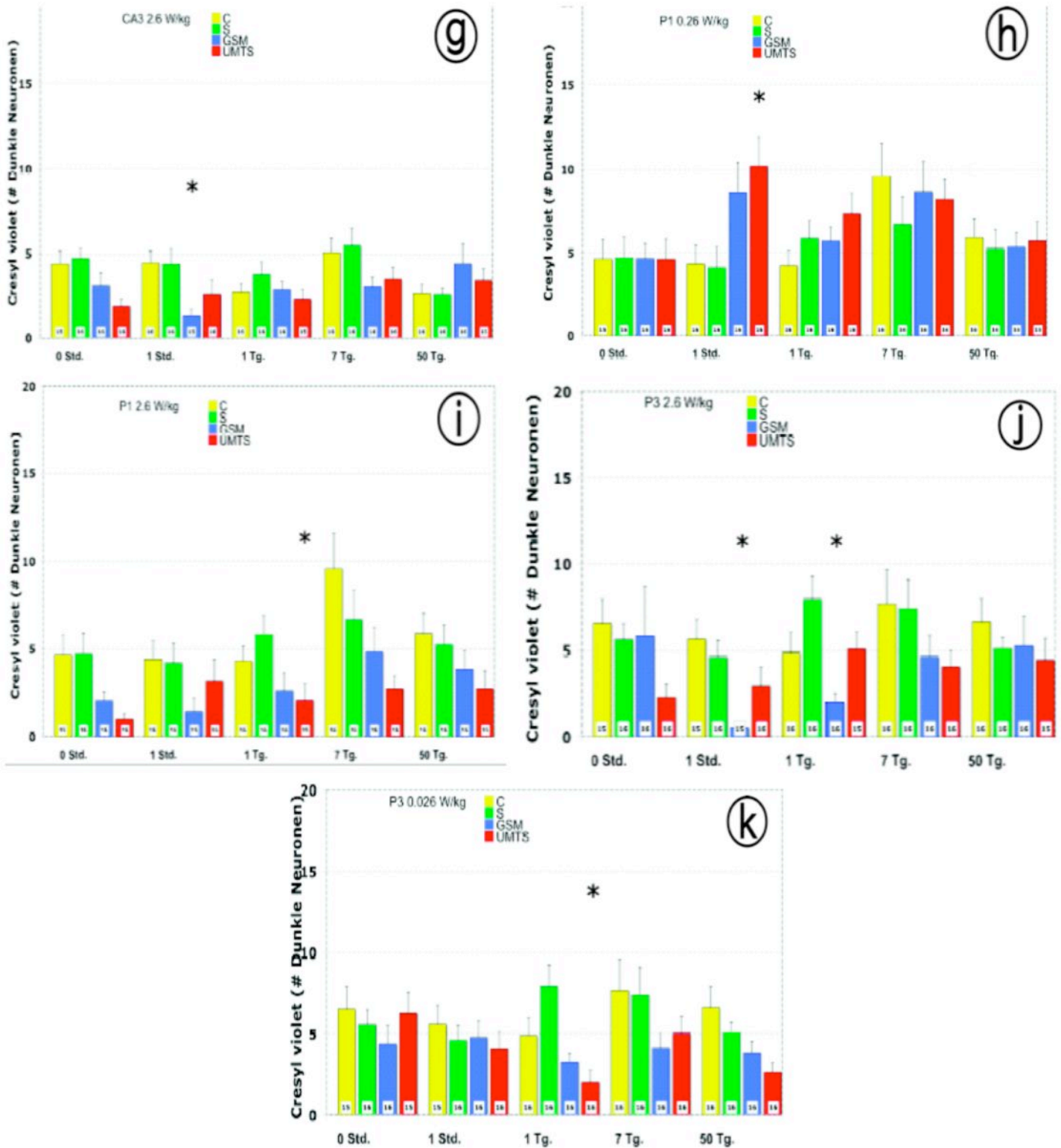
Figure 12 bis: Single 2-hour exposure to GSM-1800 or UMTS (Cresyl violet staining).
Mean ± SEM and sample (n) for the amount of "dark" neurons as identified using cresyl violet in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different times after exposure. The brain regions where statistically significant differences were observed are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the SAR value. Statistical analysis was performed using Kruskall-Wallis test between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant (*).
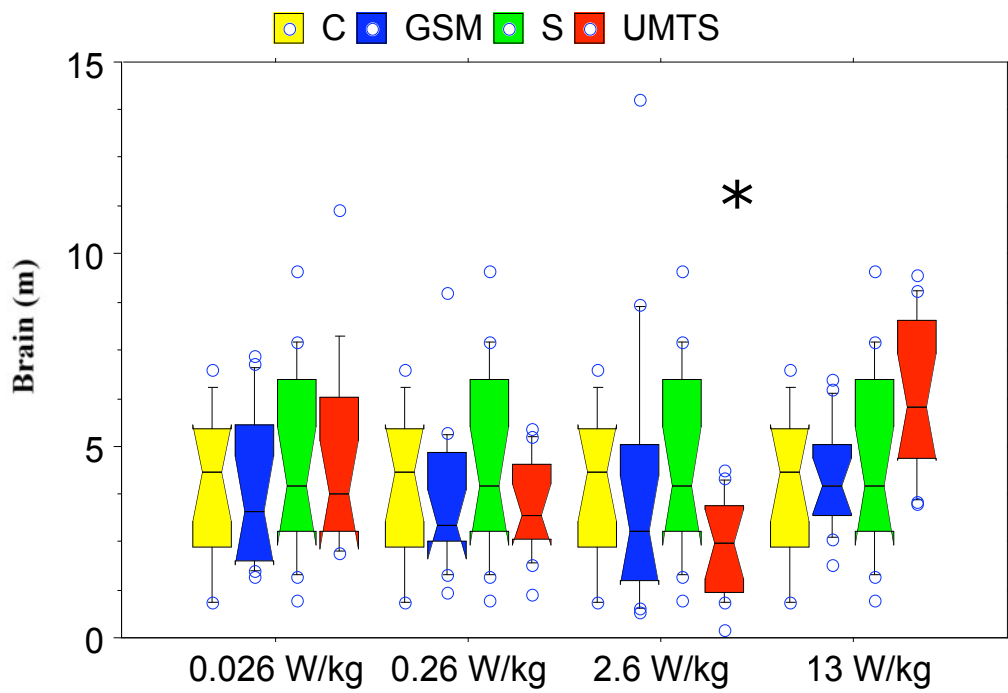
Figure 13 : Single 2-hour exposure to GSM-1800 or UMTS. In-box graphs of the mean brain amount of "dark" neurons as identified using cresyl violet in cage-control, sham-exposed and GSM-1800 or UMTS exposed rats immediately after exposure. $*$ $p < 0.05$ GSM-1800 or UMTS versus sham-exposed rats.
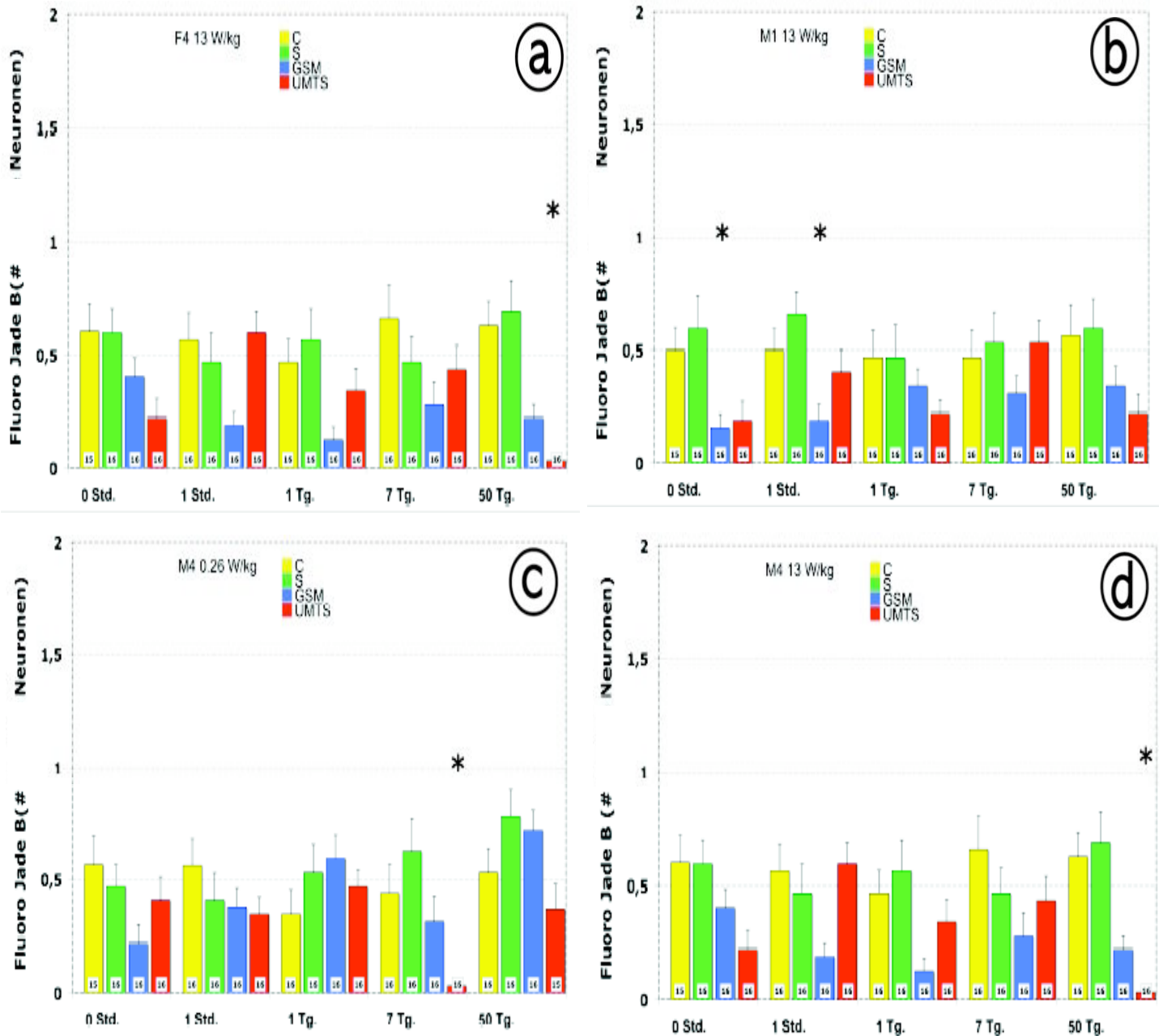
Figure 14 : **Single 2-hour exposure to GSM-1800 or UMTS (Fluoro Jade B staining).**
Mean ± SEM and sample (n) for the amount of degenerating neurons as identified using Fluoro Jade B in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different times after exposure. The brain regions where statistically significant differences were observed are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the SAR value. Statistical analysis was performed using Kruskall-Wallis test between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain region and time after exposure. A p value < 0.05 was considered as significant (*).
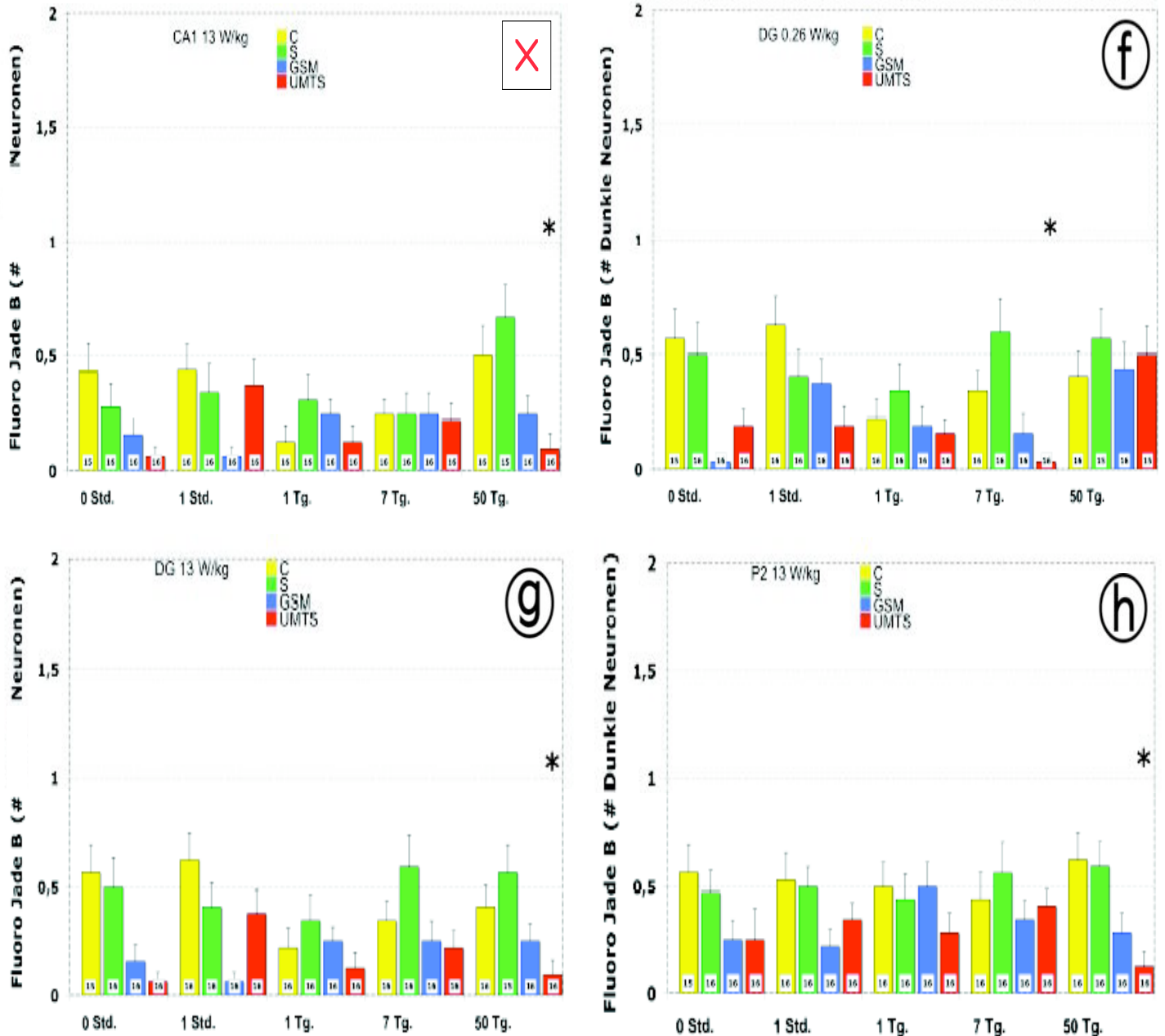
Figure 14 bis : **Single 2-hour exposure to GSM-1800 or UMTS (Fluoro Jade B staining).** Mean ± SEM and sample (n) for the amount of degenerating neurons as identified using Fluoro Jade B in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different times after exposure. The brain regions where statistically significant differences were observed are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the SAR value. Statistical analysis was performed using Kruskall-Wallis test between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain region and time after exposure. A p value < 0.05 was considered as significant
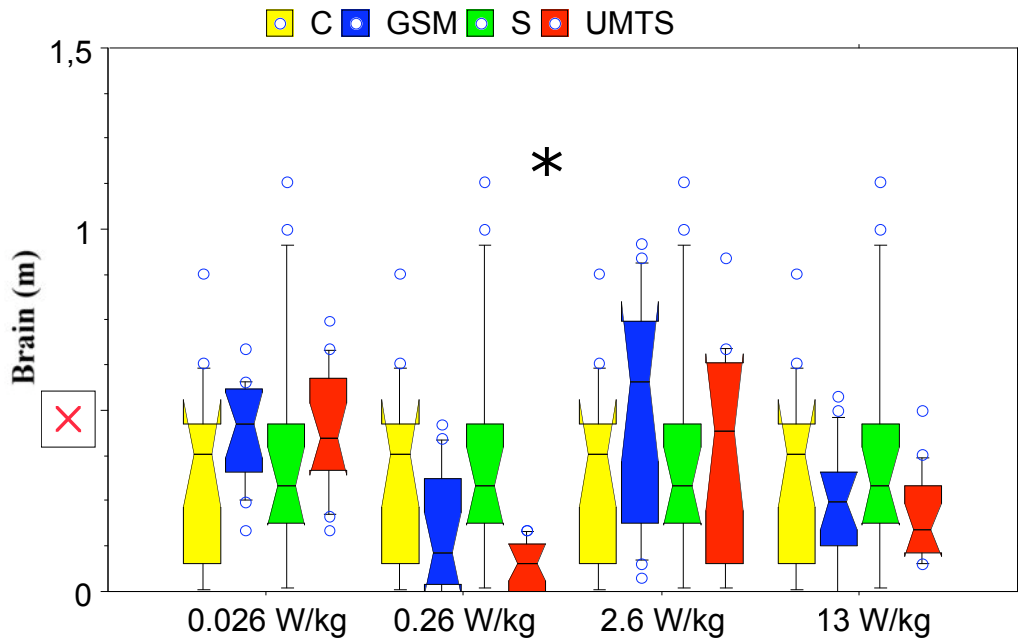
