

GSM Base Stations: Short-Term Effects on Well-Being

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The purpose of this study was to examine the effects of short-term GSM (Global System for Mobile Communications) cellular phone base station RF-EMF (radiofrequency electromagnetic fields) exposure on psychological symptoms (good mood, alertness, calmness) as measured by a standardized well-being questionnaire. Fifty-seven participants were selected and randomly assigned to one of three different exposure scenarios. Each of those scenarios subjected participants to five 50-min exposure sessions, with only the first four relevant for the study of psychological symptoms. Three exposure levels were created by shielding devices in a field laboratory, which could be installed or removed during the breaks between sessions such that double-blinded conditions prevailed. The overall median power flux densities were 5.2 $\mu\text{W}/\text{m}^2$ during “low,” 153.6 $\mu\text{W}/\text{m}^2$ during “medium,” and 2126.8 $\mu\text{W}/\text{m}^2$ during “high” exposure sessions. For scenario HM and MH, the first and third sessions were “low” exposure. The second session was “high” and the fourth was “medium” in scenario HM; and vice versa for scenario MH. Scenario LL had four successive “low” exposure sessions constituting the reference condition. Participants in scenarios HM and MH (high and medium exposure) were significantly calmer during those sessions than participants in scenario LL (low exposure throughout) ($P = 0.042$). However, no significant differences between exposure scenarios in the “good mood” or “alertness” factors were obtained. We conclude that short-term exposure to GSM base station signals may have an impact on well-being by reducing psychological arousal. Bioelectromagnetics 30:73–80, 2009. © 2008 Wiley-Liss, Inc.

Key words: electromagnetic fields; GSM base stations; psychological effects; short-term exposure; questionnaires and statistics

INTRODUCTION

From the very beginning, the enormous success of mobile phone technology has been accompanied by concerns about possible health risks. In the public discussion, “non-specific” symptoms such as headaches, problems with concentration, memory impairment and fatigue are frequently reported health effects attributed to the use of mobile phones [Ofstedal et al., 2000; Sandstrom et al., 2001] and base stations located close to homes and working areas [Navarro et al., 2003; Huss and Rössli, 2006; Hutter et al., 2006; Abdel-Rassoul et al., 2007]. The term “microwave sickness” is an attempt to summarize those and other symptoms into a characteristic syndrome [Hocking, 2001; Sage, 2001].

Epidemiologic studies deal with possible adverse health effects from long-term exposure. Only a small number of experimental studies have investigated short-term exposure from base stations [Zwamborn et al.,

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2003 in the Netherlands for GSM-signal; Eltiti et al., 2007 in Great Britain for GSM- and UMTS-signal; Regel et al., 2006 in Switzerland for UMTS-signal].

One area of psychological research concerning effects from electromagnetic fields (EMFs) focuses on the differences in sensitivities between so-called *electromagnetically hypersensitive people* and non-sensitive subjects with respect to physiological and psychological reactions to various stimuli. The term idiopathic environmental intolerance with attribution to EMF (IEI-EMF) was suggested at the WHO Workshop on Electrical Hypersensitivity in Prague, Czech Republic, in 2004 [Hansson Mild et al., 2006] to describe the phenomenon, although this term is subject to debate because it assumes merely an attribution to EMF.

Provocation studies often failed to demonstrate a causal relationship between electromagnetic field exposure and symptoms [Rubin et al., 2005; Rubin et al., 2006; Wilen et al., 2006; Oftedal et al., 2007]. However, the use of artificial laboratory exposure conditions compared to “real life” mixes of exposures, has resulted in mixed findings. In Oftedal et al. [2007], for example, investigators concluded that headaches were not associated with cell phone use, although no cell phones were actually used in that study.

