

MYSTERY IN THE SKIN

Screen dermatitis, the effect of computer work on human skin.

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An interview with associate professor Olle Johansson at the Experimental Dermatology Unit, Department of Neuroscience, Karolinska Institute, Stockholm, Sweden.

Mr. Helge Tiainen, former head of the Nokia Consumer Electronics in Sweden once said that "The results of Olle Johansson's research could very well deeply shake the world's electronics industry, but mankind still has to know!"

Some interests might feel threatened by the results of his research, but professor Johansson has been outspoken and committed to this scientific field. He started in the 1980's and he has since been continuously very productive and an advocate for the electrosensitive persons in Sweden as well as around the world. This interview will go into what professor Johansson has discovered in the skin of those injured by computer monitors, and also what remains to be done.

He has written a number of important scientific original articles as well as a great number of commentaries and debate articles in the daily newspapers. He has been awarded a series of prestigious awards, such as the Nokia Monitor Award, the Environmental/Medicin Award from the Swedish Cancer and Allergy Foundation and the SIF-Award (The Swedish Clerical and Technical Employees Union).

Altogether, his publication list within the field of neuroscience contains more than 450 original papers, review articles and conference summaries, and he has been a co-author of papers in high-impact journals, such as Nature and Science. His skill as a lecturer is very well documented and his overall knowledge in the areas of the neurosciences, health effects of electromagnetic fields, and in experimental dermatology is esteemed at the highest level.

FEB:

What made you first interested in studying people who had suffered injuries from working in front of computer monitors?

Professor Johansson:

It all started in the 1980's after having listened to a radio programme in which Ms Kajsa Vedin from Gothenburg, herself very active from a union point of view and the author of an excellent analysis entitled "In the shadow of a microchip" (about the occupational risks involved in computer-based work), asked for expertise in neurology. As a neuroscientist I thought I was close enough, and I strongly believed that the issues she wanted to highlight, using the conventional repertoire of scientific "tools", ought to be easily investigated. I did not realise at all that there were other forces not wanting to see such studies initiated, but very soon I understood that these very clear-cut and simple and obvious investigations proposed by Kajsa Vedin would be very, very hard to start.

The same type of propositions soon were brought forward by many other persons including the two journalists Gunni Nordstrom and Carl von Schéele, who later published their first book, "Sjuk av bildskarm" ("Ill from VDT work"; Tidens Forlag, 1989, ISBN 91-550-3484-5). Unfortunately, most of these proposed studies are still not brought into life, 15 years later.

FEB:

Many people abroad think that because electrosensitivity is so well known in Sweden, that we have conducted many important studies also. But this is not the case. Why is this?

Professor Johansson:

The reason is simple, I am afraid. It is not because of lack of ideas and projects, on the contrary, the only reason is lack of funding. This fact has been very important, thus, more or less putting a dead end to the

pursuit of knowledge here in Sweden. It is sad, very sad, since I strongly believe a lot would have been understood today if scientists could have been in a situation to properly investigate this enigmatic disease. And, a great deal of unnecessary suffering among the patients could, thus, have been avoided.

FEB:

Did you ever doubt the people who claimed to have been injured using computer monitors?

Professor Johansson:

For me it was immediately clear that persons claiming skin reactions after having been exposed to computer screens very well could be reacting in a highly specific way and with a completely correct avoidance reaction, especially if the provocative agent was radiation and/or chemical emissions -- just as you would do if you had been exposed to e.g. sun rays, X-rays, radioactivity or chemical odours. The working hypothesis thus became that they reacted in a cellularly correct way to the electromagnetic radiation, maybe in concert with chemical emissions such as plastic components, flame retardants, etc., something later focussed upon by professor Denis L. Henshaw and his collaborators at Bristol University (this is covered in Gunni Nordstrom's book " Morklaggning - Elektronikens rattslosa offer" (Hjalmarson & Hogberg Forlag, 2000, ISBN 91-89080-41-6)).