Figure 15 : Single 2-hour exposure to GSM-1800 or UMTS. In-box graphs of the mean brain amount of degenerating neurons as identified using Fluoro Jade B in cage-control, sham-exposed and GSM-1800 or UMTS exposed rats 7 days after exposure. * p<0.05 GSM-1800 or UMTS versus sham-exposed rats.
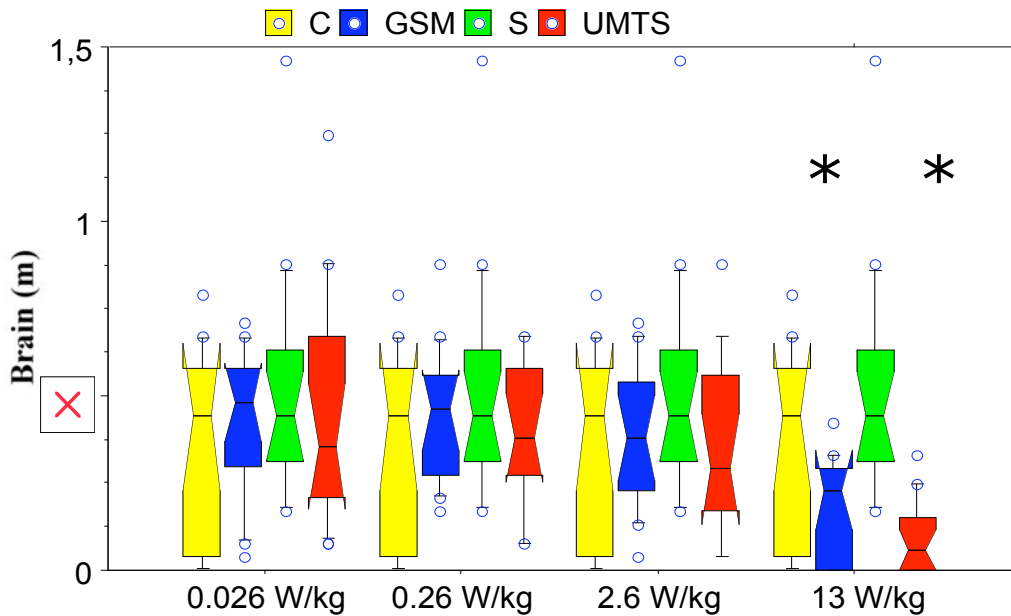
Figure 16: Single 2-hour exposure to GSM-1800 or UMTS. In-box graphs of the mean brain amount of degenerating neurons as identified using Fluoro Jade B in cage-control, sham-exposed and GSM-1800 or UMTS exposed rats 50 days after exposure. * p<0.05 GSM-1800 or UMTS versus sham-exposed rats.
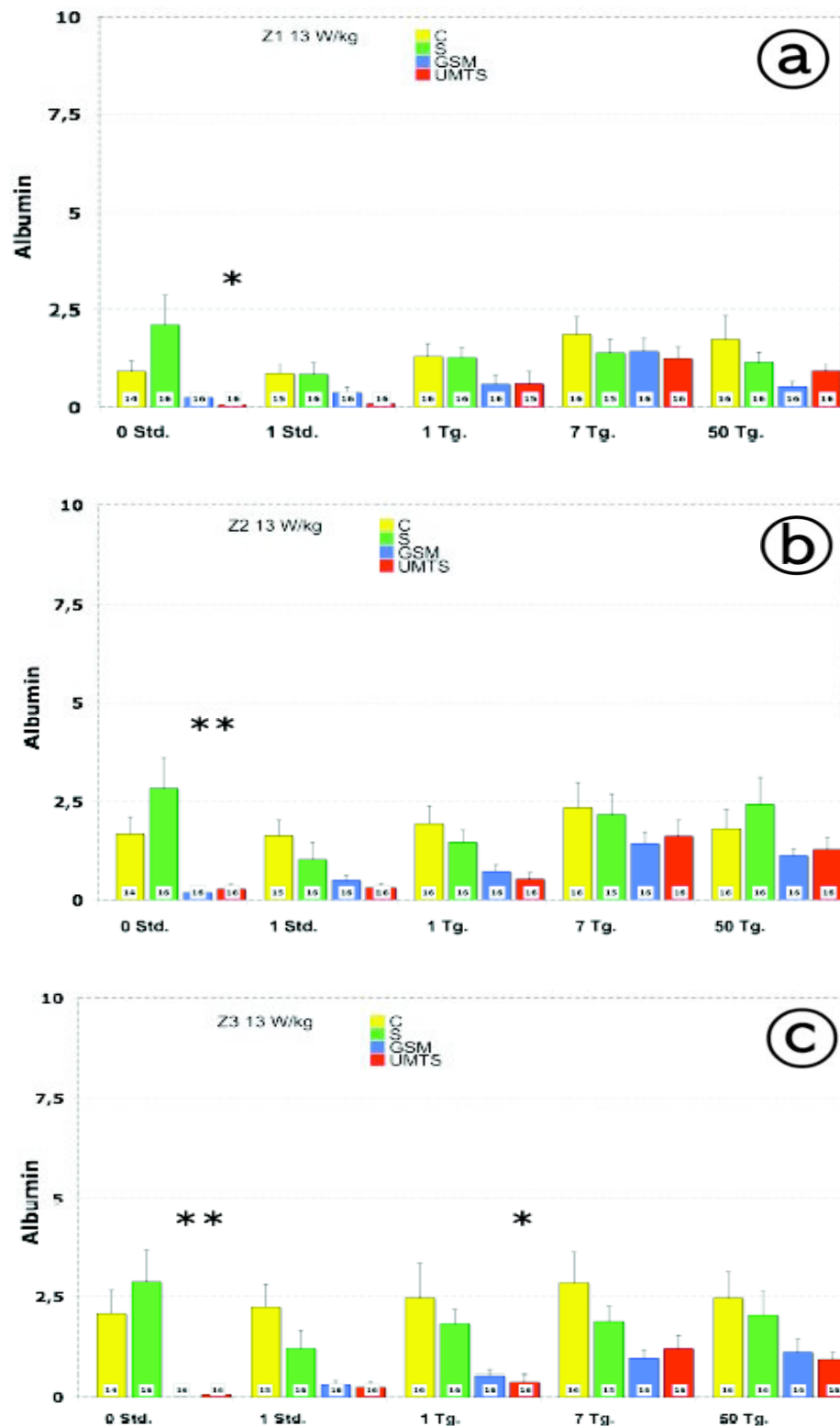
Figure 17: **Single 2-hour exposure to GSM-1800 or UMTS (Albumin leakage).**
Mean ± SEM and sample (n) for the amount of endogenous albumin leakage in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different times after exposure. The brain zones where statistically significant differences were observed are indicated (Z1, Z2, Z3) as well as the SAR value. Statistical analysis was performed using Kruskall-Wallis test between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant (*).
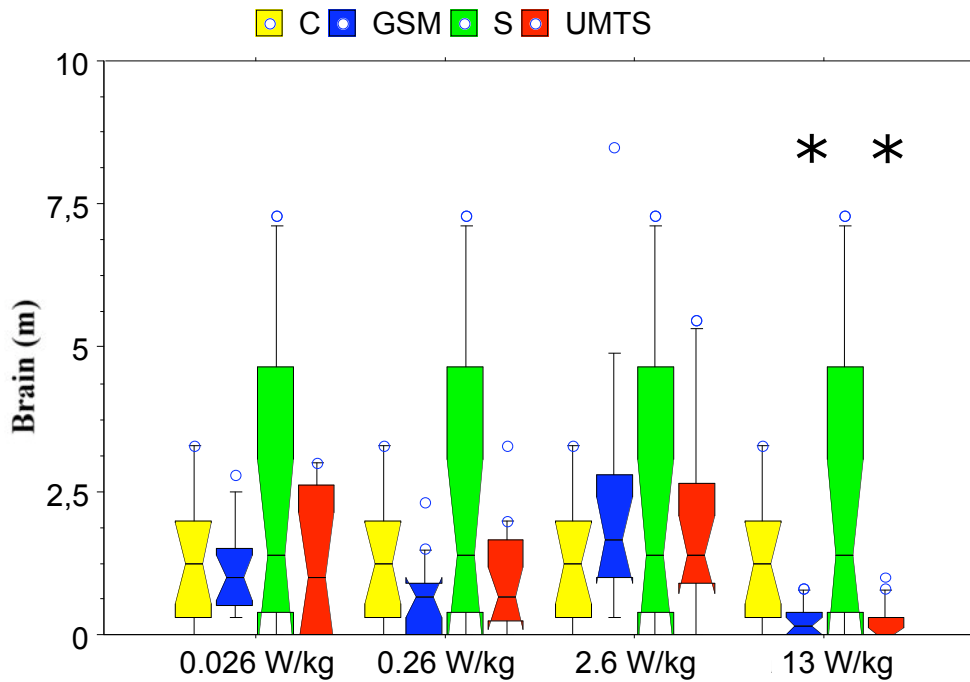
Figure 18 : Single exposure to GSM-1800 or UMTS. In-box graph of the mean brain amount of endogenous albumin leakage in cage-control, sham-exposed and GSM-1800 or UMTS exposed rats immediately after exposure. * p<0.05 GSM-1800 or UMTS versus sham-exposed rats.
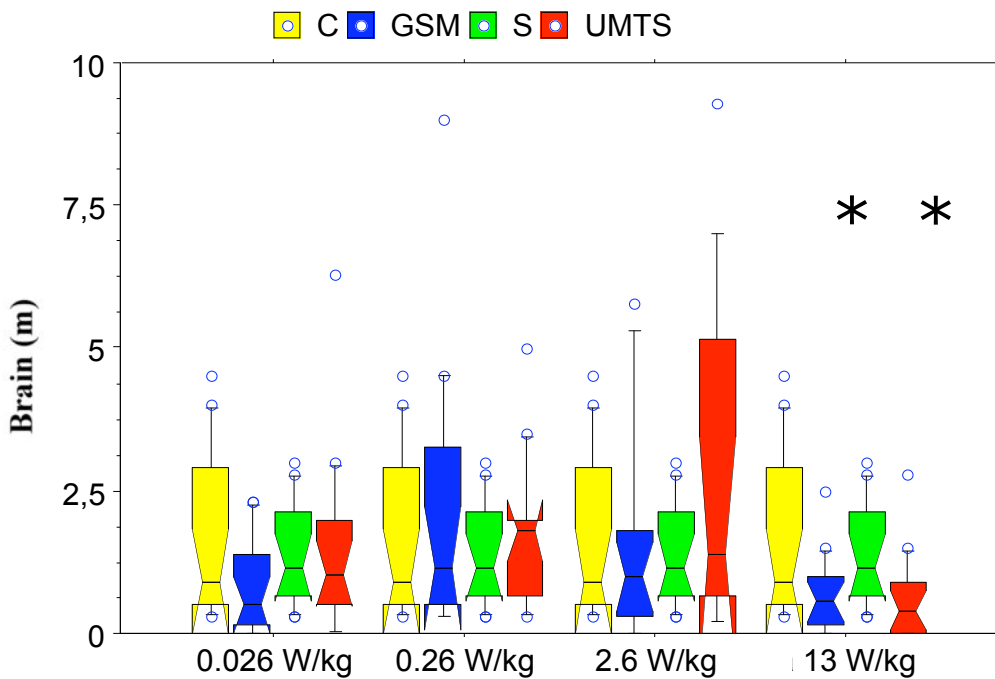
Figure 19 : Single exposure to GSM-1800 or UMTS. In-box graph of the mean brain amount of endogenous albumin leakage in cage-control, sham-exposed and GSM-1800 or UMTS exposed rats, one day after exposure. * p<0.05 GSM-1800 or UMTS versus sham-exposed rats.
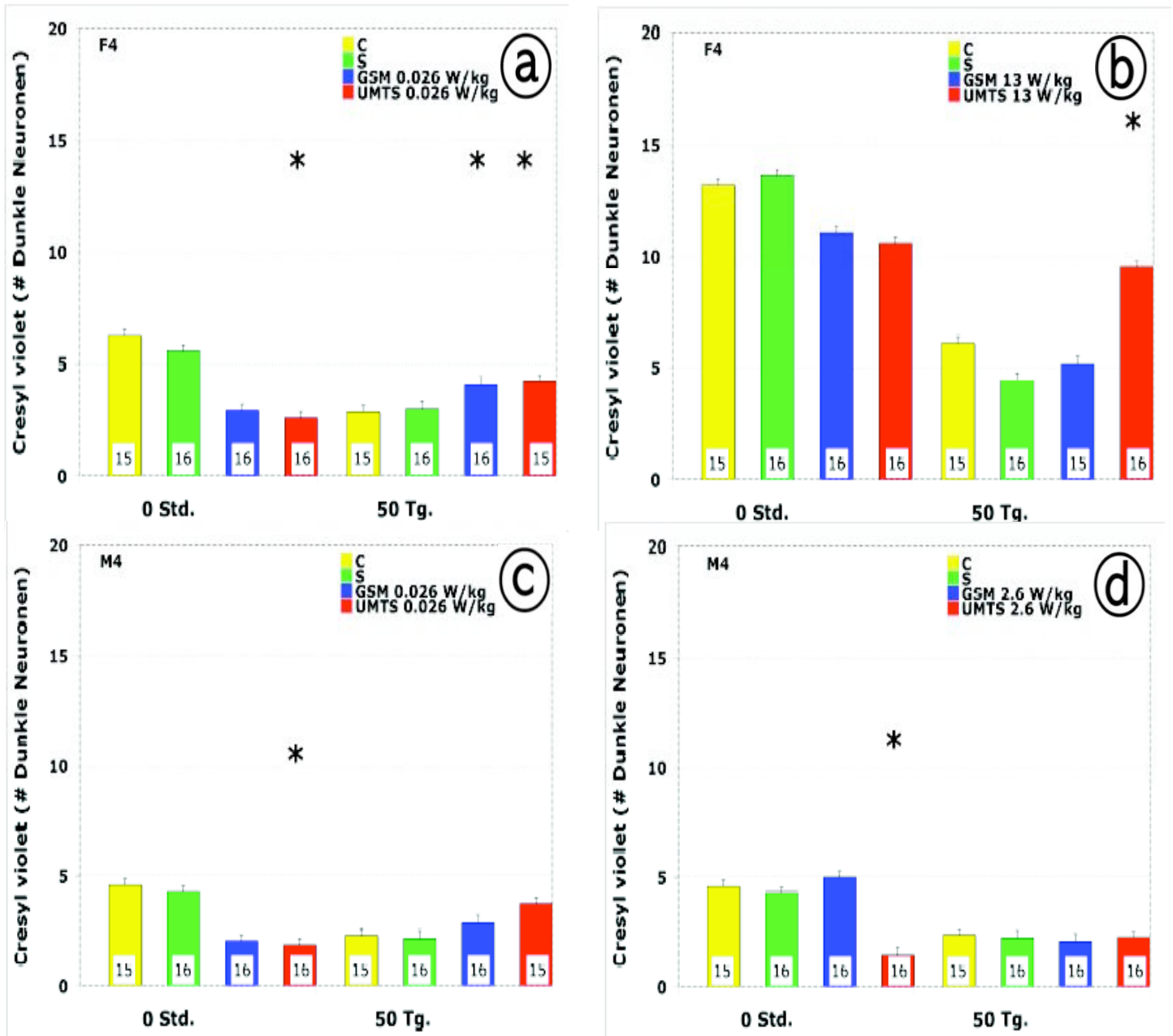
Figure 20 : **Repeated exposure to GSM-1800 or UMTS (Cresyl violet staining).**
Mean ± SEM and sample (n) for the amount of "dark" neurons as identified using cresyl violet in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different times after exposure. The statistically significant different brain regions observed are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the SAR value.. Statistical analysis was performed using Kruskall-Wallis test between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant (*).
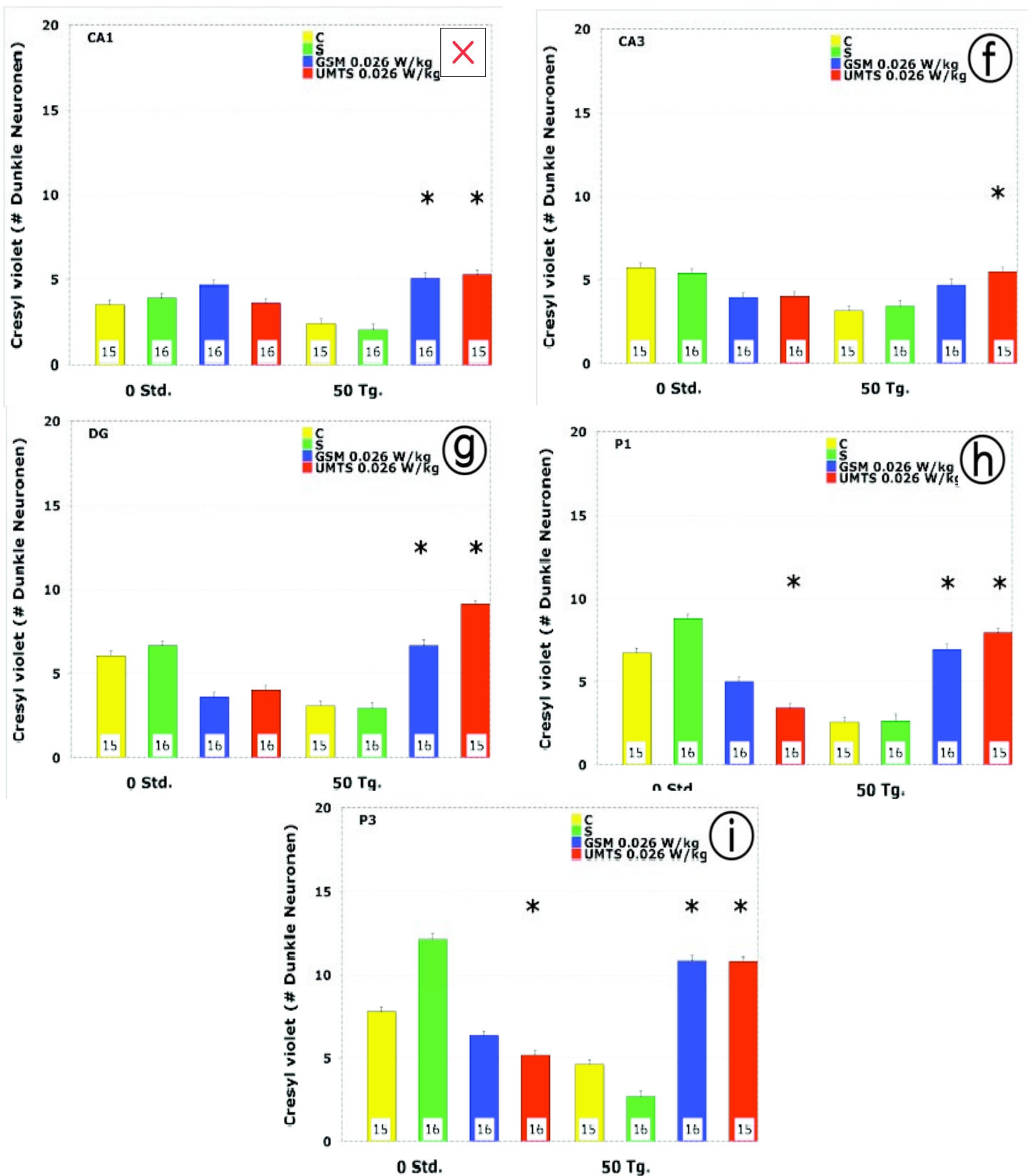
Figure 20 bis : **Repeated exposure to GSM-1800 or UMTS (Cresyl violet staining).**