Newer findings in neuropsychology revealed that self-rated electromagnetically hypersensitive persons can be characterized by a significantly reduced intracortical facilitation [Landgrebe et al., 2007]. This may indicate a neurobiological predisposition to increased reactogenicity and even vulnerability concerning environmental influences. In other words, some people may be predisposed to greater reactivity or sensitivity to such exposures. On the other hand, not all studies report significant effects on the motor cortex [Inomata-Terada et al., 2007].

The objective of this study is to evaluate whether different intensities of RF-EMF (radiofrequency EMF) exposure from an operating (real-life) mobile phone GSM-signal base station with only short-term exposure to participants (five 50-min sessions of exposure at varying intensities) can cause detectable differences in subjective well-being, as assessed by questionnaires just before and towards the end of each exposure session. Similar methodology has been used in research of low-frequency-EMF [Gamberale et al., 1989; Trimmel and Schweiger, 1998].

Secondary to the experimental testing, we evaluated whether symptoms could be shown to be associated with a “nocebo” effect caused by anxiety, concerns and stress evoked by the experimental conditions (e.g., in relation to how close participants actually live (by their own estimation) to a cellular antenna site, and their own pre-existing awareness and

level of concern about RF-EMF exposure hazards in general).

METHODS

Using a randomized double-blinded experimental design, 57 volunteers (35 women and 22 men) aged 18–67 years (mean 40.72, SD 12.75) were exposed to different levels of RF-EMF (predominantly GSM-900 downlink). Most participants of our study were recruited by announcements in a local newspaper and in the local intranet of the Salzburg University Clinics. Hypersensitive individuals were neither actively recruited nor excluded as participants in this test. The study was conducted in compliance with ethical guidelines of the expanded Helsinki Declaration, including special attention to data security [World Medical Association declaration of Helsinki, 1997]. Written consent was obtained from all participants after oral and written explanations of testing procedures, discussion of the test design and possible risks.

The experiments took place in an adapted room in a kindergarten located in Salzburg City, Austria. Different intensities of GSM RF-EMF exposure were produced by varying the exposure conditions between sessions by installing and removing RF-EMF shielding. Shielding materials applied included a special type of curtain (“Swiss-Shield Naturell”; ESAG, Vienna, Austria), and a carbonaceous wall paint (HSF53; YShield, Pocking, Germany). In addition, placebo curtains of the same color and appearance were used. Participants were removed from the testing room between sessions for “breaks,” along with the experimenter who was assisting in the tests, so that neither experimenter nor participant could know what shielding conditions were in place for any experimental session. Only the technician knew what exposure conditions were present for any session, but had no contact with the participants or the experimenter.

Dosimetry

The test site was carefully examined for extremely low frequency (ELF) and RF-EMFs (including TV and public radio signals) by an accredited measurement engineer, Dr.-Ing. Martin Virnich (ANBUS Analytik GmbH, Fürth, Germany). The frequency spectrum (80 MHz–3 GHz) in the main exposure volume (with special attention to the position of the head of the test person) has been analyzed in detail, and exposure monitoring was performed during all experimental sessions via calibrated equipment, consisting of dedicated spectrum analyzers (FSH3, Rohde & Schwarz; MS2651 B, Anritsu; both Munich, Germany), antennas (SBA 9113 and EFS9218,

Schwarzbeck, Schöna, Germany) and cables AK 9513 (Schwarzbeck). In addition, electric and magnetic fields (5 Hz–30 kHz) were measured using calibrated apparatus (EFA-3, Wandel & Goltermann). Electric fields were below 1 V/m, irrespective of whether the ceiling lighting was switched on or off. Magnetic fields measured for a 100 min period showed 0.046 μ T on average and 0.057 μ T at maximum. Both electric and magnetic ELF-exposures were considered low.