Very soon, however, from different clinical colleagues a large number of other 'explanations' became fashionable, e.g. that the persons claiming screen dermatitis only were imagining this, or they were suffering from post-menopausal psychological aberrations, or they were old, or having a short school education, or were the victims of classical Pavlovian conditioning. Strangely enough, most of the, often self-made, 'experts' who proposed these explanations had themselves never met anyone claiming screen dermatitis and these 'experts' had never done any investigations of the proposed explanatory models. The explanations were soon revealed to be excuses of a scientifically fraudulent nature! It is interesting to see that science at that time was mere witchcraft. It remains for skilful journalists to inquire how this came about.

FEB:

You created the name "screen dermatitis", a clinical term to explain the cutaneous damage developed in the late 1970's when office workers, first mostly women, began to be placed in front of computer monitors. Many of them became ill and developed cutaneous and neurological problems. Several clinical dermatologists, headed by the late professor Sture Lidén, instead talked about union-driven fears, mass media-based psychoses, imagination phenomena, Pavlovian conditioning and so forth. But you came to a totally different conclusion. Why?

Professor Johansson:

I refused to reduce people to an ill-defined psychologic home-made diagnosis, without any support even among experts in psychology and psychiatry. Instead, I called for action along lines of occupational medicine, biophysics and biochemistry, as well as neuroscience and experimental dermatology.

I support the democratic principle that citizens are allowed to be ill even in a disease, i.e. a new diagnosis, that is not yet acknowledged by the medical establishment. All diseases were once a "new diagnosis", and the medical profession strongly has doubted asbestosis, cold urticaria, AIDS, the mad cow disease, skin lice, etc. I usually end my lectures with a quotation from Albert Einstein "The important thing is not to stop questioning". I have never stopped asking questions and I am using the answers to put into place the ever-growing number of pieces of a very, very complicated and enigmatic puzzle.

FEB:

Mr. Helge Tiainen, former head of the Nokia Consumer Electronics in Sweden, in February 23, 1994, said that "The results of Olle Johansson's research could very well deeply shake the world's electronics industry, but mankind still has to know!" You have received death threats, and been generally harassed. Do you think this has anything to do with your attempts to let "mankind know" ?

Professor Johansson:

Unfortunately, yes.

FEB:

Your Ph.D. thesis was about neuropeptides in the central and peripheral nervous system. Are they also involved in the reactions in the skin of the electrically sensitive?

Professor Johansson:

This is a very important question you bring up! This is something we have wanted to study for many years, but so far we have not been able to pursue these lines of interest due to lack of funding. Since the persons claiming electrosensitivity/screen dermatitis report cutaneous sensations, such as itch, pricking pain, redness, etc., of course the peripheral as well as the central nervous system must be involved. And, by understanding alterations in the chemical neurotransmitter or neuromodulator levels, synthesis, breakdown, release and re-uptake, much could be learnt and understood about the basis for these avoidance reactions based upon signals transmitted via the classical sensory and autonomic pathways.

The reaction pattern definitely points to a true biophysical effect, and not to anything else. And, finally, if you take into consideration the large number of publications showing severe changes or damages from low- or high-frequency irradiation of cells, tissues and non-human experimental animals, such alterations cannot ever be understood as "post-menopausal stress reactions", "imagination" or "techno-stress alterations"!

FEB:

You have in 1995 shown that histamine can exist in nerves in the skin. What does this mean?

Professor Johansson:

Already in 1953, the Swedish Nobel Laureate, professor Ulf von Euler had shown that peripheral nerves biochemically could contain histamine. It was argued at that time that it only was due to a contamination of histamine from mast cells present around the peripheral nerves. However, further physiological experiments indicated that maybe there could be both central neurons containing histamine (recently proved) as well as peripheral nerves in various target organs.