Mean ± SEM and sample (n) for the amount of "dark" neurons as identified using Cresyl violet in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different times after exposure. The statistically significant different brain regions observed are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the SAR value. Statistical analysis was performed using Kruskall-Wallis test between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant
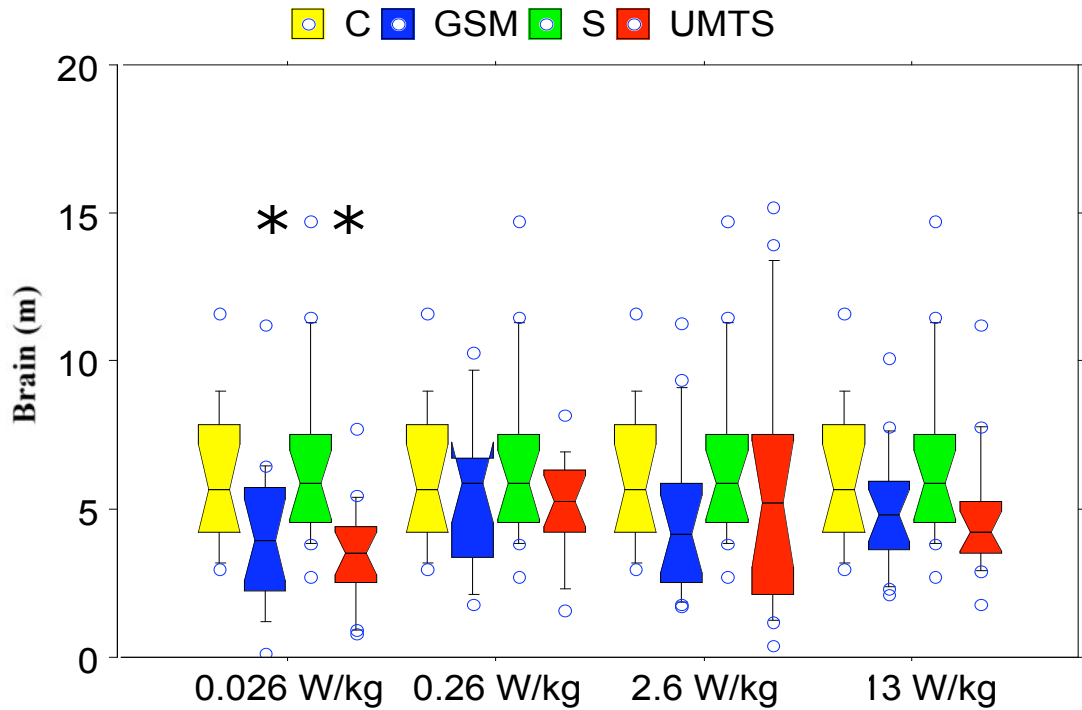
Figure 21: Repeated exposure to GSM-1800 or UMTS. In-box graph of the mean brain amount of "dark" neurons as identified using Cresyl violet in cage-control, sham-exposed and to GSM-1800 or UMTS exposed rats, immediately after exposure. * p<0.05 to GSM-1800 or UMTS versus sham-exposed rats
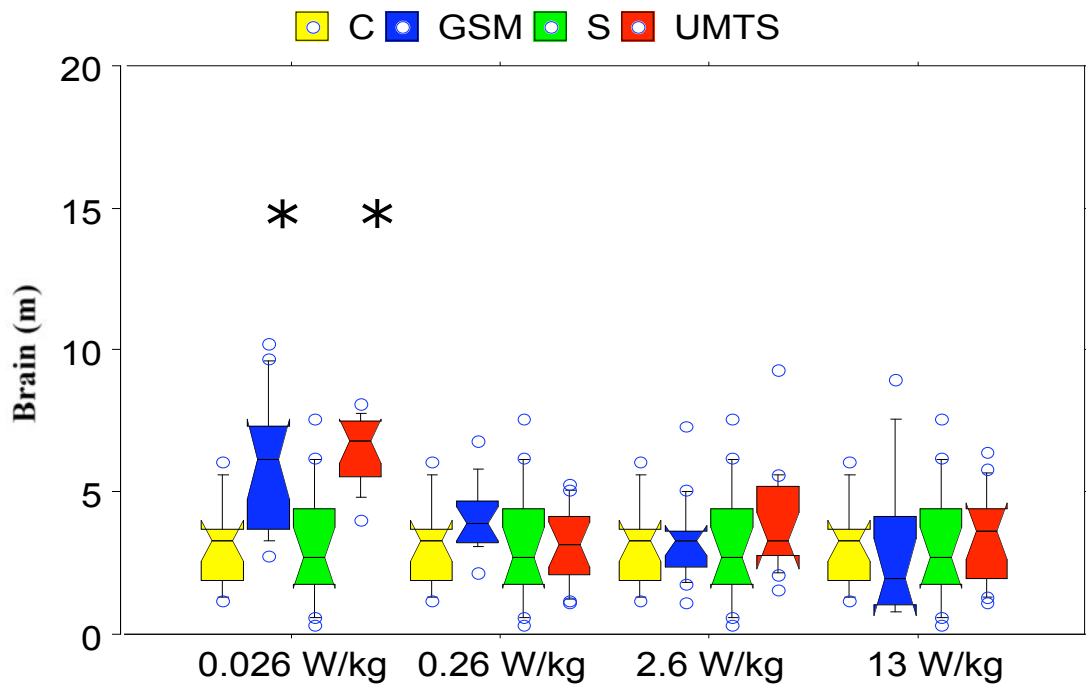
Figure 22 : Repeated exposure to GSM-1800 or UMTS. In-box graph of the mean brain amount of "dark" neurons as identified using Cresyl violet in cage-control, sham-exposed and to GSM-1800 or UMTS exposed rats, fifty days after exposure. * p<0.05 to GSM-1800 or UMTS versus sham-exposed rats.
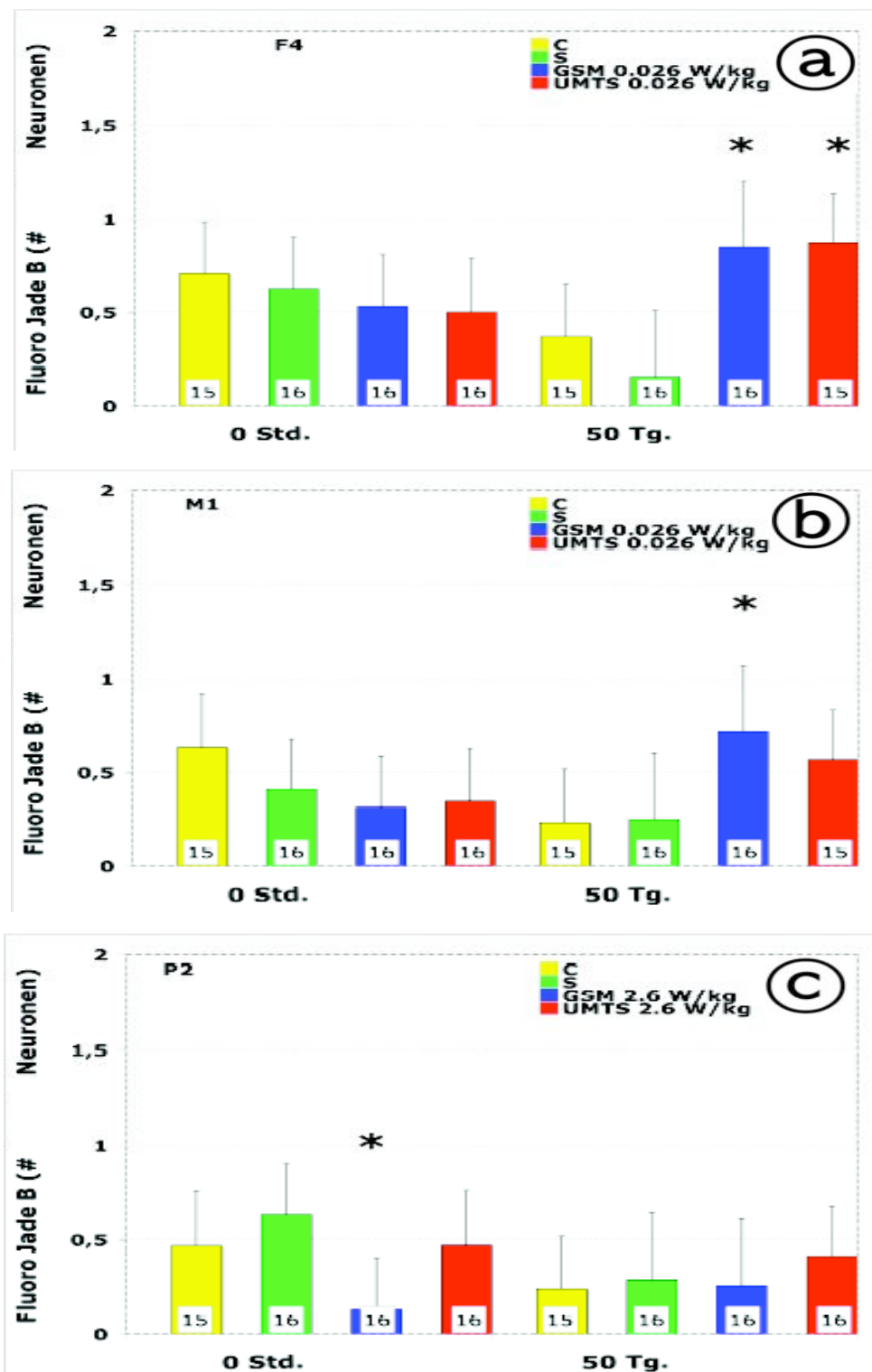
Figure 23: **Repeated exposure to GSM-1800 or UMTS (Fluoro Jade B staining).**
Mean ± SEM and sample (n) for the amount of degenerating neurons as identified using Fluoro Jade B in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different times after exposure. The statistically significant different brain regions observed are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the SAR value. Statistical analysis was performed using Kruskall-Wallis test between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant (*).
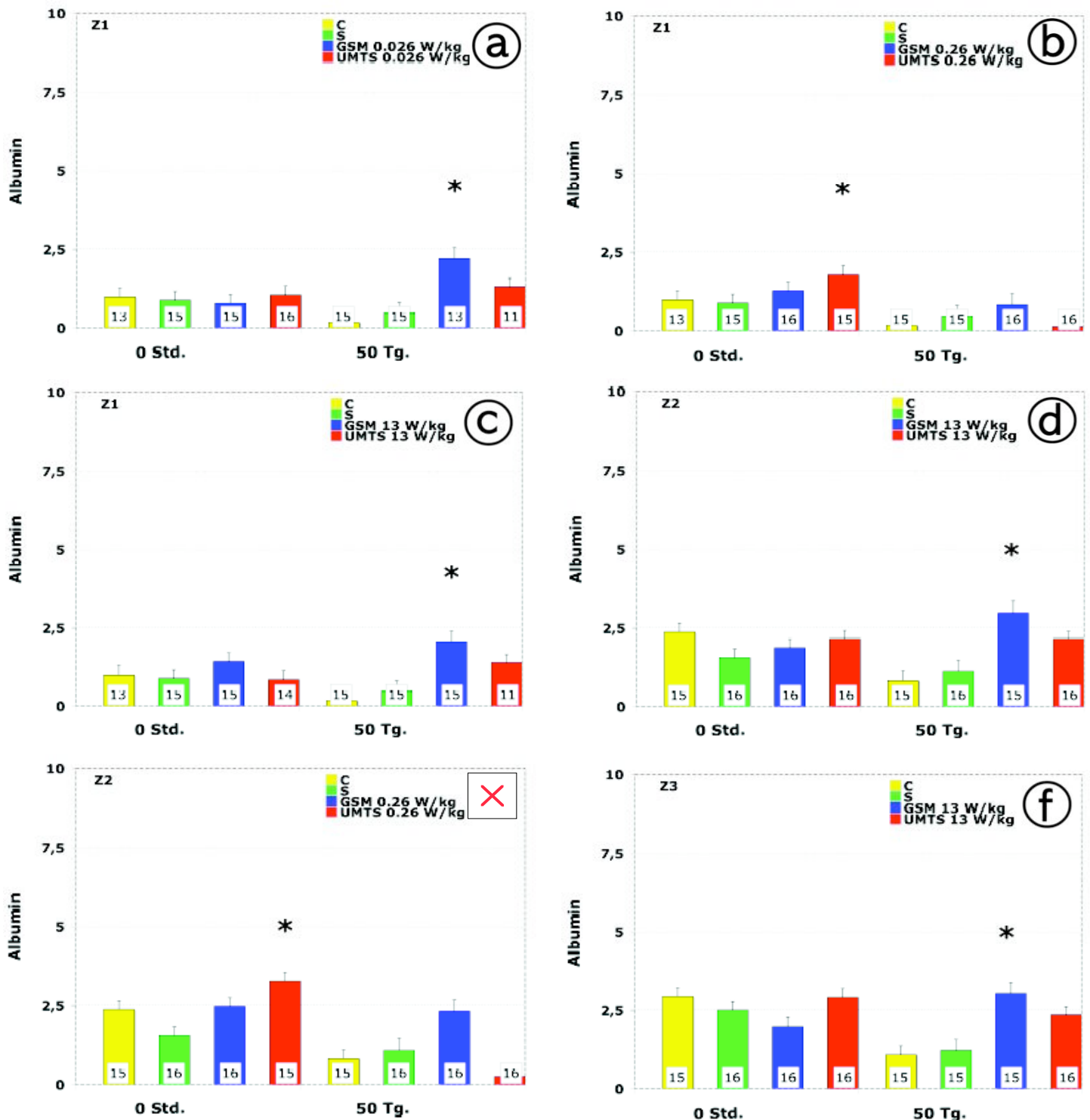
Figure 24 : **Repeated exposure to GSM-1800 or UMTS (Albumin leakage).**
Mean ± SEM and sample (n) for the amount of endogenous albumin leakage in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different times after exposure. The statistically significant different brain zones observed are indicated (Z1, Z2, Z3) as well as the BASAR value. Statistical analysis was performed using Kruskall-Wallis test between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant (*).
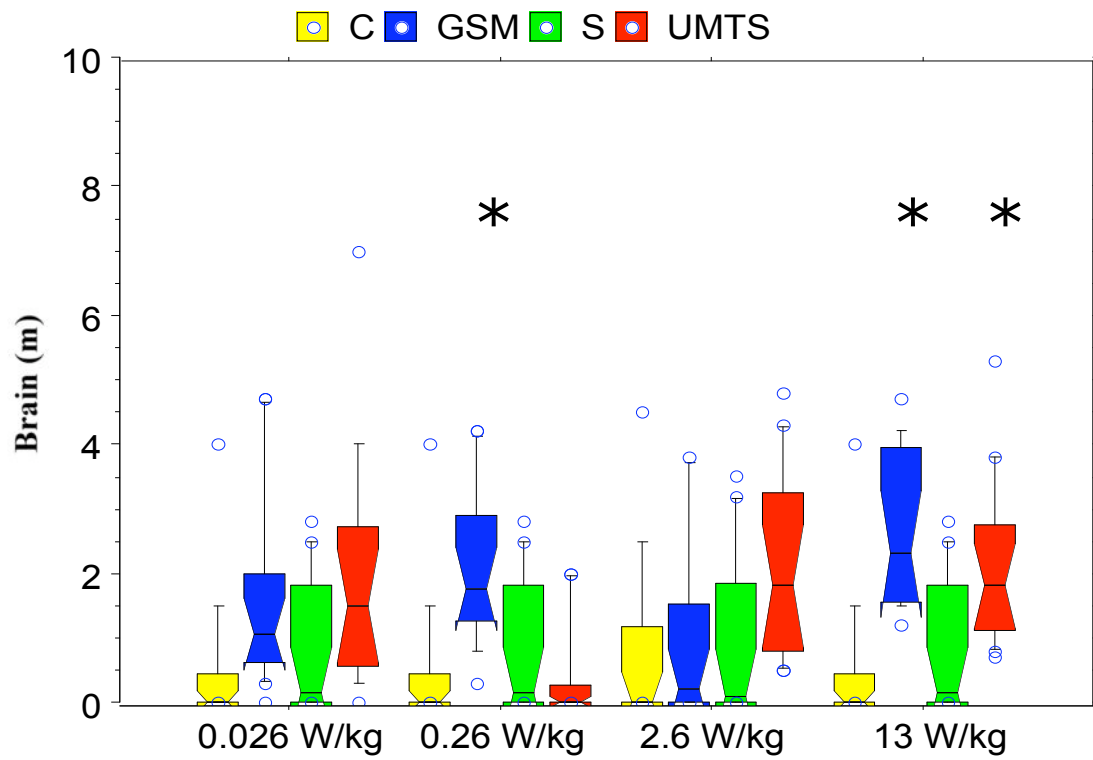
Figure 25 : Repeated exposures to GSM-1800 or UMTS. In-box graph of the mean brain amount of endogenous albumin leakage in cage-control, sham-exposed and GSM-1800 or UMTS exposed rats, fifty days after exposure. * $p < 0.05$ GSM-1800 or UMTS versus sham-exposed rats.