During five experimental sessions, the participants sat on a comfortable wooden chair at a distance of 6 m from the GSM-900 omni antenna mounted on the façade of the building. During the five 50-min sessions, three different exposure intensities were produced (low, medium, high; Table 1) in a blinded manner, by carefully adjusting shielding and placebo curtains in front of an “inflow gap” in the wall that was left free from the shielding wall paint. During this time participants were in another room during breaks of 5 min duration in between the test sessions. Changes in shielding were made by a technician who had no contact with the participants during the whole session. The personal GSM-900 downlink exposure (from the nearby antenna) was additionally assessed using a microwave dosimeter (ESM-140; Maschek, Kaufering, Germany). During the first five min of each exposure session, the dosimeter was carefully moved by hand into a vertical semicircular position a few centimeters away from the forehead, the lower face (mouth) and the thorax (chest) of the subject by the experimenter (note that no measurement results of these procedures were displayed, either to the test participant or to the experimenter). That dynamic measurement lasted about 15–20 s for each of the three regions. After that procedure, the dosimeter was permanently fixed at the right upper edge of the wooden chair, at a distance of about 20 cm from the head and the shoulder of the participant, and left there for the remainder of each test

period (static measurements). The dosimeter simultaneously recorded band specific exposures (GSM-900, GSM 1800 and UMTS each up- and downlink, DECT, ISM 2, 4 GHz) twice per second. Recordings were visible neither to the experimenter nor to the subjects but were encoded and stored on a computer for later analysis.

In addition, a calibrated spectrum analyzer (FSH3, Rohde & Schwarz) with calibrated antenna (USLP 9143, Schwarzbeck) was permanently used to record the field strengths in the test room in the frequency range of 30–3000 MHz during the entire experiment, using the software “FSH Remote” (Rhode & Schwarz).

Using computerized allocation tables, the 57 participants were randomized into one of the three experimental exposure test scenarios. In scenario HM and MH, the first session was a baseline session with maximally shielded electromagnetic radiation (low), as were the third and fifth sessions of these scenarios. In exposure scenario HM, after a baseline low-exposure session, the least shielded condition (high) was given in the second session, and the medium shielded condition (medium) in the fourth session. For scenario MH, it was the other way around: “medium” exposure in session 2, and “high” in session 4. In experimental scenario LL, all subsequent sessions one to four were under maximal shielding (low exposure), followed by one session with minimal shielding (high exposure). Due to early termination of the study because the kindergarten was reconstructed, numbers of subjects for the three scenarios were not equal as projected. Twenty-two participants were allocated to scenario HM, 26 to scenario MH, and 9 to scenario LL. The rationale of having a high exposure session after four low exposure sessions in scenario LL was to get an idea whether prolonged maximum shielding followed by a comparatively high exposure jump after those “low” sessions would produce a noticeable difference. It was mainly included for checking biochemical parameters investigated in parallel (not reported in this article).

TABLE 1. Exposure Order for Each Experimental Test Scenario and Intensity of GSM RF-EMF Exposure for Each Test Session

Session	Scenario		
	HM	MH	LL
1	Low	Low	Low
2	High	Medium	Low
3	Low	Low	Low
4	Medium	High	Low
5	Low	Low	High

Participants were exposed to GSM RF-EMF during five 50-min sessions in differing order of strength of RF exposure where “Low” is 5.2 μ W/m², “Medium” is 153.6 μ W/m², and “High” is 2126.8 μ W/m² (power flux density expressed as median values).

Questionnaires Used Before the Experimental Sessions

Before starting the experiment, participants had to complete a number of questionnaires that included questions about medical history and a symptom-checklist (*psychosomatic symptoms*, SCL-90-R [Franke, 2002]), in which the participant had to estimate the frequency of 90 symptoms relevant for mental distress during the past 7 days. Categories of the SCL-90-R are termed *somatization*, *obsessive-compulsive*, *depression*, *anxiety*, *anger-hostility*, *phobic*

anxiety, paranoid ideation and *psychoticism*. For analyzing the sum scores, the *SCL-PST* (Positive Symptom Total) checklist was applied. Further, a questionnaire to assess physical complaints (*B-L* [Zerssen, 1976]) and the *State-Trait-Anxiety-Inventory* (*STAI-state version* [Laux et al., 1970]) were used, the latter of which to test the individual's nervousness before the experiments.