Using a histamine-based immunohistochemistry we could then, in 1995, show images revealing the presence of histamine-immunoreactive nerves in the skin (1). Naturally, such a finding is of paramount importance, since all studies on histamine effects in the skin have been based on the assumption that the histamine only is released from local mast cells. So, for instance regarding itch, now we have had to reconsider the function of nerve terminal-derived histamine, something also of the greatest impact for areas such as electrosensitivity.

(1) Johansson O, Virtanen M, Hilliges M, "Histaminergic nerves demonstrated in the skin. A new direct mode of neurogenic inflammation?", *Exp Dermatol* 1995; 4: 93-96

FEB:

When you look at a biopsy from an electrically sensitive person, what do you usually find?

Professor Johansson:

We are right now in the process of examining a larger number of facial skin samples, and from them the most common finding is a profound increase of mast cells. Nowadays we do not only use histamine, but also other mast cell markers such as chymase and tryptase, but the pattern is still the same as reported previously for other electrosensitive persons (2). Furthermore, increases of similar nature have now been demonstrated in an experimental situation employing normal healthy volunteers in front of visual display units, including ordinary house-hold television sets (3).

Among earlier studies, one paper (4) ought to be mentioned. In it, facial skin from so-called screen dermatitis patients were compared with corresponding material from normal healthy volunteers. The aim of the study was to evaluate possible markers to be used for future double-blind or blind provocation investigations. Differences were found for the biological markers calcitonin gene-related peptide (CGRP), somatostatin (SOM), vasoactive intestinal polypeptide (VIP), peptide histidine isoleucine amide (PHI),

neuropeptide tyrosine (NPY), protein S-100 (S-100), neuron-specific enolase (NSE), protein gene product (PGP) 9.5 and phenylethanolamine N-methyltransferase (PNMT).

The overall impression in the blind-coded material was such that it turned out easy to blindly separate the two groups from each other. However, no single marker was 100% able to pin-point the difference, although some were quite powerful in doing so (CGRP, SOM, S-100). However, it has to be pointed out that we cannot, based upon those results, draw any definitive conclusions about the cause of the changes observed. Whether this is due to electric or magnetic fields, a surrounding airborne chemical, humidity, heating, stress factors, or something else, still remains an open question. Blind or double-blind provocations in a controlled environment (3) are necessary to elucidate the underlying causes for the changes reported in this particular investigation.

(2) Johansson O, Liu P-Y, ""Electrosensitivity", "electrosupersensitivity" and "screen dermatitis": preliminary observations from on-going studies in the human skin". In: Proceedings of the COST 244: Biomedical Effects of Electromagnetic Fields - Workshop on Electromagnetic Hypersensitivity (ed. D Simunic), EU/EC (DG XIII), Brussels/Graz, 1995; 52-57

(3) Johansson O, Gangi S, Liang Y, Yoshimura K, Jing C, Liu P-Y, "Cutaneous mast cells are altered in normal healthy volunteers sitting in front of ordinary TVs/PCs - results from open-field provocation experiments", J Cutan Pathol, 2001, in press

(4) Johansson O, Hilliges M, Han SW, "A screening of skin changes, with special emphasis on neurochemical marker antibody evaluation, in patients claiming to suffer from screen dermatitis as compared to normal healthy controls", Exp Dermatol 1996; 5: 279-285

FEB:

You made a sensational finding when you exposed two electrically sensitive individuals to a TV monitor. When you looked at their skin under a microscope, you found something that surprised you. What?