Annex 2 : Tables

Table1: **Single 2-hour exposure to GSM-1800 or UMTS.**
Mean ± SEM and sample (n) for the amount of "dark" neurons as identified using Cresyl violet in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels immediately (0 hr) after exposure. The different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain averaged value (brain)

		Single exp.-Cresyl Violet (0 hour)									
	SAR	0 W/kg		0.026 W/kg		0.26 W/kg		2.6 W/kg		13 W/kg	
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	3,39	3,88	1,77	2,85	2,63	2,31	1,58	1,87	3,33	7,10
	sem	0,71	0,79	0,62	0,63	0,49	0,52	0,44	0,32	0,39	1,02
	n	15	16	16	15	16	16	16	16	16	16
F4	m	6,63	7,96	6,99	8,05	7,78	6,22	5,15	3,39	10,79	13,12
	sem	1,56	1,49	1,60	2,36	1,76	0,80	1,36	0,94	1,21	1,32
	n	15	16	16	15	16	16	16	16	16	16
M1	m	3,58	3,27	3,06	2,62	3,59	3,22	3,73	1,81	2,64	5,15
	sem	1,52	0,86	0,71	0,65	0,65	0,65	1,61	0,39	0,60	1,09
	n	15	16	16	15	16	16	16	16	16	16
M3	m	1,57	2,42	0,60	1,61	1,97	1,41	3,56	0,85	1,54	1,59
	sem	0,39	0,93	0,25	0,58	0,39	0,39	1,62	0,28	0,35	0,21
	n	15	16	16	15	16	16	16	16	16	16
M4	m	3,13	3,35	2,93	2,85	1,59	1,94	3,90	1,98	1,97	3,72
	sem	0,98	0,70	0,64	0,67	0,34	0,49	0,85	0,73	0,38	0,65
	n	15	16	16	15	16	16	16	16	16	16
CA1	m	2,97	3,29	2,37	3,04	2,47	3,13	3,22	1,58	3,28	4,87
	sem	0,66	0,72	0,48	1,06	0,64	0,47	1,17	0,50	0,53	0,63
	n	15	16	16	15	16	16	16	16	16	16
CA2	m	2,48	4,14	3,49	4,28	2,06	2,03	2,09	1,41	2,61	5,07
	sem	0,52	0,89	0,71	1,01	0,42	0,42	0,73	0,39	0,38	0,72
	n	15	16	16	15	16	16	16	16	16	16
CA3	m	4,40	4,72	3,49	4,60	2,28	3,09	3,11	1,87	3,49	6,28
	sem	0,70	0,53	0,64	1,10	0,42	0,43	0,79	0,41	0,47	0,50
	n	15	16	16	15	16	16	16	16	16	16
DG	m	3,61	6,25	5,99	6,35	3,69	2,66	4,07	4,58	3,41	4,95
	sem	0,80	1,15	2,09	1,29	0,55	0,47	1,45	1,22	0,50	0,58
	n	15	16	16	15	16	16	16	16	16	16
P1	m	4,63	4,69	5,39	6,07	4,66	4,63	2,04	0,96	5,69	8,17
	sem	1,13	1,20	1,20	1,38	0,87	1,16	0,52	0,31	1,15	1,02
	n	15	16	16	15	16	16	16	16	16	16
P2	m	3,45	5,22	5,82	7,31	4,31	3,91	8,60	5,37	4,13	5,82
	sem	0,77	1,08	0,74	0,94	0,93	0,67	3,04	1,15	0,79	1,32
	n	15	16	16	15	16	16	16	16	16	16
P3	m	6,56	5,61	4,40	6,30	6,06	5,97	5,83	2,26	6,79	10,22
	sem	1,39	0,91	1,14	1,31	1,16	0,78	2,91	0,82	0,85	1,27
	n	15	16	16	15	16	16	16	16	16	16
Brain (m)	m	3,87	4,57	3,86	4,66	3,59	3,38	3,91	2,33	4,14	6,34
	sem	0,53	0,61	0,50	0,66	0,48	0,32	0,92	0,33	0,33	0,50
	n	15	16	16	15	16	16	16	16	16	16

Table 2: **Single 2-hour exposure to GSM-1800 or UMTS.**
Mean ± SEM and sample (n) for the amount of "dark" neurons as identified using Cresyl violet in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels, 1 hour after exposure. The different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain averaged value (brain)

		Single exp.-Cresyl Violet (1 hour)									
	SAR	0 W/kg		0.026 W/kg		0.26 W/kg		2.6 W/kg		13 W/kg	
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	3,24	3,23	2,11	2,07	5,44	5,81	2,17	2,77	3,31	3,02
	sem	0,69	0,75	1,02	0,59	0,87	0,89	0,74	0,91	0,42	0,45
	n	16	16	16	16	16	16	15	16	16	16
F4	m	6,61	7,51	6,21	4,27	12,94	12,63	1,87	2,21	8,64	9,71
	sem	1,46	1,26	1,61	0,85	0,80	1,85	0,78	0,48	1,00	1,22
	n	16	16	16	16	16	16	15	16	16	16
M1	m	3,46	2,90	2,98	2,46	3,78	4,78	1,33	1,70	4,43	2,38
	sem	1,42	1,04	1,05	0,52	0,53	0,61	0,51	0,60	0,72	0,26
	n	16	16	16	16	16	16	15	16	16	16
M3	m	1,47	1,35	1,51	0,91	2,25	2,22	1,03	1,87	1,51	1,10
	sem	0,38	0,41	0,57	0,43	0,36	0,19	0,73	0,58	0,25	0,28
	n	16	16	16	16	16	16	15	16	16	16
M4	m	3,22	2,65	2,07	1,85	2,88	3,53	1,03	3,96	2,26	2,49
	sem	0,92	0,56	0,46	0,59	0,60	0,42	0,40	1,05	0,46	0,38
	n	16	16	16	16	16	16	15	16	16	16
CA1	m	2,84	3,33	2,72	2,37	4,97	5,53	1,09	2,83	3,41	3,14
	sem	0,63	0,80	0,72	0,63	0,86	0,45	0,36	1,33	0,40	0,30
	n	16	16	16	16	16	16	15	16	16	15
CA2	m	2,39	3,42	3,88	3,28	3,75	4,47	1,21	2,66	3,84	2,92
	sem	0,49	0,79	0,54	0,82	0,64	0,60	0,43	0,77	0,58	0,45
	n	16	16	16	16	16	16	15	16	16	15
CA3	m	4,46	4,39	3,28	3,67	5,47	5,72	1,33	2,60	4,02	3,72
	sem	0,65	0,85	0,60	0,72	0,72	0,67	0,36	0,83	0,44	0,36
	n	16	16	16	16	16	16	15	16	16	15
DG	m	3,50	4,76	3,97	3,97	4,81	5,69	5,19	4,36	4,69	4,48
	sem	0,76	1,01	0,65	0,84	0,70	0,61	1,86	1,29	0,77	0,96
	n	16	16	16	16	16	16	15	16	16	15
P1	m	4,34	4,14	2,42	2,50	8,59	10,19	1,39	3,17	6,56	5,95
	sem	1,09	1,17	0,71	0,77	1,81	1,73	0,79	1,19	1,19	0,85
	n	16	16	16	16	16	16	15	16	16	16
P2	m	3,23	4,38	4,18	4,74	6,00	8,19	3,56	4,81	3,87	4,51
	sem	0,75	1,06	1,01	0,89	1,23	1,09	1,07	1,30	0,40	0,92
	n	16	16	16	16	16	16	15	16	16	16
P3	m	5,63	4,62	4,79	4,10	9,31	11,63	0,54	2,94	8,99	8,07
	sem	1,15	0,97	1,03	1,05	1,46	1,81	0,29	1,10	1,31	1,01
	n	15	16	16	16	16	16	15	16	16	16
Brain (m)	m	3,70	3,89	3,34	3,02	5,85	6,70	1,81	2,99	4,63	4,29
	sem	0,48	0,50	0,45	0,45	0,60	0,55	0,41	0,66	0,37	0,35
	n	16	16	16	16	16	16	15	16	16	16

Table 3: **Single 2-hour exposure to GSM-1800 or UMTS.**
Mean ± SEM and sample (n) for the amount of "dark" neurons as identified using Cresyl violet in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels, 1 day after exposure. The different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain averaged value (brain)

	Single exp.-Cresyl Violet (1 day)									
SAR	0 W/kg		0.026 W/kg		0.26 W/kg		2.6 W/kg		13 W/kg	
	C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1 m	3,10	4,38	1,64	1,85	4,13	4,47	3,05	3,14	3,51	3,31
sem	0,70	1,13	0,36	0,52	0,64	1,05	0,98	0,88	0,54	0,63
n	16	16	16	16	16	16	16	15	16	16
F4 m	5,44	8,91	3,84	2,89	7,63	8,84	5,83	4,22	9,20	7,94
sem	1,28	1,59	1,09	0,95	1,15	1,74	1,64	1,20	1,26	1,12
n	16	16	16	16	16	16	16	15	16	16
M1 m	3,09	3,86	1,25	1,64	4,41	3,72	2,60	3,02	4,95	3,28
sem	1,13	0,85	0,49	0,46	1,44	0,73	0,72	0,85	0,91	0,72
n	16	16	16	16	16	16	16	15	16	16
M3 m	3,11	1,61	1,12	0,73	2,22	1,88	2,32	1,39	1,41	1,97
sem	0,95	0,56	0,39	0,25	0,78	0,45	1,14	0,64	0,29	0,67
n	16	16	16	16	16	16	16	15	16	16
M4 m	4,41	3,57	1,94	1,94	2,22	2,25	5,15	2,96	3,87	2,67
sem	1,19	1,21	0,48	0,37	0,47	0,49	1,98	1,32	1,19	0,63
n	16	16	16	16	16	16	16	15	16	16
CA1 m	2,52	3,03	1,47	1,85	3,28	3,84	2,15	1,45	5,25	4,20
sem	0,49	0,67	0,34	0,53	1,06	0,78	0,62	0,51	0,77	1,40
n	16	16	16	16	16	16	16	15	16	16
CA2 m	2,74	2,86	3,58	2,42	2,53	2,28	2,26	2,11	4,28	2,69
sem	0,75	0,78	0,75	0,52	0,49	0,60	0,80	0,97	0,83	0,51
n	16	16	16	16	16	16	16	15	16	16
CA3 m	2,71	3,80	2,50	2,59	3,81	4,28	2,88	2,29	5,25	4,61
sem	0,54	0,72	0,58	0,38	0,89	0,76	0,48	0,58	0,64	0,63
n	16	16	16	16	16	16	16	15	16	16
DG m	3,11	4,53	4,31	3,49	2,97	4,56	4,81	5,55	2,92	3,66
sem	0,64	1,72	1,19	0,68	0,53	0,75	1,17	1,81	0,45	0,82
n	16	16	16	16	16	16	16	15	16	16
P1 m	4,25	5,82	3,67	2,93	5,66	7,31	2,60	2,05	5,15	5,43
sem	0,90	1,07	0,77	0,96	0,84	1,20	1,04	0,97	1,09	1,05
n	16	16	16	16	16	16	16	15	16	16
P2 m	4,55	5,87	4,23	4,27	5,38	4,72	6,05	6,21	5,23	5,25
sem	0,61	1,27	0,98	1,47	1,24	1,24	1,76	1,29	1,03	0,65
n	16	16	16	16	16	16	16	15	16	16
P3 m	4,89	7,97	3,28	2,03	7,25	8,91	1,98	5,07	9,61	7,41
sem	1,14	1,31	0,55	0,72	1,30	1,80	0,52	0,97	1,57	1,12
n	16	16	16	16	16	16	16	15	16	16
Brain (m) m	3,66	4,68	2,73	2,39	4,29	4,76	3,47	3,29	5,05	4,37
sem	0,54	0,74	0,30	0,36	0,70	0,75	0,73	0,54	0,63	0,52
n	16	16	16	16	16	16	16	15	16	16

