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Altered cortical excitability in subjectively electrosensitive patients: Results of a pilot study

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Abstract

Objective: Hypersensitivity to electromagnetic fields is frequently claimed to be linked to a variety of unspecific somatic and/or neuropsychological complaints. Whereas provocation studies often failed to demonstrate a causal relationship between electromagnetic field exposure and symptom formation, neurophysiological examinations highlight baseline deviations in people claiming to be electrosensitive. **Methods:** To elucidate a potential role of dysfunctional cortical regulations in mediating hypersensitivity to electromagnetic fields, cortical excitability parameters were measured by transcranial magnetic stimulation in subjectively electrosensitive patients (n=23) and two control groups (n=49) differing in their level of unspecific health complaints. **Results:** Electrosensitive patients showed reduced intracortical facilitation as compared to both control groups, while motor thresholds and intracortical inhibition were unaffected. **Conclusions:** This pilot study gives additional evidence that altered central nervous system function may account for symptom manifestation in subjectively electrosensitive patients as has been postulated for several chronic multisymptom illnesses sharing a similar clustering of symptoms.

Keywords: Chronic multisymptom illnesses; Electromagnetic hypersensitivity; Intracortical facilitation; Transcranial magnetic stimulation

Introduction

Hypersensitivity to electromagnetic fields as an alleged cause of many unspecific somatic and/or neuropsychological complaints of patients is very common in western communities, with an assumed prevalence of up to 3% [1,2]. However, a clear definition of "electromagnetic hypersensitivity" and its diagnostic criteria is lacking so far [3]. The initial symptoms recognized in association with exposure to electromagnetic fields were dermatologic in nature, such as itching, burning, and various kinds of dermatoses frequently found on the face. This prior symptom constellation extended to a so-called "general syndrome" [4], including neurasthenic and/or somatic symptoms, such as dizziness, fatigue, headache, difficulties in breathing, or palpitations. Despite accumulating experience, a clear relationship between exposure to electromagnetic fields and these symptoms has not yet been established, and a majority of published provocation studies failed to demonstrate this relationship [5–8]. Due to these findings, symptom generation in these patients may be rather based on dysfunctional attributions of somatic symptoms to electromagnetic field exposure than to the exposure itself. The symptoms of subjectively electrosensitive patients are unspecific and overlap with many other syndromes of environmental intolerance, such as multiple chemical sensitivity or sick building syndrome [9,10], suggesting that hypersensitivity to electromagnetic fields should be considered as a form of a more general diagnostic entity labeled as chronic multisymptom illnesses (CMI) [11]. Despite serious scientific problems in definition

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and diagnostic criteria, the social impact of these illnesses is considerable, taking into account their high prevalence [1,2,4] and typical course, often ending in disablement [12].

Aggregated research concerning the pathophysiology of CMI has suggested that an aberrant function of centrally mediated processes may play a significant role in initiating and/or perpetuating symptoms [13]. In line with these findings, a growing body of literature reports imbalances in nervous system functions in patients with perceived electrical hypersensitivity [14–16]. To further address this issue, we used transcranial magnetic stimulation (TMS) to measure different parameters of cortical excitability (e.g., resting and active motor threshold, intracortical inhibition, and intracortical facilitation) [17] in patients claiming to be hypersensitive to electromagnetic fields. These parameters are assumed to reflect the integrity of distinct interneuronal circuits [18] and have proven to be sensitive to the detection of dysfunctional cortical regulation associated with different neuropsychiatric diseases or personality traits [19–21]. Here, we investigated whether electrosensitive patients display altered cortical excitability as compared to population controls, indicating a potential contribution of centrally mediated dysfunctional processes to symptom formation.

Materials and methods

Parameters of cortical excitability were measured in a group of people who claim themselves to be sensitive to electromagnetic fields (subjectively electrosensitive patients; n=23) and compared to those of two control groups from a representative sample of the general population in the city of Regensburg. To recruit subjectively electrosensitive patients, an article was published in a local Regensburg newspaper reporting on the study and its objectives. People who perceived themselves as electrosensitive after reading this article were invited to participate in the study. Inclusion criteria for patients with subjective electrohypersensitivity were as follows: age between 18 and 64 years and articulation of serious complaints limiting activities of daily living. Complaints were subjectively interpreted as caused by explicitly named sources of electromagnetic fields (e.g., mobile phone base stations, TV towers, etc.).

Cortical excitability parameters were measured subsequent to initial determination of individual subjective perception levels using magnetic stimuli [22]. For various reasons (e.g., refusal to give informed consent), not all probands participated in the subsequent determination of cortical excitability. Therefore, study groups are slightly smaller in the present study than in a previously published perception experiment [22].

Population controls were recruited according to their level of unspecific health complaints, which they had reported during a prior health survey [23]. In order to maximize differences in the complaint level of the two control groups, they were measured on a Rasch conform list of 36 unspecific health symptoms, which all had been alleged in the literature to be potentially related to electromagnetic field exposure. The most frequently reported symptoms encompassed fatigue, daytime sleepiness, headache, problems in concentrating, and neck pain. Latent class and latent trait analyses revealed that all symptoms, despite their heterogeneity concerning affected organ systems, measured all the same latent psychological traits [24]. Complaint scores range from 0 (*no complaints at all*) to a theoretical maximum of 108 (*all 36 symptoms experienced in maximum intensity*). One control group stemmed from the upper decile of that sample displaying a high symptom load (high complaint level; n=23), whereas the second control group stemmed from the lowest decile with virtually no complaints (low complaint level; n=26; for details in study group recruitment and for a complete list of unspecific health complaints, see Frick et al. [22]). Mean scores in Table 1 reflect the prevalence of symptoms during the last 7 days prior to paired-pulse experiment.

Two population control groups with maximized differences concerning their levels of health complaints were chosen in order to gain maximum statistical power for potential differences in variables causing these

Table 1
Demographic characteristics and cortical excitability parameters

	Subjectively electrosensitive patients (n=23)		High-complaint-level group (n=23)		Low-complaint-level group (n=26)	
Age (years)	41.3±12.1		47.2±13.8		44.4±13.9	
Gender (male/female)	6/17		5/18		20/6	
Major depression	1/23		12/23		0	
Generalized anxiety disorder	1/23		1/23		0	
Somatoform disorder (SOMS)	0		1/23		0	
Complaint score (last 7 days)	10.9 (7.7)		16.7 (6.7)		4.5 (5.6)	
ISI (ms)	Male (n=6)	Female (n=17)	Male (n=5)	Female (n=18)	Male (n=20)	Female (n=6)
2	0.62±0.3	0.77±0.3	0.83±0.3	0.52±0.3	0.70±0.2	0.61±0.3
6	1.10±0.2	1.10±0.2	1.54±0.4	1.13±0.3	1.09±0.2	1.09±0.3
15	1.10±0.2	1.14±0.6	1.61±0.1	1.40±0.4	1.23±0.2	1.46±0.5

Demographic characteristics of subjectively electrosensitive patients and control groups, as well as parameters of cortical excitability, comorbidity rates, and Rasch scores of health complaints. Data are presented as mean±S.D.