Professor Johansson:

I guess that you are aiming at one of the early papers (5). In this article, we used an open-field provocation, in front of an ordinary TV set, of 2 patients regarding themselves as suffering from skin problems due to work at video display terminals. Employing immunohistochemistry, in combination with a wide range of antisera directed towards cellular and neurochemical markers, we were able to show a high-to-very high number of somatostatin-immunoreactive dendritic cells as well as histamine-positive mast cells in skin biopsies from the anterior neck taken before the start of the provocation. At the end of the provocation the number of mast cells was unchanged, however, the somatostatin-positive cells had seemingly disappeared. The reason for this latter finding is discussed in terms of loss of immunoreactivity, increase of breakdown, etc. The high number of mast cells present may explain the clinical symptoms of itch, pain, edema and erythema. Naturally, in view of the present public debate, the observed results are highly provocative and, I believe, have to be taken much more seriously.

(5) Johansson O, Hilliges M, Bjornhagen V, Hall K, "Skin changes in patients claiming to suffer from "screen dermatitis": a two-case open-field provocation study", Exp Dermatol, 1994; 3: 234-238

FEB:

You mention mast cells in the skin. A doctor, John Holt, in Australia has written to us saying that when working with microwaves (to irradiate cancer cells) he has observed that the microwaves from cell phones cause a doubling of histamine (which are released from mast cells) and that such electrosmog from mobile phones could be the cause of the ever increasing asthma and other allergies. Does his reasoning make any sense?

Professor Johansson:

It certainly does! I have put forward this hypothesis many years ago, in public here in Sweden, and I am now happy to finally see more and more data gathering to support this idea. I and my collaborator, dr. Shabnam Gangi, have also addressed this in two recent publications (see below).

FEB:

You and your partner Shabnam Gangji have presented a theoretical model for how mast cells and substances secreted from them (e.g. histamine, heparin and serotonin) could explain sensitivity to electromagnetic fields. Could you, please, explain this? And also, please, explain the function of the Langerhans cells and how long it takes for them to return.

Professor Johansson:

Yes, we have published two papers of theoretical nature (6,7). They bounce off from known facts in the fields of UV- and ionizing irradiation-related damages, and use all the new papers dealing with alterations seen after e.g. power-frequency or microwave electromagnetic fields to propose a simple summarizing model for how we can understand the phenomenon of electrosensitivity. I strongly recommend the readers of this interview to familiarize themselves with these publications, since I fully believe they have a lot to offer as food for further thoughts.

In the first paper, in the journal *Experimental Dermatology* (6), we describe the fact that an increasing number of persons say that they get cutaneous problems as well as symptoms from certain internal organs, such as the central nervous system and the heart, when being close to electric equipment. A major group of these patients are the users of video display terminals, who claim to have subjective and objective skin- and mucosa-related symptoms, such as pain, itch, heat sensation, erythema, papules, and pustules. The central nervous system-derived symptoms are, e.g. dizziness, tiredness, and headache. Erythema, itch, heat sensation, edema and pain are also common symptoms of sunburn (UV dermatitis). Alterations have been observed in cell populations of the skin of patients suffering from so-called screen dermatitis similar to those observed in the skin damaged due to ultraviolet light or ionizing radiation. In screen dermatitis patients a much higher number of mast cells have been observed. It is known that UVB irradiation induces mast cell degranulation and release of TNF-alpha. The high number of mast cells present in the screen dermatitis patients and the possible release of specific substances, such as histamine, may explain their clinical symptoms of itch, pain, edema and erythema. The most remarkable change among cutaneous cells, after exposure with the above-mentioned irradiation sources, is the disappearance of the Langerhans' cells. This change has also been observed in screen dermatitis patients, again pointing to a common cellular and molecular basis. The results of this literature study demonstrate that highly similar changes exist in the skin of screen dermatitis patients, as regards the clinical manifestations as well as alterations in the cell populations, and in skin damaged by ultraviolet light or ionizing radiation.