Table 4: **Single 2-hour exposure to GSM-1800 or UMTS.**
Mean ± SEM and sample (n) for the amount of "dark" neurons as identified using
Cresyl violet in cage-control, sham-exposed and GSM-1800- or UMTS exposed
rats at different SAR levels, 7 days after exposure. The different brain regions
tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as
well as the brain averaged value (brain)

		Single exp.-Cresyl Violet (7 days)									
	SAR	0 W/kg		0.026 W/kg		0.26 W/kg		2.6 W/kg		13 W/kg	
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	5,28	4,84	5,82	3,84	3,81	3,63	3,85	5,54	4,36	3,59
	sem	0,96	0,77	1,41	1,21	0,64	0,71	0,88	1,97	0,56	0,47
	n	16	16	16	16	16	16	16	16	16	16
F4	m	9,37	8,85	7,37	5,99	12,69	10,00	8,26	7,24	15,79	14,53
	sem	1,66	1,38	1,52	1,43	1,82	1,91	1,73	1,33	1,05	1,34
	n	16	16	16	16	16	16	16	16	16	16
M1	m	6,58	4,91	6,43	3,32	5,09	4,72	4,53	6,39	3,59	3,97
	sem	1,29	1,00	1,81	1,20	0,65	0,70	0,70	1,80	0,75	0,51
	n	16	16	16	16	16	16	16	16	16	16
M3	m	3,17	2,95	1,98	1,47	2,50	2,50	1,64	2,72	2,00	2,20
	sem	0,67	0,65	0,44	0,54	0,49	0,44	0,62	1,00	0,35	0,24
	n	16	16	16	16	16	16	16	16	16	16
M4	m	4,19	4,85	3,84	3,15	3,41	2,84	3,79	7,47	5,13	4,25
	sem	1,15	1,32	0,87	0,98	0,74	0,54	0,84	2,05	0,77	0,54
	n	16	16	16	16	16	16	16	16	16	16
CA1	m	3,05	4,31	3,67	3,15	4,70	5,75	1,98	2,49	6,12	4,87
	sem	0,60	0,51	0,86	0,79	0,46	0,62	0,57	0,66	1,09	0,47
	n	16	16	16	16	15	16	16	16	16	16
CA2	m	3,39	4,51	5,05	3,97	3,33	3,84	2,66	3,17	3,31	3,95
	sem	0,68	0,89	0,77	0,79	0,56	0,76	0,72	0,91	0,33	0,43
	n	16	16	16	16	15	16	16	16	16	16
CA3	m	5,07	5,45	4,70	4,10	4,47	4,16	3,05	3,51	5,69	4,77
	sem	0,82	1,00	0,74	0,83	0,66	0,75	0,58	0,71	0,54	0,56
	n	16	16	16	16	15	16	16	16	16	16
DG	m	5,36	6,91	4,96	5,22	3,57	4,00	5,54	9,56	5,64	5,07
	sem	1,26	1,72	1,07	1,37	0,71	0,57	1,40	2,20	0,99	0,80
	n	16	16	16	16	15	16	16	16	16	16
P1	m	9,58	6,67	5,35	5,74	8,63	8,19	4,81	2,72	10,15	9,12
	sem	1,97	1,67	1,19	1,62	1,82	1,23	1,42	0,75	1,11	0,60
	n	16	16	16	16	16	16	16	16	16	16
P2	m	11,05	8,63	6,81	7,42	6,66	7,81	11,88	6,79	5,66	6,71
	sem	4,18	2,94	1,57	1,62	1,16	0,97	2,65	1,60	0,48	0,58
	n	16	16	16	16	16	16	16	16	16	16
P3	m	7,69	7,43	4,14	5,00	9,97	11,84	4,64	4,07	11,61	10,51
	sem	1,96	1,69	0,97	1,14	2,12	1,47	1,22	0,93	1,10	0,95
	n	16	16	16	16	16	16	16	16	16	16
Brain (m)	m	6,15	5,86	5,01	4,36	5,69	5,77	4,72	5,14	6,59	6,13
	sem	1,01	0,77	0,81	0,76	0,59	0,57	0,72	0,86	0,49	0,21
	n	16	16	16	16	16	16	16	16	16	16

Table 5: **Single 2-hour exposure to GSM-1800 or UMTS.**
Mean ± SEM and sample (n) for the amount of "dark" neurons as identified using Cresyl violet in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels, 50 days after exposure. The different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain averaged value (brain)

| | | Single exp.-Cresyl Violet (50 days) |
| | SAR | \multicolumn{2}{c}{0 W/kg} | \multicolumn{2}{c}{0.026 W/kg} | \multicolumn{2}{c}{0.26 W/kg} | \multicolumn{2}{c}{2.6 W/kg} | \multicolumn{2}{c}{13 W/kg} |
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	3,615	4,347	2,5013	2,415	3,156	3,133	4,242	2,232	4,356	2,742
	sem	0,706	1,03	0,5558	0,5738	0,42	0,451	1,179	0,598	0,847	0,439
	n	16	16	16	16	16	15	16	15	16	16
F4	m	9,133	6,487	6,3825	5,175	9,281	10,43	4,808	4,344	8,482	8,508
	sem	1,742	1,478	1,1434	1,17	1,077	0,851	1,011	0,914	1,292	1,37
	n	16	16	16	16	16	15	16	15	16	16
M1	m	2,893	2,615	2,7169	2,2425	3,219	3,6	5,656	5,008	3,639	3,716
	sem	0,773	0,46	0,7752	0,647	0,783	0,493	2,028	1,432	0,661	0,731
	n	16	16	16	16	16	15	16	15	16	16
M3	m	1,556	2,274	1,5956	1,725	1,969	1,667	1,98	1,146	1,358	1,743
	sem	0,393	0,742	0,3316	0,3673	0,417	0,427	0,574	0,541	0,239	0,399
	n	16	16	16	16	16	15	16	15	16	16
M4	m	3,01	3,14	2,93	2,72	4,00	4,00	5,66	3,02	1,77	2,51
	sem	0,59	1,09	0,67	0,45	0,81	1,02	2,86	0,80	0,28	0,49
	n	16	16	16	16	16	15	16	15	16	16
CA1	m	2,72	2,70	3,75	3,84	4,03	5,23	3,51	1,69	3,20	4,23
	sem	0,76	0,43	0,82	0,99	0,65	0,90	1,50	0,64	0,43	0,62
	n	16	16	16	16	16	15	16	15	15	16
CA2	m	2,21	2,49	5,30	4,57	2,25	2,63	2,55	1,99	2,62	3,84
	sem	0,48	0,59	0,86	0,77	0,52	0,63	0,59	0,59	0,39	0,59
	n	16	16	16	16	16	15	16	15	15	16
CA3	m	2,64	2,59	4,10	3,32	3,84	4,13	4,41	3,44	3,69	3,69
	sem	0,56	0,37	0,60	0,54	0,68	0,64	1,12	0,68	0,46	0,48
	n	16	16	16	16	16	15	16	15	15	16
DG	m	3,19	4,24	6,51	5,78	2,91	3,43	7,07	7,66	3,42	3,18
	sem	0,60	1,18	1,22	1,57	0,58	0,79	2,44	3,64	0,67	0,47
	n	16	16	16	16	16	15	16	15	15	16
P1	m	5,86	5,23	3,32	2,11	5,31	5,67	3,85	2,72	6,20	6,59
	sem	1,15	1,12	0,76	0,42	0,86	1,14	1,07	1,07	0,86	1,13
	n	16	16	16	16	16	15	16	15	16	16
P2	m	7,53	4,44	4,44	5,87	4,59	4,80	6,73	4,89	5,79	4,92
	sem	1,30	0,79	1,17	1,07	1,17	0,96	1,71	1,39	0,94	1,02
	n	16	16	16	16	16	15	16	15	16	16
P3	m	6,65	5,11	3,84	2,63	5,63	9,77	5,26	4,46	6,18	8,82
	sem	1,31	0,65	0,70	0,60	0,81	1,22	1,70	1,21	0,83	1,40
	n	16	16	16	16	16	15	16	15	16	16
Brain (m)	m	4,25	3,81	3,95	3,53	4,18	4,88	4,64	3,55	4,17	4,54
	sem	0,57	0,52	0,52	0,39	0,38	0,31	0,80	0,69	0,36	0,56
	n	16	16	16	16	16	15	16	15	16	16

Table 6: Single 2 hour exposure to GSM or UMTS.

Kruskall Wallis test on data on "dark" neurons as identified using Cresyl violet in cage-control, and GSM-1800- or UMTS exposed rats versus sham-exposed rats. Different SAR levels and different brain regions (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3 and brain averaged) were tested. For each parameter studied, statistical analysis was performed between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant. NS: non significant effect ; green box: significant decrease ; yellow box: significant increase.

[green box] Significant decrease (p<0.05)   [yellow box] Significant increase (p<0.05)

Cresyl violet-Single Exp. (Comparison versus sham)

Signal	SAR (W/kg)	Time	F1	F4	M1	M3	M4	CA1	CA2	CA3	DG	P1	P2	P3	Brain (m)
C	0	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C	0	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C	0	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C	0	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C	0	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,026	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,026	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,026	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,026	7d	ns	green	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,026	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,26	0h	ns	ns	ns	ns	ns	ns	ns	green	ns	ns	ns	ns	ns
GSM	0,26	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,26	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,26	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,26	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	2,6	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	2,6	1h	ns	green	ns	ns	ns	ns	ns	green	ns	ns	ns	green	ns
GSM	2,6	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	green	ns
GSM	2,6	7d	ns	ns	ns	ns	ns	green	ns	ns	ns	ns	ns	ns	ns
GSM	2,6	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,026	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,026	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,026	1d	ns	green	ns	ns	ns	ns	ns	ns	ns	ns	ns	green	ns
UMTS	0,026	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,026	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,26	0h	ns	ns	ns	ns	ns	ns	ns	ns	green	ns	ns	ns	ns
UMTS	0,26	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	yellow	ns	ns	ns
UMTS	0,26	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,26	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,26	50d	ns	yellow	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2,6	0h	ns	ns	ns	ns	ns	ns	green	ns	ns	ns	ns	ns	green
UMTS	2,6	1h	ns	green	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2,6	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	green	ns	ns	ns
UMTS	2,6	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2,6	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 7: **Single 2-hour exposure to GSM or UMTS.**
Mean ± SEM and sample (n) for the amount of degenerating neurons as identified
using Fluoro-Jade B in cage-control, sham-exposed and GSM-1800- or UMTS-
exposed rats at different SAR levels immediately (0 hr) after exposure. The
different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3,
DG, P1, P2, P3) as well as the brain averaged value (brain)

		Single exp. Fluoro Jade B (0 hour)									
	SAR	0 W/kg		0.026 W/kg		0.26 W/kg		2.6 W/kg		13 W/kg	
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	0,40	0,59	0,25	0,33	0,47	0,25	0,66	0,59	0,41	0,38
	sem	0,13	0,13	0,10	0,12	0,12	0,09	0,12	0,13	0,11	0,11
	n	15	16	16	15	16	16	16	16	16	16
F4	m	0,60	0,59	0,72	0,70	0,22	0,41	0,63	0,59	0,41	0,22
	sem	0,12	0,10	0,08	0,11	0,09	0,10	0,14	0,12	0,08	0,09
	n	15	16	16	15	16	16	16	16	16	16
M1	m	0,50	0,59	0,69	0,43	0,47	0,50	0,56	0,41	0,16	0,19
	sem	0,10	0,15	0,11	0,11	0,11	0,11	0,13	0,13	0,06	0,09
	n	15	16	16	15	16	16	16	16	16	16
M3	m	0,30	0,38	0,00	0,33	0,06	0,06	0,66	0,53	0,03	0,16
	sem	0,10	0,11	0,00	0,14	0,04	0,04	0,14	0,11	0,03	0,10
	n	15	16	16	15	16	16	16	16	16	16
M4	m	0,57	0,47	0,47	0,63	0,22	0,41	0,78	0,72	0,25	0,25
	sem	0,13	0,10	0,10	0,11	0,08	0,10	0,12	0,12	0,08	0,09
	n	15	16	16	15	16	16	16	16	16	16
CA1	m	0,43	0,28	0,28	0,17	0,03	0,19	0,47	0,53	0,16	0,06
	sem	0,12	0,10	0,08	0,08	0,03	0,08	0,12	0,11	0,08	0,04
	n	15	16	16	15	16	16	16	16	16	16
CA2	m	0,50	0,28	0,06	0,07	0,06	0,19	0,44	0,38	0,06	0,03
	sem	0,14	0,11	0,04	0,07	0,06	0,09	0,14	0,10	0,04	0,03
	n	15	16	16	15	16	16	16	16	16	16
CA3	m	0,33	0,28	0,06	0,03	0,06	0,03	0,50	0,47	0,03	0,00
	sem	0,12	0,12	0,04	0,03	0,04	0,03	0,12	0,09	0,03	0,00
	n	15	16	16	15	16	16	16	16	16	16
DG	m	0,57	0,50	0,47	0,33	0,16	0,16	0,88	0,63	0,13	0,09
	sem	0,13	0,14	0,11	0,11	0,08	0,08	0,14	0,11	0,07	0,05
	n	15	16	16	15	16	16	16	16	16	16
P1	m	0,20	0,22	0,31	0,20	0,03	0,00	0,28	0,19	0,03	0,00
	sem	0,11	0,06	0,08	0,08	0,03	0,00	0,11	0,10	0,03	0,00
	n	15	16	16	15	16	16	16	16	16	16
P2	m	0,57	0,47	0,75	0,53	0,56	0,44	0,63	0,44	0,25	0,25
	sem	0,13	0,11	0,09	0,08	0,11	0,12	0,11	0,13	0,09	0,14
	n	15	16	16	15	16	16	16	16	16	16
P3	m	0,30	0,19	0,34	0,27	0,06	0,13	0,22	0,13	0,00	0,00
	sem	0,11	0,06	0,09	0,08	0,04	0,07	0,09	0,07	0,00	0,00
	n	15	16	16	15	16	16	16	16	16	16
Brain (m)	m	0,44	0,40	0,37	0,34	0,20	0,23	0,56	0,47	0,16	0,14
	sem	0,09	0,06	0,03	0,04	0,03	0,05	0,09	0,07	0,04	0,04
	n	15	16	16	15	16	16	16	16	16	16

Table 8: **Single 2-hour exposure to GSM or UMTS.**
Mean ± SEM and sample (n) for the amount of degenerating neurons as identified using Fluoro-Jade B in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels, 1 hour after exposure. The different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain averaged value (brain)