Additionally, we used a questionnaire designed to assess EMF health concerns, which included two parts—the individual's concerns about EMF-sources (*EMF-concern source*) (e.g., mobile phone), and the individual's concerns about specific symptoms (e.g., headache) from base-stations (*EMF-concern symptoms*). Both parts contained five-point scales for rating (0 = no concern, to 4 = very high concern).

The participants were also asked to estimate the distance from their home to the nearest mobile phone base-station. Those who estimated living 100 m or less from a base station were asked to rate their concerns about effects on health, and also on well-being possibly due to exposure from this base station. All other participants were asked to imagine living in proximity to a base station and to rate their possible concern. This procedure was necessary to obtain a valid personal risk assessment which may differ from estimation of general risk, as it is often discussed [Slovic, 2001]. *Electromagnetic hypersensitivity* was self-identified (five-point scale: 0 = not at all, 4 = very strong).

Questionnaires Used During the Experimental Sessions

Well-being was assessed using a standardized well-being questionnaire (*MDBF*—Mehrdimensionaler Befindlichkeitsfragebogen [Steyer et al., 1997]) shortly before starting the test sessions and three min before the end of each of the five sessions. That test included three factors of well-being (*good mood, alertness, and calmness*) and a sum score for each. Participants were asked to answer how well 24 adjectives would describe their own well-being at the specific moment (e.g., for “tired,” the response categories ranged from 1 = “not at all” etc., to 5 = “very”).

Statistics

For statistical analyses, the software packages *SPSS 14.0* (SPSS, Chicago, IL) and *Statistica 6.0* (Statsoft, Tulsa, OK) were used. All scores for each of the sessions were related to the baseline ratings. Normality and homogeneity of variances of these relative figures were obtained by logarithmic transformation. In those analyses, we have omitted the last session to allow comparison to a control condition with all sessions under maximum shielding. Well-being was

statistically analyzed by ANOVA with linear contrasts comparing scenario HM (high exposure followed by low and then medium exposure), and scenario MH (medium exposure followed by low and then high exposure) with the control condition LL (low exposure throughout). The second factor, sequence of sessions, was included in the analyses as done with the subjects factor.

Age, gender, and degree of possible electromagnetic hypersensitivity were assessed as covariates. However, because gender and hypersensitivity were far from being significant, only age was retained.

RESULTS

Experimental Findings

Dosimetry. Narrow band measurements via spectrum analyzers showed that the RF-EMF spectrum was dominated by two GSM-900 MHz downlink signals, one broadcast control channel (BCCH) plus one traffic channel (TCH), originating from a 50-cm-micro-cell omni-directional antenna mounted on the outer wall of the building. During the experiments, that GSM 900 antenna operated with constant BCCH and variable TCH output, leading to a fluctuation in power flux density by a factor of two (3 dB). At exposure situation “high,” other RF-EMF sources like public radio, TV channels, GSM 1800, DECT, UMTS, WiFi, etc., had power densities of at least a factor of 400 below the GSM-900 downlink signals mentioned before.

Results of the permanent (static) measurements in the GSM-900 downlink band showed stable exposure conditions during each of the sessions. Overall power flux densities given as a median were 5.2 (5th percentile (P5) = 1.4, 95th percentile (P95) = 15.5) $\mu\text{W}/\text{m}^2$ for low, 153.6 (P5 = 21.3, P95 = 468.0) $\mu\text{W}/\text{m}^2$ for medium, and 2126.8 (P5 = 827.3, P95 = 4908.4) $\mu\text{W}/\text{m}^2$ for high (Table 2). Table 2 also shows power flux densities by scenario and session.