In the second publication (7), from the journal *Medical Hypotheses*, the relationship between exposure to electromagnetic fields and human health is even more in focus. This is mainly because of the rapidly increasing use of such electromagnetic fields within our modern society. Exposure to electromagnetic fields has been linked to different cancer forms, e.g. leukemia, brain tumors, neurological diseases, such as Alzheimer's disease, asthma and allergy, and recently to the phenomenon of electrosensitivity and screen dermatitis. There is an increasing number of reports about cutaneous problems as well as symptoms from internal organs, such as the heart, in people exposed to video display terminals. These people suffer from subjective and objective skin and mucosa-related symptoms, such as itch, heat sensation, pain, erythema, papules and pustules (cf. above). In severe cases, people can not, for instance, use video display terminals or artificial light at all, or be close to mobile telephones. Mast cells, when activated, release a spectrum of mediators, among them histamine, which is involved in a variety of biological effects with clinical relevance, e.g. allergic hypersensitivity, itch, edema, local erythema and many types of dermatoses.

From the results of recent studies, it is clear that electromagnetic fields affect the mast cell, and also the dendritic cell, population and may degranulate these cells. The release of inflammatory substances, such as histamine, from mast cells in the skin results in a local erythema, edema and sensation of itch and pain, and the release of somatostatin from the dendritic cells may give rise to subjective sensations of on-going inflammation and sensitivity to ordinary light. These are, as mentioned, the common symptoms reported from patients suffering from electrosensitivity/screen dermatitis. Mast cells are also present in the heart tissue and their localization is of particular relevance to their function. Data from studies made on interactions of electromagnetic fields with the cardiac function have demonstrated that highly interesting changes are present in the heart after exposure to electromagnetic fields.

(6) Gangi S, Johansson O, "Skin changes in "screen dermatitis" versus classical UV- and ionizing irradiation-related damage--similarities and differences. Two neuroscientists' speculative review", *Exp Dermatol* 1997; 6: 283-291

(7) Gangi S, Johansson O, "A theoretical model based upon mast cells and histamine to explain the recently proclaimed sensitivity to electric and/or magnetic fields in humans", *Med Hypotheses* 2000; 54: 663-671

FEB:

Some electrically sensitive have symptoms similar to heart attacks after exposure to electromagnetic fields. Any comment on that?

Professor Johansson:

One could speculate that the cardiac mast cells are responsible for these changes due to degranulation after exposure to electromagnetic fields. However, it is still not known how, and through which mechanisms, all these different cells are affected by electromagnetic fields. In this article (7), we present a theoretical model, based upon the above observations of electromagnetic fields and their cellular effects, to explain the proclaimed sensitivity to electric and/or magnetic fields in humans.

FEB:

You have been called a scientist who has climbed down from his ivory tower to get in contact with the real world people live in. Has this been a hindrance to you?

Professor Johansson:

Unfortunately, yes, to a very, very large degree. For readers interested in this, I warmly recommend the books by Gunni Nordstrom and Carl von Scheele (8-10). They are of great value for persons wanting to acquaintance themselves with the political implications and impact of the phenomenon of new diagnoses in our society.

(8) "Sjuk av bildskarm" by Gunni Nordstrom and Carl von Schéele (Tidens Forlag, 1989, ISBN 91-550-3484-5)

(9) "Faltslaget om de eloverkansliga" by Gunni Nordstrom and Carl von Schéele (Tidens Forlag, 1995, ISBN 91-550-4083-7)

(10) "Morklaggning - Elektronikens rattlosa offer" by Gunni Nordstrom (Hjalmarson & Hogberg Forlag, 2000, ISBN 91-89080-41-6)

FEB:

How would you depict the world the electrically sensitive live in?

Professor Johansson:

As a healthy individual it is always very hard to try to describe patients' own situation, so I would rather have someone else to answer this. But, in essence, it must be a very tough daily life, having to always (very much as an allergic or asthmatic person) look out for situations of provocative nature. And, where today would you find an electric environment equal to e.g. the 1950's? Or, even more mind-boggling, where would you find a high-frequency milieu the same as last year?