		Single exp. Fluoro Jade B (1 hour)								
	SAR	0 W/kg		0.026 W/kg		0.26 W/kg		2.6 W/kg		13 W/kg	
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	0,41	0,47	0,34	0,34	0,44	0,47	0,53	0,50	0,34	0,56
	sem	0,12	0,12	0,11	0,10	0,10	0,13	0,10	0,09	0,11	0,10
	n	16	16	16	16	16	16	15	16	16	16
F4	m	0,56	0,47	0,75	0,66	0,53	0,47	0,57	0,53	0,19	0,59
	sem	0,12	0,12	0,08	0,08	0,11	0,10	0,14	0,12	0,06	0,09
	n	16	16	16	16	16	16	15	16	16	16
M1	m	0,50	0,66	0,53	0,66	0,59	0,44	0,47	0,44	0,19	0,41
	sem	0,09	0,10	0,11	0,10	0,11	0,12	0,09	0,11	0,08	0,09
	n	16	16	16	16	16	16	15	16	16	16
M3	m	0,28	0,22	0,16	0,13	0,19	0,31	0,20	0,38	0,16	0,19
	sem	0,09	0,09	0,08	0,07	0,08	0,10	0,11	0,12	0,09	0,10
	n	16	16	16	16	16	16	15	16	16	16
M4	m	0,56	0,41	0,28	0,38	0,38	0,34	0,40	0,69	0,22	0,28
	sem	0,12	0,12	0,11	0,11	0,09	0,08	0,11	0,12	0,08	0,10
	n	16	16	16	16	16	16	15	16	16	16
CA1	m	0,44	0,34	0,22	0,25	0,38	0,19	0,30	0,47	0,06	0,38
	sem	0,11	0,12	0,09	0,08	0,11	0,09	0,13	0,14	0,04	0,11
	n	16	16	16	16	16	16	15	16	16	16
CA2	m	0,50	0,22	0,06	0,16	0,31	0,09	0,33	0,47	0,06	0,19
	sem	0,13	0,09	0,06	0,10	0,11	0,07	0,13	0,14	0,04	0,08
	n	16	16	16	16	16	16	15	16	16	16
CA3	m	0,31	0,16	0,09	0,19	0,03	0,06	0,37	0,41	0,09	0,06
	sem	0,11	0,08	0,09	0,11	0,03	0,04	0,12	0,15	0,05	0,06
	n	16	16	16	16	16	16	15	16	16	16
DG	m	0,63	0,41	0,38	0,59	0,25	0,19	0,50	0,72	0,13	0,31
	sem	0,13	0,11	0,11	0,12	0,09	0,06	0,13	0,11	0,07	0,10
	n	16	16	16	16	16	16	15	16	16	16
P1	m	0,19	0,13	0,13	0,16	0,16	0,16	0,27	0,19	0,03	0,00
	sem	0,10	0,06	0,06	0,08	0,08	0,06	0,11	0,09	0,03	0,00
	n	16	16	16	16	16	16	15	16	16	16
P2	m	0,53	0,50	0,59	0,66	0,50	0,56	0,60	0,56	0,22	0,34
	sem	0,12	0,09	0,11	0,09	0,10	0,10	0,11	0,14	0,08	0,08
	n	16	16	16	16	16	16	15	16	16	16
P3	m	0,28	0,16	0,16	0,25	0,19	0,22	0,23	0,19	0,00	0,00
	sem	0,10	0,06	0,06	0,08	0,08	0,08	0,12	0,08	0,00	0,00
	n	16	16	16	16	16	16	15	16	16	16
Brain (m)	m	0,43	0,34	0,31	0,37	0,33	0,29	0,40	0,46	0,14	0,28
	sem	0,08	0,07	0,05	0,05	0,06	0,05	0,09	0,09	0,03	0,04
	n	16	16	16	16	16	16	15	16	16	16

Table 9: **Single 2-hour exposure to GSM-1800 or UMTS.**
Mean ± SEM and sample (n) for the amount of degenerating neurons as identified using Fluoro-Jade B in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels, 1 day after exposure. The different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain averaged value (brain)

		Single exp. Fluoro Jade B (1 day)									
	SAR	0 W/kg		0.026 W/kg		0.26 W/kg		2.6 W/kg		13 W/kg	
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	0,38	0,69	0,34	0,34	0,69	0,50	0,50	0,40	0,34	0,34
	sem	0,11	0,13	0,12	0,13	0,12	0,10	0,11	0,13	0,10	0,11
	n	16	16	16	16	16	16	16	15	16	16
F4	m	0,47	0,56	0,53	0,47	0,59	0,38	0,56	0,57	0,13	0,34
	sem	0,10	0,14	0,11	0,14	0,09	0,07	0,10	0,12	0,06	0,10
	n	16	16	16	16	16	16	16	15	16	16
M1	m	0,47	0,47	0,31	0,50	0,47	0,72	0,38	0,40	0,34	0,22
	sem	0,12	0,14	0,10	0,11	0,09	0,09	0,10	0,12	0,08	0,06
	n	16	16	16	16	16	16	16	15	16	16
M3	m	0,19	0,22	0,31	0,25	0,31	0,16	0,22	0,33	0,09	0,19
	sem	0,08	0,10	0,13	0,10	0,09	0,06	0,12	0,11	0,05	0,09
	n	16	16	16	16	16	16	16	15	16	16
M4	m	0,34	0,53	0,47	0,31	0,59	0,47	0,50	0,63	0,25	0,25
	sem	0,11	0,12	0,12	0,11	0,10	0,07	0,12	0,11	0,08	0,10
	n	16	16	16	16	16	16	16	15	16	16
CA1	m	0,13	0,31	0,16	0,34	0,19	0,16	0,22	0,33	0,25	0,13
	sem	0,07	0,11	0,09	0,11	0,09	0,06	0,08	0,11	0,06	0,07
	n	16	16	16	16	16	16	16	15	16	16
CA2	m	0,03	0,22	0,03	0,13	0,19	0,09	0,22	0,37	0,13	0,13
	sem	0,03	0,09	0,03	0,09	0,09	0,05	0,09	0,11	0,06	0,07
	n	16	16	16	16	16	16	16	15	16	16
CA3	m	0,16	0,22	0,09	0,09	0,19	0,06	0,22	0,20	0,13	0,09
	sem	0,06	0,11	0,07	0,07	0,10	0,04	0,10	0,10	0,06	0,07
	n	16	16	16	16	16	16	16	15	16	16
DG	m	0,22	0,34	0,31	0,41	0,19	0,22	0,38	0,63	0,13	0,13
	sem	0,09	0,12	0,11	0,10	0,10	0,08	0,10	0,10	0,06	0,06
	n	16	16	16	16	16	16	16	15	16	16
P1	m	0,16	0,13	0,13	0,19	0,25	0,06	0,16	0,20	0,03	0,00
	sem	0,08	0,06	0,07	0,06	0,10	0,04	0,10	0,10	0,03	0,00
	n	16	16	16	16	16	16	16	15	16	16
P2	m	0,50	0,44	0,38	0,53	0,72	0,59	0,44	0,47	0,50	0,28
	sem	0,11	0,12	0,11	0,12	0,14	0,11	0,13	0,10	0,11	0,09
	n	16	16	16	16	16	16	16	15	16	16
P3	m	0,13	0,16	0,09	0,13	0,25	0,16	0,13	0,13	0,06	0,00
	sem	0,06	0,06	0,05	0,06	0,10	0,06	0,10	0,08	0,04	0,00
	n	16	16	16	16	16	16	16	15	16	16
Brain (m)	m	0,26	0,36	0,26	0,31	0,39	0,30	0,33	0,39	0,20	0,17
	sem	0,05	0,08	0,05	0,07	0,06	0,03	0,07	0,08	0,03	0,04
	n	16	16	16	16	16	16	16	15	16	16

Table 10: **Single 2-hour exposure to GSM-1800 or UMTS.**
Mean ± SEM and sample (n) for the amount of degenerating neurons as identified
using Fluoro-Jade B in cage-control, sham-exposed and GSM-1800- or UMTS-
exposed rats at different SAR levels, 7 days after exposure. The different brain
regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2,
P3) as well as the brain averaged value (brain)

		Single exp. Fluoro Jade B (7 days)									
	SAR	0 W/kg		0.026 W/kg		0.26 W/kg		2.6 W/kg		13 W/kg	
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	0,66	0,50	0,47	0,41	0,28	0,28	0,66	0,53	0,34	0,19
	sem	0,13	0,14	0,07	0,10	0,10	0,10	0,11	0,12	0,10	0,09
	n	16	16	16	16	16	16	16	16	16	16
F4	m	0,66	0,47	0,78	0,72	0,09	0,13	0,78	0,63	0,28	0,44
	sem	0,15	0,11	0,08	0,06	0,05	0,06	0,14	0,14	0,10	0,10
	n	16	16	16	16	16	16	16	16	16	16
M1	m	0,47	0,53	0,59	0,56	0,34	0,19	0,59	0,38	0,31	0,53
	sem	0,12	0,13	0,09	0,09	0,10	0,08	0,10	0,11	0,08	0,10
	n	16	16	16	16	16	16	16	16	16	16
M3	m	0,25	0,22	0,16	0,31	0,03	0,03	0,44	0,41	0,25	0,06
	sem	0,08	0,08	0,06	0,10	0,03	0,03	0,13	0,10	0,09	0,04
	n	16	16	16	16	16	16	16	16	16	16
M4	m	0,44	0,63	0,53	0,59	0,31	0,03	0,69	0,69	0,53	0,28
	sem	0,13	0,15	0,11	0,09	0,11	0,03	0,09	0,13	0,13	0,08
	n	16	16	16	16	16	16	16	16	16	16
CA1	m	0,25	0,25	0,47	0,44	0,16	0,03	0,38	0,31	0,25	0,22
	sem	0,06	0,09	0,10	0,09	0,09	0,03	0,09	0,09	0,09	0,08
	n	16	16	16	16	16	16	16	16	16	16
CA2	m	0,13	0,13	0,34	0,31	0,09	0,06	0,25	0,19	0,13	0,03
	sem	0,06	0,07	0,09	0,10	0,07	0,04	0,10	0,08	0,09	0,03
	n	16	16	16	16	16	16	16	16	16	16
CA3	m	0,06	0,19	0,09	0,22	0,06	0,00	0,25	0,16	0,03	0,06
	sem	0,04	0,08	0,05	0,09	0,04	0,00	0,08	0,08	0,03	0,04
	n	16	16	16	16	16	16	16	16	16	16
DG	m	0,34	0,59	0,53	0,63	0,19	0,09	0,69	0,56	0,25	0,16
	sem	0,09	0,15	0,07	0,09	0,06	0,05	0,09	0,11	0,08	0,06
	n	16	16	16	16	16	16	16	16	16	16
P1	m	0,13	0,22	0,34	0,22	0,00	0,00	0,28	0,16	0,06	0,00
	sem	0,07	0,11	0,10	0,06	0,00	0,00	0,10	0,08	0,04	0,00
	n	16	16	16	16	16	16	16	16	16	16
P2	m	0,44	0,56	0,63	0,63	0,31	0,09	0,69	0,41	0,34	0,41
	sem	0,13	0,14	0,10	0,10	0,11	0,07	0,12	0,11	0,09	0,08
	n	16	16	16	16	16	16	16	16	16	16
P3	m	0,13	0,09	0,38	0,28	0,06	0,00	0,34	0,34	0,03	0,09
	sem	0,06	0,05	0,07	0,08	0,06	0,00	0,10	0,14	0,03	0,05
	n	16	16	16	16	16	16	16	16	16	16
Brain (m)	m	0,33	0,36	0,44	0,44	0,16	0,08	0,50	0,40	0,23	0,21
	sem	0,06	0,08	0,04	0,04	0,04	0,02	0,08	0,07	0,04	0,03
	n	16	16	16	16	16	16	16	16	16	16

Table 11: **Single 2-hour exposure to GSM or UMTS.**
Mean ± SEM and sample (n) for the amount of degenerating neurons as identified using Fluoro-Jade B in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels, 50 days after exposure. The different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain averaged value (brain)

		Single exp. Fluoro Jade B (50 days)									
	SAR	0 W/kg		0.026 W/kg		0.26 W/kg		2.6 W/kg		13 W/kg	
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	0,38	0,56	0,53	0,53	0,41	0,47	0,53	0,47	0,22	0,22
	sem	0,12	0,14	0,11	0,13	0,11	0,15	0,11	0,09	0,06	0,08
	n	16	16	16	16	16	15	16	15	16	16
F4	m	0,63	0,69	0,72	0,91	0,97	0,87	0,66	0,47	0,22	0,03
	sem	0,11	0,14	0,10	0,10	0,03	0,08	0,12	0,10	0,06	0,03
	n	16	16	16	16	16	15	16	15	16	16
M1	m	0,56	0,59	0,59	0,66	0,66	0,63	0,47	0,40	0,34	0,22
	sem	0,14	0,13	0,09	0,12	0,11	0,10	0,10	0,13	0,09	0,09
	n	16	16	16	16	16	15	16	15	16	16
M3	m	0,16	0,25	0,13	0,19	0,44	0,13	0,34	0,23	0,09	0,06
	sem	0,06	0,09	0,07	0,10	0,14	0,06	0,10	0,08	0,05	0,04
	n	16	16	16	16	16	15	16	15	16	16
M4	m	0,53	0,78	0,44	0,56	0,72	0,37	0,53	0,63	0,28	0,19
	sem	0,11	0,12	0,13	0,14	0,09	0,11	0,12	0,10	0,08	0,08
	n	16	16	16	16	16	15	16	15	16	16
CA1	m	0,50	0,67	0,50	0,41	0,44	0,50	0,38	0,30	0,25	0,09
	sem	0,13	0,14	0,09	0,15	0,11	0,12	0,11	0,10	0,08	0,07
	n	16	15	16	16	16	15	16	15	16	16
CA2	m	0,16	0,47	0,31	0,19	0,19	0,30	0,28	0,13	0,13	0,06
	sem	0,09	0,15	0,09	0,10	0,09	0,10	0,09	0,06	0,06	0,06
	n	16	15	16	16	16	15	16	15	16	16
CA3	m	0,06	0,37	0,25	0,16	0,09	0,03	0,25	0,17	0,06	0,09
	sem	0,06	0,15	0,09	0,09	0,07	0,03	0,09	0,06	0,04	0,07
	n	16	15	16	16	16	15	16	15	16	16
DG	m	0,41	0,57	0,50	0,47	0,19	0,40	0,53	0,60	0,19	0,03
	sem	0,10	0,13	0,09	0,12	0,08	0,09	0,12	0,13	0,06	0,03
	n	16	15	16	16	16	15	16	15	16	16
P1	m	0,25	0,34	0,31	0,44	0,19	0,07	0,09	0,13	0,13	0,06
	sem	0,11	0,11	0,10	0,10	0,08	0,05	0,07	0,06	0,06	0,06
	n	16	16	16	16	16	15	16	15	16	16
P2	m	0,63	0,59	0,69	0,66	0,81	0,77	0,56	0,53	0,28	0,13
	sem	0,13	0,11	0,11	0,11	0,11	0,11	0,10	0,10	0,09	0,07
	n	16	16	16	16	16	15	16	15	16	16
P3	m	0,22	0,25	0,25	0,44	0,28	0,27	0,03	0,10	0,03	0,00
	sem	0,08	0,09	0,09	0,10	0,08	0,08	0,03	0,07	0,03	0,00
	n	16	16	16	16	16	15	16	15	16	16
Brain (m)	m	0,37	0,50	0,43	0,47	0,45	0,40	0,39	0,35	0,18	0,10
	sem	0,07	0,08	0,05	0,08	0,05	0,05	0,05	0,07	0,04	0,03
	n	16	16	16	16	16	15	16	15	16	16

Table 12: Single 2-hour exposure to GSM-1800 or UMTS.

Kruskall Wallis test on data on degenerating neurons as identified using Fluoro-Jade B in cage-control, and GSM-1800- or UMTS-exposed rats versus sham-exposed rats. Different SAR levels and different brain regions (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3 and averaged brain) were tested.

For each parameter studied, statistical analysis was performed between sham-exposure and exposure to GSM-1800- or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant. NS: non significant effect ; green box: significant decrease ; yellow box: significant increase.