The dynamic body measurements via the ESM-140 showed comparable power densities for the three key body regions (forehead, mouth, chest) examined.

Well-being during exposure experiments. No relation to age, gender or hypersensitivity was found, and no exposure/gender-interaction or exposure/hypersensitivity-interaction was detected. A priori contrasts of scenarios HM and MH versus scenario LL showed no differences for *good mood* and *alertness* but were significant for *calmness*. Both the contrasts of HM and MH versus LL ($P = 0.042$) as well as of HM versus LL ($P = 0.030$) showed that higher exposed participants had significantly higher values for *calmness* than those

TABLE 2. Percentiles (5th, 50th, and 95th) of Power Flux Densities Measured During Three Experimental Sessions Differing in the Sequence of Shielding of High Frequency EMFs and Overall Power Flux Densities of the Three Different Exposure Levels

Session	Scenario HM			Scenario MH			Scenario LL		
	P5	P50	P95	P5	P50	P95	P5	P50	P95
1	1.6	5.2	15.7	1.5	5.7	14.7	1.9	6.5	26.0
2	694.5	1858.0	3829.8	30.5	168.4	446.5	1.5	5.1	16.5
3	1.1	3.9	13.8	1.4	5.4	16.0	1.6	5.0	16.0
4	16.0	128.8	490.8	912.6	2130.5	5389.7	1.6	5.2	14.3
5	1.2	4.7	14.3	1.6	5.6	14.1	1289.8	2939.0	4967.7
Exposure	Low			Medium			High		
	P5	P50	P95	P5	P50	P95	P5	P50	P95
	1.4	5.2	15.5	21.3	153.6	468.0	827.3	2126.8	4908.4

The results shown here were obtained using the microwave dosimeter ESM-140 at a fixed position near the subject's head during the whole experimental session after dynamically measuring three body regions. The three shielding conditions are indicated with white background for maximum shielding, with light gray background for medium shielding, and with dark gray background for no shielding.

from control condition with lowest exposure (Table 3). For all scores of well-being except calmness, no significant effect of session (time trend) was found. Calmness showed a significantly stronger decrease over experimental sessions in the LL condition compared to both HM ($P=0.002$) and MH ($P=0.009$). *EMF-concern symptoms* had no differential effect on well-being across different exposures, although there was an a priori difference in ratings of *good mood* between groups of high versus low *EMF-concern symptoms* as seen in session 1 (low exposure) (Table 4).

Non-Experimental Findings

Electromagnetic hypersensitivity and health concern. Regarding a variety of “general” EMF-sources (*EMF-concern source*), participants stated strongest concerns about possible adverse health effects from *mobile phones* (mean 2.16, SD 2.09), followed by *high-voltage power lines* (mean 2.09, SD 1.24) or by *mobile phone base stations* (mean 2.00, SD 1.34). Lowest concerns were expressed about health effects possibly caused by a *home radio apparatus* (mean 0.75, SD 0.76), a *portable CD player* (mean 0.80, SD 0.85), or *baby monitors* (mean 0.93, SD 1.25). Health concerns

regarding EMF-sources had high internal consistency (Cronbach's $\alpha=0.91$).

Concerning *symptoms* possibly caused by mobile phone base station exposure (*EMF-concern symptoms*), *sleep disorders* raised the most concerns (mean 2.12, SD 1.36), followed by *headaches* (mean 2.04, SD 1.41) and *tiredness* (mean 1.89, SD 1.40). Lowest concerns were stated for *burning skin* (mean 0.67, SD 0.97), for conditions of *collapse* (mean 0.77, SD 1.00), and for a general feeling of *heaviness* (mean 0.77, SD 1.01). Items of *EMF-concern symptoms* to base-stations showed high internal consistency too (Cronbach's $\alpha=0.97$). Results include both participants living near base stations who have concerns or fears, and participants who do not live near base stations but were asked to imagine living near a base station.