Nowhere, I guess, since the growth of all such systems is so rapid and quickly covers us all. Therefore, to enable the basic freedom of choosing where to live, where to work, etc., is impossible in relation to the electrosensitive persons' requirements. And, thus, the question of electrosensitivity becomes a question about democracy!

FEB:

Why do you think some people become electrically sensitive and others do not?

Professor Johansson:

This is also a most important and interesting question. As you know, in any kind of disease, not everyone is ill, and not at the same time. Everyone will not get cancer, everyone will not break a leg, everyone will not have malaria.

This is governed by the biological statistical rules of the natural variation. But, maybe you should turn the issue around somewhat.

Perhaps all healthy persons, i.e. in the sense not being electrosensitive, ought to be extra happy for the electrosensitive ones, since they have acted as a warning for all of us? It could be, that we will owe them a lot since they reacted in time to something which the main bulk of mankind did not. Furthermore, the possibility is also that the electrosensitive persons will turn out to be tomorrow's great winners, given the fact that this Summer, twentyone world-leading scientists during a gathering in the French city Lyon, within IARC's (IARC = International Agency for Research on Cancer) expert panel, have concluded low-frequency magnetic fields as a possible cancer risk (=group 2B, containing in addition i.a. diesel and petrol fumes, chloroform, welding fume, lead and DDT). For children exposed to such low-frequency magnetic fields above 0.4 microTesla the cancer risk is doubled. (Therefore, I ask myself: How will people feel after having spent their everyday working hours at or around Vasagatan in Stockholm where the low-frequency magnetic field 1.2 meters above ground is between 0.3 and 2.2 microTesla, or in the commuter trains having levels between 1 and 100 microTesla in the traveller's compartment!?)

FEB:

Does it worry you that children use mobile telephones?

Professor Johansson:

Yes, definitely. And, as you know, also the British government has, in December last year, taken firm action in respect to this question.

FEB:

How will we look on mobile telephones in ten years?

Professor Johansson:

Hopefully without any remaining questions, scepticism or fear. I look forward to see the question-marks around this technology resolved, and a well-documented and 100% responsible, human-friendly technology being presented. And, hopefully, tomorrow's human-friendly technology will be made by Swedish companies, in that way creating a 'healthy wealth' for our country.

FEB:

What do you tell people who suggest that electric sensitivity is purely imagined or psychological?

Professor Johansson:

Well, I always ask them to then, in parallel, explain all the peer-review-published results around effects of, often very weak, electromagnetic fields on molecules, cells, tissues, organs and various non-human experimental animals, i.e. situations which cannot at all be understood in terms of imagination or psychology. In failing this task, I then ask them to return to the first statement regarding humans, and to scrutinize and re-evaluate it. As you understand, people at that moment suddenly lack scientifically sound arguments, and most of them also confess this. As you know, in the same way it is also very easy to say that all Finns carry knives, but when you look upon this statement in a scientific way it is even easier to show that it is not true!

FEB:

There are many self-appointed 'experts' who have made life difficult for the electrically sensitive. Are they always scientists?

Professor Johansson:

I am, and have always been, very surprised to see how sloppy some of my colleagues address important issues such as the above. Very often one has to realize that all 'experts' are not true scientists and scholars.

Furthermore, it is also very annoying to see that 'experts' claiming, for instance, "that the best way to treat electrosensitive persons is to completely ignore them through silence", did not have to face any personal consequence...!? Nothing happened to them, their position was not questioned, their competence as physicians was not questioned, their suitability as representatives for the medical profession was not questioned. Nothing!

What kind of society is that?

I am also very disturbed by the fact that even if the electrosensitive persons were victims of an illusion, where in the Swedish health and law system does it say that you can treat them so badly as several have done?

When I attended the medical school I was taught the very opposite: You should always address patients with kindness, a will to learn and help, support them, meet them and their concerns in a most respectful way, and so on. Where did that disappear? It seems as our world-famous Swedish health insurance policy contains very big gaps through which electrosensitive people, as well as other new diagnoses, fell, and still fall, head down!