Signal	SAR (W/kg)	Time	F1	F4	M1	M3	M4	CA1	CA2	CA3	DG	P1	P2	P3	Brain (m)
C	0	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C	0	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C	0	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C	0	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C	0	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,026	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,026	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,026	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,026	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,026	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,26	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,26	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,26	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,26	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0,26	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	2,6	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	2,6	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	2,6	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	2,6	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	2,6	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13	0h	ns	ns	(green)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13	1h	ns	ns	(green)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	(green)
UMTS	0,026	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,026	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,026	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,026	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,026	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,26	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,26	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,26	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0,26	7d	ns	ns	ns	ns	(green)	ns	ns	ns	(green)	ns	ns	ns	(green)
UMTS	0,26	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2,6	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2,6	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2,6	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2,6	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2,6	50d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13	0h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13	1h	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13	1d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13	7d	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13	50d	ns	(green)	ns	ns	(green)	ns	ns	ns	(green)	ns	(green)	ns	(green)

Table 15: **Single 2-hour exposure to GSM or UMTS.**
Mean ± SEM and sample (n) for the amount of endogenous albumin leakage in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels and different times after exposure. The different brain zones tested are indicated (Z1, Z2, Z3), as well as the brain averaged value (brain)

			Single exp.-Albumin leakage									
		SAR	0 W/kg		0.026 W/kg		0.26 W/kg		2.6 W/kg		13 W/kg	
			C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
0 hour	Z1	m	0,93	2,13	1,10	1,35	0,63	1,03	1,46	1,47	0,25	0,06
		sem	0,27	0,71	0,30	0,37	0,24	0,38	0,35	0,40	0,10	0,06
		n	14	16	15	13	16	15	14	16	16	16
	Z2	m	1,68	2,84	1,03	1,35	0,59	0,91	2,96	2,25	0,19	0,28
		sem	0,43	0,78	0,17	0,39	0,17	0,22	0,90	0,63	0,08	0,12
		n	14	16	15	13	16	16	14	16	16	16
	Z3	m	2,07	2,88	0,83	2,12	0,60	0,72	2,18	1,34	0,00	0,06
		sem	0,59	0,80	0,26	0,62	0,18	0,20	0,58	0,40	0,00	0,06
		n	14	16	15	13	15	16	14	16	16	16
	Brain	m	1,56	2,61	0,99	1,60	0,63	0,87	2,20	1,69	0,15	0,14
		sem	0,37	0,68	0,16	0,43	0,15	0,19	0,56	0,37	0,05	0,07
		n	14	16	15	13	15	16	14	16	16	16
1 hour	Z1	m	0,87	0,84	0,40	0,56	0,09	0,75	0,63	0,87	0,38	0,09
		sem	0,26	0,30	0,12	0,21	0,05	0,38	0,19	0,27	0,15	0,07
		n	15	16	15	16	16	16	15	15	16	16
	Z2	m	1,63	1,03	1,83	1,19	0,38	1,19	1,47	1,10	0,50	0,31
		sem	0,40	0,44	0,47	0,36	0,12	0,58	0,49	0,30	0,13	0,11
		n	15	16	15	16	16	16	15	15	16	16
	Z3	m	2,23	1,19	0,77	1,19	0,16	0,97	1,27	1,10	0,31	0,25
		sem	0,58	0,46	0,19	0,28	0,08	0,32	0,37	0,30	0,10	0,16
		n	15	16	15	16	16	16	15	15	16	16
	Brain	m	1,58	1,02	1,00	0,98	0,21	0,97	1,12	1,02	0,40	0,22
		sem	0,35	0,34	0,19	0,22	0,06	0,41	0,23	0,21	0,10	0,08
		n	15	16	15	16	16	16	15	15	16	16
1 day	Z1	m	1,31	1,28	0,53	0,94	1,41	1,19	1,07	2,29	0,59	0,60
		sem	0,33	0,25	0,20	0,30	0,46	0,27	0,34	0,78	0,23	0,33
		n	16	16	16	16	16	16	15	12	16	15
	Z2	m	1,94	1,47	1,06	1,97	2,75	2,22	1,93	3,21	0,72	0,53
		sem	0,46	0,30	0,24	0,58	0,83	0,46	0,71	1,19	0,18	0,16
		n	16	16	16	16	16	16	15	12	16	16
	Z3	m	2,47	1,81	0,88	1,97	2,97	1,09	2,67	2,21	0,53	0,38
		sem	0,87	0,35	0,23	0,52	1,54	0,25	0,81	0,98	0,12	0,17
		n	16	16	16	16	16	16	15	12	16	16
	Brain	m	1,91	1,52	0,82	1,63	2,38	1,50	1,89	2,57	0,61	0,52
		sem	0,44	0,22	0,18	0,40	0,87	0,27	0,54	0,84	0,14	0,17
		n	16	16	16	16	16	16	15	12	16	15
7 days	Z1	m	1,88	1,40	0,81	0,84	1,64	2,06	1,43	0,93	1,44	1,25
		sem	0,46	0,36	0,19	0,32	0,42	0,65	0,49	0,28	0,34	0,31
		n	16	16	16	16	14	16	15	15	16	16
	Z2	m	2,34	2,17	1,22	0,91	2,71	1,66	2,13	1,67	1,44	1,63
		sem	0,64	0,53	0,31	0,34	0,55	0,38	0,42	0,36	0,28	0,41
		n	16	15	16	16	14	16	15	15	16	16
	Z3	m	2,84	1,87	1,66	1,19	1,11	1,09	2,70	1,40	0,94	1,19
		sem	0,78	0,39	0,31	0,24	0,31	0,30	0,62	0,46	0,21	0,34
		n	16	15	16	16	14	16	15	15	16	16
	Brain	m	2,35	1,81	1,23	0,98	1,82	1,60	2,09	1,33	1,27	1,35
		sem	0,57	0,34	0,21	0,21	0,39	0,42	0,38	0,29	0,21	0,29
		n	16	15	16	16	14	16	15	15	16	16
50 days	Z1	m	1,75	1,16	1,40	1,13	1,50	1,39	0,93	0,67	0,53	0,94
		sem	0,62	0,26	0,40	0,21	0,27	0,48	0,28	0,30	0,13	0,19
		n	16	16	15	16	16	14	14	15	16	16
	Z2	m	1,81	2,44	2,30	2,59	2,66	1,77	1,32	1,20	1,13	1,28
		sem	0,49	0,68	0,29	0,51	0,53	0,42	0,33	0,45	0,16	0,31
		n	16	16	15	16	16	15	14	15	16	16
	Z3	m	2,47	2,03	3,50	3,03	2,66	1,13	1,25	1,43	1,09	0,91
		sem	0,65	0,59	0,51	0,51	0,42	0,25	0,39	0,49	0,33	0,18
		n	16	16	15	16	16	15	14	15	16	16
	Brain	m	2,01	1,88	2,40	2,25	2,27	1,50	1,17	1,10	0,92	1,04
		sem	0,53	0,43	0,26	0,31	0,30	0,28	0,28	0,34	0,17	0,17
		n	16	16	15	16	16	14	14	15	16	16

Table 16: Single 2-hour exposure to GSM-1800 or UMTS.
Kruskall Wallis test on data on endogenous albumin leakages in cage-control, and GSM-1800- or UMTS-exposed rats versus sham-exposed rats. Different SAR levels and different brain zones (Z1, Z2, Z3) and averaged brain were tested.
For each parameter studied, statistical analysis was performed between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant.
NS: non significant effect ; green box: significant decrease ; yellow box: significant

[green box]   Significant decrease (p<0.05)

Albumin leakage-Single Exp. (Comparison versus sham)

Signal	SAR (W/kg)	Time	Z1	Z2	Z3	Brain (m)
C	0	0h	ns	ns	ns	ns
C	0	1h	ns	ns	ns	ns
C	0	1d	ns	ns	ns	ns
C	0	7d	ns	ns	ns	ns
C	0	50d	ns	ns	ns	ns
GSM	0,026	0h	ns	ns	ns	ns
GSM	0,026	1h	ns	ns	ns	ns
GSM	0,026	1d	ns	ns	ns	ns
GSM	0,026	7d	ns	ns	ns	ns
GSM	0,026	50d	ns	ns	ns	ns
GSM	0,26	0h	ns	ns	ns	ns
GSM	0,26	1h	ns	ns	ns	ns
GSM	0,26	1d	ns	ns	ns	ns
GSM	0,26	7d	ns	ns	ns	ns
GSM	0,26	50d	ns	ns	ns	ns
GSM	2,6	0h	ns	ns	ns	ns
GSM	2,6	1h	ns	ns	ns	ns
GSM	2,6	1d	ns	ns	ns	ns
GSM	2,6	7d	ns	ns	ns	ns
GSM	2,6	50d	ns	ns	ns	ns
GSM	13	0h	ns	[green]	[green]	[green]
GSM	13	1h	ns	ns	ns	ns
GSM	13	1d	ns	ns	ns	[green]
GSM	13	7d	ns	ns	ns	ns
GSM	13	50d	ns	ns	ns	ns
UMTS	0,026	0h	ns	ns	ns	ns
UMTS	0,026	1h	ns	ns	ns	ns
UMTS	0,026	1d	ns	ns	ns	ns
UMTS	0,026	7d	ns	ns	ns	ns
UMTS	0,026	50d	ns	ns	ns	ns
UMTS	0,26	0h	ns	ns	ns	ns
UMTS	0,26	1h	ns	ns	ns	ns
UMTS	0,26	1d	ns	ns	ns	ns
UMTS	0,26	7d	ns	ns	ns	ns
UMTS	0,26	50d	ns	ns	ns	ns
UMTS	2,6	0h	ns	ns	ns	ns
UMTS	2,6	1h	ns	ns	ns	ns
UMTS	2,6	1d	ns	ns	ns	ns
UMTS	2,6	7d	ns	ns	ns	ns
UMTS	2,6	50d	ns	ns	ns	ns
UMTS	13	0h	[green]	[green]	[green]	[green]
UMTS	13	1h	ns	ns	ns	ns
UMTS	13	1d	ns	ns	[green]	[green]
UMTS	13	7d	ns	ns	ns	ns
UMTS	13	50d	ns	ns	ns	ns

Table 17: **Repeated exposure to GSM-1800 or UMTS.**
Mean ± SEM and sample (n) for the amount of "dark" neurons as identified using Cresyl violet in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels, immediately after last exposure. The different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain averaged value (brain)

Repeated exp.-Cresyl Violet (0 hour)

		0 W/kg		0.026 W/kg	0.026 W/kg	0.26 W/kg	0.26 W/kg	2.6 W/kg	2.6 W/kg	13 W/kg	13 W/kg
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	6,23	5,53	2,91	2,56	3,88	2,70	3,81	3,78	4,88	2,50
	sem	1,24	1,08	0,85	0,43	0,98	0,44	1,09	0,89	0,67	0,32
	n	15	16	16	16	16	15	16	16	16	16
F4	m	13,17	13,59	8,38	5,31	9,78	11,67	7,38	11,50	11,00	10,59
	sem	2,01	1,98	1,59	0,85	1,92	1,69	1,32	2,57	1,36	1,32
	n	15	16	16	16	16	15	16	15	16	16
M1	m	5,90	5,47	2,78	2,09	4,30	3,37	3,97	3,94	2,72	2,97
	sem	1,01	1,22	1,01	0,51	0,84	0,40	0,93	0,66	0,62	0,78
	n	15	16	16	16	15	15	16	16	16	16
M3	m	2,53	2,38	1,13	1,38	2,19	2,67	2,22	1,75	1,97	1,63
	sem	0,52	0,78	0,33	0,41	0,41	0,82	0,58	0,56	0,52	0,39
	n	15	16	16	16	16	15	16	16	16	16
M4	m	4,57	4,25	2,06	1,88	2,72	3,07	5,00	1,47	3,22	3,09
	sem	0,52	0,74	0,57	0,62	0,60	0,42	1,19	0,51	0,80	0,70
	n	15	16	16	16	16	15	16	16	16	16
CA1	m	3,53	3,94	4,66	3,63	3,87	4,27	3,88	2,73	3,72	4,16
	sem	0,79	0,95	1,27	0,75	0,82	0,80	0,70	0,66	0,48	0,65
	n	15	16	16	16	15	15	16	15	16	16
CA2	m	3,67	3,28	4,47	4,28	3,30	2,77	3,53	4,63	3,59	3,81
	sem	0,55	0,64	0,79	0,64	0,66	0,53	0,39	0,58	0,48	0,71
	n	15	16	16	16	15	15	16	16	16	16
CA3	m	5,70	5,38	3,91	3,97	5,97	4,97	5,25	4,44	5,06	5,31
	sem	0,71	1,00	0,71	0,66	0,76	0,83	0,72	0,74	0,76	0,87
	n	15	16	16	16	15	15	16	16	16	16
DG	m	6,03	6,66	3,56	3,97	6,20	7,63	4,88	7,09	5,31	5,72
	sem	1,26	1,58	0,78	0,84	1,13	1,64	0,63	2,23	1,09	1,83
	n	15	16	16	16	15	15	16	16	16	16
P1	m	6,73	8,75	5,00	3,38	6,88	5,97	4,03	6,72	5,19	5,66
	sem	1,48	1,56	1,34	0,98	0,96	1,25	0,76	1,56	1,13	1,35
	n	15	16	16	16	16	15	16	16	16	16
P2	m	8,63	8,16	4,25	3,78	6,16	5,67	4,88	4,75	4,06	4,56
	sem	1,58	1,37	1,02	0,87	1,16	1,46	1,18	1,43	0,53	1,11
	n	15	16	16	16	16	15	16	16	16	16
P3	m	7,73	12,16	6,34	5,16	7,78	6,90	7,34	9,31	8,41	8,16
	sem	1,04	1,52	1,35	1,17	0,98	0,97	1,50	1,78	1,63	1,28
	n	15	16	16	16	16	15	16	16	16	16
Brain (m)	m	6,20	6,63	4,12	3,45	5,26	5,14	4,68	5,21	4,93	4,85
	sem	0,62	0,78	0,68	0,44	0,60	0,46	0,67	0,94	0,52	0,57
	n	15	16	16	16	16	15	16	16	16	16

Table 18: **Repeated exposure to GSM-1800 or UMTS.**
Mean ± SEM and sample (n) for the amount of "dark" neurons as
identified using Cresyl violet in cage-control, sham-exposed and GSM-
1800 or UMTS-exposed rats at different SAR levels, fifty days after last
exposure. The different brain regions tested are indicated (F1, F4, M1,
M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain
averaged value (brain)

Repeated exp.-Cresyl Violet (50 days)

		0 W/kg		0.026 W/kg	0.026 W/kg	0.26 W/kg	0.26 W/kg	2.6 W/kg	2.6 W/kg	13 W/kg	13 W/kg
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	2,83	2,97	4,06	4,23	3,69	3,84	3,25	3,41	2,63	2,09
	sem	0,51	0,84	0,83	0,51	0,88	0,77	0,68	0,78	1,12	0,45
	n	15	16	16	15	16	16	16	16	15	16
F4	m	6,10	4,38	12,72	12,37	7,38	5,31	4,56	7,38	5,17	9,53
	sem	1,08	1,31	1,47	1,58	0,95	0,65	0,77	0,91	1,02	1,32
	n	15	16	16	15	16	16	16	16	15	16
M1	m	3,07	4,66	4,78	5,50	3,28	3,66	2,44	3,19	2,03	2,53
	sem	0,81	0,99	1,02	0,83	0,71	0,57	0,53	0,72	0,72	0,67
	n	15	16	16	15	16	16	16	16	15	16
M3	m	1,47	1,69	2,47	2,63	2,19	1,94	1,25	3,06	1,57	2,09
	sem	0,39	0,43	0,59	0,32	0,48	0,38	0,43	0,69	0,35	0,36
	n	15	16	16	15	16	16	16	16	15	16
M4	m	2,30	2,16	2,81	3,70	1,59	1,91	2,00	1,81	1,60	2,28
	sem	0,55	0,46	0,56	0,59	0,43	0,41	0,34	0,41	0,48	0,29
	n	15	16	16	15	16	16	16	16	15	16
CA1	m	2,40	2,03	5,03	5,27	2,67	1,97	2,75	2,44	3,27	2,53
	sem	0,60	0,41	0,79	0,50	0,60	0,35	0,56	0,65	0,99	0,43
	n	15	16	16	15	15	16	16	16	13	16
CA2	m	2,53	3,16	3,69	4,10	2,43	2,31	3,59	2,94	2,04	1,69
	sem	0,72	0,76	0,70	0,52	0,39	0,51	0,84	0,71	0,60	0,36
	n	15	16	16	15	15	16	16	16	13	16
CA3	m	3,10	3,38	4,66	5,47	3,40	2,88	3,00	3,50	2,96	4,03
	sem	0,38	0,78	0,86	0,50	0,47	0,47	0,50	0,44	0,56	0,53
	n	15	16	16	15	15	16	16	16	13	16
DG	m	3,03	2,88	6,66	9,07	3,67	2,53	3,09	4,34	3,62	2,91
	sem	0,83	0,75	1,15	2,07	0,58	0,43	0,50	1,09	0,99	0,46
	n	15	16	16	15	15	16	16	16	13	16
P1	m	2,60	2,66	6,94	7,90	6,28	3,56	2,81	4,63	3,33	3,47
	sem	0,65	0,71	1,02	0,73	0,79	1,10	0,63	0,90	0,86	1,00
	n	15	16	16	15	16	16	16	16	15	16
P2	m	4,10	4,88	6,91	7,80	5,50	3,53	5,75	6,00	3,83	3,78
	sem	0,74	0,95	1,16	1,23	0,81	0,62	1,06	0,97	1,07	0,86
	n	15	16	16	15	16	16	16	16	15	16
P3	m	4,60	2,72	10,84	10,80	7,50	4,25	4,44	5,78	5,00	4,50
	sem	0,87	0,65	1,31	0,96	0,86	0,75	0,82	1,49	1,52	1,03
	n	15	16	16	15	16	16	16	16	15	16
Brain (m)	m	3,18	3,13	5,96	6,57	4,18	3,14	3,24	4,04	3,10	3,45
	sem	0,35	0,53	0,61	0,32	0,29	0,31	0,38	0,48	0,61	0,39
	n	15	16	16	15	16	16	16	16	15	16

Table 19: Repeated exposure to GSM-1800 or UMTS.
Kruskall Wallis test on data on "dark" neurons as identified using Cresyl violet in cage-control, and GSM-1800- or UMTS-exposed rats versus sham-exposed rats. Different SAR levels and different brain regions (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3 and brain averaged) were tested.
For each parameter studied, statistical analysis was performed between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant.
NS: non significant effect, green box : significant decrease, yellow box: significant increase.