Self-rated *electromagnetic hypersensitivity* was low in prevalence (29 persons or 55.8% answered 0 = not at all, only 8 persons or 14.3% answered with 3 = strong, or 4 = very strong) and did not correlate with any of the factors describing psychological stress. Both *EMF-concern source* as well as *EMF-concern symptoms* showed a moderate though significant positive correlation with *anger-hostility* (Spearman's $\rho=0.361$, $P=0.007$; Spearman's $\rho=0.380$,

TABLE 3. Geometric Mean Ratio of Experimental Session Ratings to Baseline Ratings, and 95% Confidence Intervals for the Three Experimental Conditions and the Three Factors of the MDBF Questionnaire [Steyer et al., 1997]

Factor	HM	MH	LL
Good mood	1.007 [0.973–1.042]	1.017 [0.985–1.049]	0.978 [0.927–1.031]
Alertness	0.891 [0.816–0.973]	0.938 [0.865–1.017]	0.832 [0.725–0.954]
Calmness	1.063 [1.013–1.116]	1.034 [0.989–1.082]	0.962 [0.892–1.038]

HM, high exposure followed by low and then medium exposure; MH, medium exposure followed by low and then high exposure; LL, low exposure throughout.

TABLE 4. Comparison of Subgroups With Low and High Health Concerns (Cut-Point Median Score) About Base Stations (EMF-Concern to Obtain Symptoms From Base Stations) By Mann–Whitney *U*-tests of the session 1—ratings of well-being (MDBF questionnaire [Steyer et al., 1997])

Factor	“Low concern”		“High concern”		U	P
	Md	P25–P75	Md	P25–P75		
Good vs. bad mood	39.0	36.3–40.0	37.0	35.0–38.0	215.0	0.005
Alertness vs. fatigue	35.0	29.3–39.8	32.0	28.0–37.0	279.5	0.096
Calmness vs. restlessness	39.0	32.3–40.0	36.0	33.0–39.0	314.0	0.274

Md, median; P25, 25th percentile; P75, 75th percentile.

$P = 0.004$) and *interpersonal sensitivity* (Spearman’s $\rho = 0.301$, $P = 0.025$; Spearman’s $\rho = 0.344$, $P = 0.010$). *EMF-concern symptoms* is also correlated with *anxiety* (Spearman’s $\rho = 0.312$, $P = 0.020$) and *SCL sum score PST* (an indicator for psychological distress) (Spearman’s $\rho = 0.274$, $P = 0.043$).

DISCUSSION

The present study was carried out in an attempt to assess well-being during short-term exposure to EMF similar to exposures near a GSM-900 base station antenna. In contrast to other experimental studies carried out in a laboratory [Zwamborn et al., 2003; Regel et al., 2006; Eltiti et al., 2007], the present study was conducted in a room of a kindergarten under real-world conditions expected to arouse less anxiety or other negative feelings (“nocebo” effect), whilst at the same time maintaining strict control over the exposure conditions by application of shielding curtains and permanent dosimetry. During all exposure sessions, power densities in close proximity to participants were recorded using calibrated scanning equipment. Personal exposure to the GSM-900-downlink-signals was assessed via a microwave dosimeter in three different regions of the body (forehead, mouth, chest) of each study participant at the beginning of each session, followed by static measurement using the same dosimeter at a constant distance adjacent to the head and the shoulder of the participant for the remaining time. Real life exposure conditions were guaranteed due to normal operation of the base-station antenna resulting in fluctuations of power flux density of around twofold during each of five experimental sessions of 50 min each. An additional source of variation is wave interference from reflection and multi-path propagation, resulting in a local variation of the power flux densities of about tenfold. Interference is the usual situation in real life, and exposures in anechoic chambers compared to real life exposure conditions are very limited in their ability to capture circumstances

where multi-path propagation is the rule. Static permanent measurements during the five sessions showed, however, sufficiently stable exposure conditions during each session required to obtain relevant differences between the exposure levels (low, medium, high).