FEB:

Do you know of anyone else in the world who has taken biopsies of electrically sensitive individuals?

Professor Johansson:

Yes, the assistant professor and histopathologist Bjorn Lagerholm at the Karolinska Hospital in Stockholm did that already in the middle of the 1980's. He also found an increase in the mast cell number, but, unfortunately, he could never publish it.

As a matter of fact, his interest very much started with a female bank employee that had received a work injury compensation for skin changes after sitting in front of a visual display monitor. Bjorn Lagerholm described in great detail her skin changes, which turned out to be very similar to the kind of cutaneous alterations you may encounter in connection with ultraviolet light or X-ray damage. It is to be noted that Bjorn Lagerholm's reputation as a histopathologist was, and is, undisputed. He had examined at least 10,000 biopsies from other skin diseases before this particular case. In addition to her, he also examined nearly 100 further screen dermatitis cases, all having the same skin changes.

Bjorn Lagerholm wrote an article in the Swedish Medical Journal ("Lakartidningen") to describe his observations. Apart from this he was never able to pursue his ground-breaking and very elegant studies. They would be buried for several years, until I and my collaborators re-initiated them in the early 1990's.

FEB:

Some doctors say that the radiation from a computer monitor could not possibly affect the human skin. The nerves are not that superficial, but what do you say?

Professor Johansson:

This is completely wrong! The idea of the deeply buried nerve fibers were put forward by the late professors David Ingvar and Bernard Frankenheuser. However, we shortly after published the first true demonstration of the epidermal nerves in human skin (11), followed by an ultrastructural identification (12) as well as a detailed description and quantification of these very superficial nerves (13).

(11) Wang L, Hilliges M, Jernberg T, Wiegleb-Edstrom D, Johansson O, Protein gene product 9.5-immunoreactive nerve fibres and cells in human skin", Cell Tissue Res 1990; 261: 25-33

(12) Hilliges M, Wang L, Johansson O, "Ultrastructural evidence for nerve fibers within all vital layers of the human epidermis", J Invest Dermatol 1995; 104: 134-137

(13) Johansson O, Wang L, Hilliges M, Liang Y "Intraepidermal nerves in human skin: PGP 9.5 immunohistochemistry with special reference to the nerve density in skin from different body regions", J Peripher Nerv Syst 1999; 4: 43-52

FEB:

Exactly how superficial are these nerves in the skin? When a person places his or her hands on a computer keyboard which gives off electromagnetic fields, can these fields affect the person enough to cause RSI (Repetitive Strain Injury). In Sweden this phenomenon is called "mouse arm" and is quite common.

Professor Johansson:

The nerves come as close as 10-40 micrometers from the stratum corneum, which could be, in e.g. the face, in itself very thin, thus, these nerves are very superficially located. Whether this is the cause for RSI, I honestly do not know, but, naturally, it is definitely a possibility to take into careful consideration.

FEB:

The skin is the largest organ of the body. It is also our foremost protector against the outside world. How does this protection-process work?

Professor Johansson:

This is a very large question, and it would take too much space and time to answer it in full detail. But, in brief, one could understand the skin as a very sensitive 'antenna system' containing, in addition, special sensory organs, such as the eyes, the nose and the ears. The function of the skin is, among many, to always guide us in an ever-changing environment, thus, enabling us to avoid tissue-damaging threats, such as heat, cold, UV-light, X-rays, radioactivity, etc. In the center of this avoidance system is, of course, our nervous system which will help us to go in the right direction, away from some situations, maybe including e.g. electromagnetic fields from computer screens and cellular telephones? The future will tell us if I was right or wrong.

FEB:

Does it seem alarming to you that so many people have reactions in their skin that point to the skin having defensive reactions from say computer work. What of the risk of developing cancer if the skin is always in a defensive mode?