🟩 Significant decrease (p<0.05)
🟨 Significant increase (p<0.05)

Cresyl violet-Repeated exp. (Comparison versus sham)

	SAR	Time	F1	F4	M1	M3	M4	CA1	CA2	CA3	DG	P1	P2	P3	Brain (m)
Cage control	0 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Cage control	0 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0.026 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0.026 W/kg	50 days	ns	🟨	ns	ns	ns	🟨	ns	ns	🟨	🟨	ns	🟨	🟨
GSM	0.26 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0.26 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	2.6 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	2.6 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0.026 W/kg	0 hour	ns	🟩	ns	ns	🟩	ns	ns	ns	🟩	🟩	ns	🟩	🟩
UMTS	0.026 W/kg	50 days	ns	🟨	ns	ns	ns	🟨	ns	🟨	🟨	🟨	ns	🟨	🟨
UMTS	0.26 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0.26 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2.6 W/kg	0 hour	ns	ns	ns	ns	🟩	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2.6 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13 W/kg	50 days	ns	🟨	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 20: **Repeated exposure to GSM-1800 or UMTS**
Mean ± SEM and sample (n) for the amount of degenerating neurons as identified using Fluoro-Jade B in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels, immediately after last exposure. The different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain averaged value (brain)

Repeated exp.-Fluoro Jade B (0 hour)

		0 W/kg		0.026 W/kg	0.026 W/kg	0.26 W/kg	0.26 W/kg	2.6 W/kg	2.6 W/kg	13 W/kg	13 W/kg
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	0,50	0,41	0,41	0,16	0,44	0,57	0,31	0,28	0,47	0,53
	sem	0,14	0,11	0,11	0,08	0,12	0,08	0,11	0,12	0,13	0,11
	n	15	16	16	16	16	15	16	16	16	16
F4	m	0,70	0,63	0,53	0,50	0,56	0,57	0,41	0,41	0,78	0,69
	sem	0,08	0,09	0,10	0,10	0,10	0,09	0,08	0,11	0,09	0,08
	n	15	16	16	16	16	15	16	16	16	16
M1	m	0,63	0,41	0,31	0,34	0,56	0,67	0,22	0,38	0,56	0,38
	sem	0,08	0,12	0,09	0,10	0,10	0,10	0,09	0,12	0,11	0,09
	n	15	16	16	16	16	15	16	16	16	16
M3	m	0,40	0,41	0,19	0,19	0,22	0,23	0,16	0,09	0,19	0,16
	sem	0,12	0,11	0,08	0,06	0,09	0,10	0,09	0,05	0,08	0,08
	n	15	16	16	16	16	15	16	16	16	16
M4	m	0,57	0,47	0,47	0,41	0,47	0,50	0,25	0,41	0,66	0,47
	sem	0,14	0,11	0,12	0,10	0,12	0,12	0,10	0,10	0,13	0,12
	n	15	16	16	16	16	15	16	16	16	16
CA1	m	0,33	0,28	0,25	0,28	0,28	0,43	0,09	0,25	0,53	0,53
	sem	0,11	0,11	0,09	0,09	0,10	0,11	0,07	0,10	0,10	0,12
	n	15	16	16	16	16	15	16	16	16	16
CA2	m	0,00	0,03	0,03	0,16	0,19	0,13	0,28	0,09	0,16	0,09
	sem	0,00	0,03	0,03	0,08	0,09	0,08	0,09	0,07	0,08	0,05
	n	15	16	16	16	16	15	16	16	16	16
CA3	m	0,13	0,06	0,09	0,09	0,09	0,20	0,19	0,13	0,06	0,13
	sem	0,08	0,06	0,05	0,07	0,05	0,10	0,09	0,07	0,04	0,09
	n	15	16	16	16	16	15	16	16	16	16
DG	m	0,47	0,50	0,19	0,31	0,47	0,50	0,31	0,25	0,56	0,41
	sem	0,10	0,13	0,08	0,09	0,11	0,12	0,10	0,10	0,10	0,10
	n	15	16	16	16	16	15	16	16	16	16
P1	m	0,23	0,13	0,03	0,03	0,13	0,00	0,00	0,06	0,13	0,13
	sem	0,10	0,07	0,03	0,03	0,06	0,00	0,00	0,04	0,07	0,06
	n	15	16	16	16	16	15	16	16	16	16
P2	m	0,47	0,63	0,25	0,34	0,53	0,40	0,13	0,47	0,53	0,28
	sem	0,11	0,12	0,08	0,10	0,09	0,06	0,07	0,12	0,09	0,08
	n	15	16	16	16	16	15	16	16	16	16
P3	m	0,30	0,19	0,03	0,00	0,16	0,13	0,03	0,09	0,22	0,13
	sem	0,11	0,09	0,03	0,00	0,06	0,06	0,03	0,05	0,09	0,06
	n	15	16	16	16	16	15	16	16	16	16
Brain (m)	m	0,39	0,34	0,23	0,23	0,34	0,36	0,20	0,24	0,40	0,33
	sem	0,06	0,07	0,03	0,04	0,05	0,04	0,05	0,06	0,06	0,04
	n	15	16	16	16	16	15	16	16	16	16

Table 21: **Repeated (exposure to GSM-1800 or UMTS**
Mean ± SEM and sample (n) for the amount of degenerating neurons as identified using Fluoro-Jade B in cage-control, sham-exposed and GSM-1800- or UMTS-exposed rats at different SAR levels, fifty days after last exposure. The different brain regions tested are indicated (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3) as well as the brain averaged value (brain)

Repeated exp.-Fluoro Jade B (50 days)

		0 W/kg		0.026 W/kg	0.026 W/kg	0.26 W/kg	0.26 W/kg	2.6 W/kg	2.6 W/kg	13 W/kg	13 W/kg
		C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
F1	m	0,37	0,38	0,44	0,33	0,38	0,22	0,34	0,50	0,07	0,19
	sem	0,11	0,11	0,12	0,13	0,11	0,09	0,10	0,12	0,07	0,08
	n	15	16	16	15	16	16	16	16	15	16
F4	m	0,37	0,16	0,84	0,87	0,53	0,19	0,25	0,34	0,43	0,25
	sem	0,09	0,08	0,08	0,09	0,12	0,09	0,09	0,09	0,09	0,08
	n	15	16	16	15	16	16	16	16	15	16
M1	m	0,23	0,25	0,72	0,57	0,41	0,22	0,22	0,38	0,13	0,06
	sem	0,08	0,08	0,09	0,13	0,07	0,09	0,06	0,11	0,06	0,06
	n	15	16	16	15	16	16	16	16	15	16
M3	m	0,13	0,09	0,31	0,17	0,28	0,03	0,06	0,22	0,17	0,16
	sem	0,08	0,07	0,10	0,08	0,10	0,03	0,06	0,09	0,06	0,09
	n	15	16	16	15	16	16	16	16	15	16
M4	m	0,20	0,28	0,63	0,40	0,72	0,13	0,13	0,53	0,47	0,50
	sem	0,08	0,11	0,12	0,10	0,10	0,07	0,07	0,12	0,13	0,11
	n	15	16	16	15	16	16	16	16	15	16
CA1	m	0,27	0,19	0,47	0,50	0,38	0,16	0,25	0,28	0,10	0,25
	sem	0,08	0,08	0,12	0,12	0,11	0,09	0,10	0,09	0,06	0,08
	n	15	16	16	15	16	16	16	16	15	16
CA2	m	0,10	0,25	0,25	0,13	0,16	0,06	0,03	0,09	0,17	0,16
	sem	0,06	0,10	0,10	0,09	0,06	0,04	0,03	0,07	0,10	0,09
	n	15	16	16	15	16	16	16	16	15	16
CA3	m	0,10	0,28	0,19	0,10	0,09	0,06	0,19	0,06	0,03	0,03
	sem	0,06	0,10	0,09	0,07	0,05	0,04	0,09	0,04	0,03	0,03
	n	15	16	16	15	16	16	16	16	15	16
DG	m	0,23	0,19	0,53	0,47	0,41	0,16	0,19	0,31	0,17	0,22
	sem	0,08	0,09	0,13	0,12	0,10	0,08	0,09	0,10	0,08	0,09
	n	15	16	16	15	16	16	16	16	15	16
P1	m	0,03	0,00	0,16	0,10	0,06	0,00	0,06	0,13	0,03	0,03
	sem	0,03	0,00	0,08	0,06	0,04	0,00	0,06	0,06	0,03	0,03
	n	15	16	16	15	16	16	16	16	15	16
P2	m	0,23	0,28	0,59	0,50	0,41	0,19	0,25	0,41	0,17	0,19
	sem	0,08	0,06	0,10	0,08	0,08	0,08	0,09	0,09	0,08	0,08
	n	15	16	16	15	16	16	16	16	15	16
P3	m	0,03	0,00	0,25	0,17	0,03	0,00	0,03	0,25	0,03	0,03
	sem	0,03	0,00	0,09	0,08	0,03	0,00	0,03	0,06	0,03	0,03
	n	15	16	16	15	16	16	16	16	15	16
Brain (m)	m	0,19	0,20	0,45	0,36	0,32	0,12	0,17	0,29	0,16	0,17
	sem	0,04	0,03	0,06	0,06	0,04	0,04	0,03	0,05	0,03	0,04
	n	15	16	16	15	16	16	16	16	15	16

Table 22: Repeated exposure to GSM-1800 or UMTS.

Kruskall Wallis test on data on degenerating neurons as identified using Fluoro-Jade B in cage-control, and GSM-1800- or UMTS-exposed rats versus sham-exposed rats. Different SAR levels and different brain regions (F1, F4, M1, M3, M4, CA1, CA2, CA3, DG, P1, P2, P3 and brain averaged) were tested.

For each parameter studied, statistical analysis was performed between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant.

NS: non significant effect ; green box: significant decrease ; yellow box: significant increase.

Significant decrease (p<0.05)
Significant increase (p<0.05)

Fluoro Jade B Repeated exp. (Comparison versus Sham)

	SAR	Time	F1	F4	M1	M3	M4	CA1	CA2	CA3	DG	P1	P2	P3
Cage control	0 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Cage control	0 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0.026 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0.026 W/kg	50 days	ns	(yellow)	(yellow)	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0.26 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	0.26 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	2.6 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	(green)	ns
GSM	2.6 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
GSM	13 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0.026 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0.026 W/kg	50 days	ns	(yellow)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0.26 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	0.26 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2.6 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	2.6 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13 W/kg	0 hour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UMTS	13 W/kg	50 days	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 23: **Repeated (exposure to UMTS.**
Mean ± SEM and sample (n) for the amount of endogenous albumin leakage in cage-control, sham-exposed and GSM-1800 exposed rats at different SAR levels, immediately after last exposure. The different brain zones tested are indicated (Z1, Z2, Z3), as well as the brain averaged value (brain)

Repeated exp.-Albumin leakage

			0 W/kg		0.026 W/kg	0.026 W/kg	0.26 W/kg	0.26 W/kg	2.6 W/kg	2.6 W/kg	13 W/kg	13 W/kg
			C	S	GSM	UMTS	GSM	UMTS	GSM	UMTS	GSM	UMTS
0 hour	**Z1**	m	1,00	0,90	0,80	1,06	1,28	1,77	0,72	0,82	1,34	0,86
		sem	0,28	0,62	0,19	0,27	0,26	0,39	0,32	0,27	0,26	0,30
		n	13	15	15	16	16	15	16	14	16	14
	Z2	m	2,37	1,53	1,56	1,16	2,47	3,27	1,09	0,75	1,84	2,13
		sem	0,62	0,52	0,46	0,34	0,33	0,55	0,34	0,26	0,49	0,46
		n	15	16	16	16	16	15	16	16	16	16
	Z3	m	2,93	2,50	2,69	2,56	2,78	2,87	2,03	0,97	2,00	2,91
		sem	0,56	0,69	0,76	0,78	0,68	0,81	0,74	0,33	0,46	0,78
		n	15	16	16	16	16	15	16	15	16	16
	Brain	m	2,12	1,66	1,68	1,59	2,18	2,63	1,28	0,80	1,80	2,06
		sem	0,40	0,46	0,43	0,41	0,35	0,34	0,37	0,20	0,33	0,48
		n	15	16	16	16	16	15	16	16	16	16
50 days	**Z1**	m	0,17	0,47	2,19	1,32	0,84	0,13	0,10	1,83	2,03	1,36
		sem	0,14	0,20	0,69	0,33	0,13	0,06	0,06	0,44	0,36	0,26
		n	15	15	13	11	16	16	15	15	15	11
	Z2	m	0,83	1,09	1,47	1,70	2,31	0,25	0,93	2,06	2,97	2,13
		sem	0,45	0,42	0,44	0,36	0,36	0,16	0,41	0,33	0,42	0,30
		n	15	16	16	15	16	16	15	16	15	16
	Z3	m	1,10	1,23	1,78	2,71	3,03	0,78	1,73	2,47	3,03	2,34
		sem	0,53	0,49	0,44	0,80	0,60	0,43	0,70	0,49	0,61	0,54
		n	15	15	16	14	16	16	15	16	15	16
	Brain	m	0,70	0,90	1,70	1,95	2,06	0,39	0,92	2,09	2,68	2,13
		sem	0,35	0,32	0,35	0,48	0,29	0,19	0,35	0,36	0,32	0,32
		n	15	16	16	15	16	16	15	16	15	16

Table 24: Repeated exposure to GSM-1800 or UMTS.
Kruskall Wallis test on data on endogenous albumin leakages in cage-control, and GSM-1800- or UMTS-exposed rats versus sham-exposed rats. Different SAR levels and different brain zones (Z1, Z2, Z3) and averaged brain were tested.
For each parameter studied, statistical analysis was performed between sham-exposure and exposure to GSM-1800 or UMTS (all SAR levels) for each brain zone and time after exposure. A p value < 0.05 was considered as significant.

🟩 Significant decrease (p<0.05)
🟨 Significant increase (p<0.05)

Albumin leakage-Repeated exp. (Comparison versus sham)

	SAR	Time	Z1	Z2	Z3
Cage control	0 W/kg	0 hour	ns	ns	ns
Cage control	0 W/kg	50 days	ns	ns	ns
GSM	0.026 W/kg	0 hour	ns	ns	ns
GSM	0.026 W/kg	50 days	🟨	ns	ns
GSM	0.26 W/kg	0 hour	ns	ns	ns
GSM	0.26 W/kg	50 days	ns	ns	ns
GSM	2.6 W/kg	0 hour	ns	ns	ns
GSM	2.6 W/kg	50 days	ns	ns	ns
GSM	13 W/kg	0 hour	ns	ns	ns
GSM	13 W/kg	50 days	🟨	🟨	🟨
UMTS	0.026 W/kg	0 hour	ns	ns	ns
UMTS	0.026 W/kg	50 days	ns	ns	ns
UMTS	0.26 W/kg	0 hour	🟨	🟨	ns
UMTS	0.26 W/kg	50 days	ns	ns	ns
UMTS	2.6 W/kg	0 hour	ns	ns	ns
UMTS	2.6 W/kg	50 days	ns	ns	ns
UMTS	13 W/kg	0 hour	ns	ns	ns
UMTS	13 W/kg	50 days	ns	ns	ns