Well-being was assessed by a standardized questionnaire (MDBF—Mehrdimensionaler Befindlichkeitsfragebogen [Steyer et al., 1997]). This kind of measurement has advantages but also raises problems: First, one cannot rule out that the vocabulary choices are too limited for participants to describe the feelings they have with exposures, and the choices given for adjectives describing their symptoms are inadequate or off-target. Second, vocabulary can easily be suggestive—so the questionnaire itself could have an effect. Third, symptom lists—frequently used in RF-EMF-studies—are problematic with repeated measurements in short intervals and not very sensitive to subtle changes in general condition of a person. We addressed these problems by selection of questionnaire. The German MDBF-version uses 24 adjectives belonging to three well-being dimensions extracted by factor analysis, an instrument suitable for repeated measurements in short intervals. Further, adjectives were not suggestive—that is, not related to RF-EMF area or formulated to raise fear or concern. Although electromagnetic hypersensitives often claim that their symptoms start within minutes after exposure, some researchers have doubts that very short time RF-EMF exposure can have detectable effects within this time [Zinelis, 2008]. In other words, exposure can have delayed effects. Our data analysis tried to focus on this problem—as well as is possible in a short-term experiment. By comparing sessions 2–4 by scenario, scenario LL was the control condition. Under the assumption of no RF-EMF effects, time trend should be the same in all three scenarios. If we had significant effects from exposure scenarios HM and MH, then these effects must be different from those produced by exposures in scenario LL, because scenario LL had low exposure throughout between sessions 2 and 4.

Although subacute effects possibly occurring hours after exposure could not be measured in this test protocol, at least this test provided results for a longer time period than had previous testing.

A statistically significant difference in the scale *calmness versus restlessness* between higher exposure conditions compared to the control condition with maximal shielding in all sessions was observed; the other factors of well-being showed no significant differences. It appears therefore that, during the higher exposure sessions, participants felt calmer than during low exposure. Although this result could be due to chance because of testing of multiple endpoints (note that applying multiple endpoint adjustment, for example, by the Hochberg procedure, no significance at the 5% level would be obtained), it is consistent with evidence from sleep experiments and EEG studies which revealed a slight hypnotic effect and an increased power in the Alpha band [Mann and Röschke, 1996; Borbély et al., 1999; Huber et al., 2000; Lebedeva et al., 2000, 2001].

Calmness declined in the low exposure condition, as may be expected to occur while sitting for hours in the same room. This decline, however, was not observed in scenarios HM and MH with higher exposures, suggesting an inhibitory effect.

There was no difference in well-being related to exposure between self-rated high versus low electromagnetic hypersensitivity, or between high versus low health concerns (*EMF-concern symptoms*). Similar results had been reported for well-being ratings and also for certain physiological measurements in sensitive individuals and controls [Eltiti et al., 2007], suggesting that short-term exposure may not result in substantial differences in well-being, either in individuals perceiving themselves as sensitive to EMF exposures, or in less subjectively affected persons.

A moderate correlation between *EMF-concern source* as well as about *EMF-concern symptoms* and *anger-hostility* as well as with *interpersonal sensitivity* was found. The latter concerns also correlated moderately with *anxiety* and the *PST score*. Although anxiety and concerns must be differentiated due to the specific target of the latter, there is an overlap insofar as people with high anxiety are expected to be more concerned about health risks that are possible but not yet established. The “psychosomatic hypothesis” claims that psychological factors could lead to physiological symptoms and decreased well-being, if a person has concerns about adverse health effects and realizes he/she is in the vicinity of a base station [Mortazavi et al., 2007]. Our results give only weak support for this hypothesis, because only mood at baseline showed a relationship to concerns about base-

stations, and there was no difference in any of the indicators of well-being in the course of the experiment between individuals with high versus low concerns (EMF-concern symptoms).

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