Professor Johansson:

Yes, the whole concept of skin reactions is frightening, especially since the skin cancer forms, such as malignant melanoma and basalioma, are so quickly increasing their incidence. I have asked, over and over again, many colleagues if they really can rule out the surrounding electromagnetic fields as an important background factor for such cancers, and mostly they just do not even answer me.

FEB:

Helmut Kohls wife recently committed suicide due to a severe and lengthy light sensitivity condition. She had to remain in total darkness and could never go out. Many electrically sensitive have experienced precisely the same light sensitivity after their work with computers. You have written about a woman who became so light sensitive after working with a computer that she had to live in total darkness. Could you tell us more about what goes on in the skin to cause such sensitivity to light.

Professor Johansson:

Yes, to begin with, light sensitivity is increasing as a general problem in the population, and reports have been published in several countries about this. The reason behind it is not known, but from our work one could just speculate around the heat-, light- and UV-adsorbing cellular layer in the epidermis, the so-called melanocytes and their production of the pigment melanin. In the above-mentioned case-report (14), it was evident that this layer, for some unknown reason, was, more or less, completely gone. We used protein S-100 and HLA-DR (human histocompatibility complex class II (subregion DR)) as markers, and it was found that the immunoreactive dendritic cells were dramatically decreased in number, especially in the epidermis.

One could imagine that e.g. increased levels of light or UV-light, or increased levels of other frequencies of electromagnetic fields, such as microwaves, have led to a wear-down of the protective cellular shield in the skin after a long-term continuous irradiation period. If such a damage takes place, maybe the first sign would be light sensitivity in parallel to a modest electrosensitivity. However, if the damage proceeds naturally the situation could be very difficult for the patient, finally leading to a life in basically complete darkness. Several such cases have been reported, but too few studies have been done, again due to lack of funding. In our own case report (14), we could also demonstrate that vitamin A was effective as a treatment for the patient. During the vitamin A treatment, the patient was to a large extent rehabilitated regarding her general light sensitivity, however, she was still sensitive to the presence of electric equipment, although not as much as before. The metabolism of vitamin A should be considered, since, in the human visual system, vitamin A is converted to alpha-cis-retinol, which is an essential chromophore component of rhodopsin, the photoreceptor protein of the retinal rods and is therefore essential for human vision. Maybe vitamin A influences cutaneous (as well as other) cellular systems similar to the retina. One explanation is that the patient for a time lost her melanocytes (or melanocytic content) as seen with the S-100 immunofluorescence, in response to an external or internal provocation. As a reaction to this, also her HLA-DR positive dendritic cells were affected. The vitamin A may have been capable of restoring this balance, at least partially.

(14) Johansson O, Liu P-Y, Enhamre A, Wetterberg L, "A case of extreme and general cutaneous light sensitivity in combination with so-called 'screen dermatitis' and 'electrosensitivity' - a successful rehabilitation after vitamin A treatment - a case report", *J Aust Coll Nutr & Env Med* 1999; 18: 13-16

FEB:

You conducted a blind test to see if electrically sensitive persons reacted to microwaves from mobile phones, What was the outcome?

Professor Johansson:

I, and my collaborators, have done a series of such tests, some done here in Stockholm, some in Goteborg and also some in Linkoping. The experiments in Stockholm and Goteborg failed, maybe due to the fact that the surrounding environment could not be controlled from the point of low- and high-frequency signals, which may have interacted with the tests subjects. However, the study in Linkoping (15) was done in the country-side, more than 1 kilometer from the nearest live electric power source. One person was actually able to respond correctly to a mobile phone-based double-blind provocation experiment, 9 times out of 9 tests ($p < 2/1000$), both in the 'acute' phase as well as in the 'chronic' phase ($p < 1/1000$). This would mean that there may very well be negative health effects from such mobile telephones, most likely depending on their high-frequency fields.

(15) Johansson O, "Eloverkanslighet samt overkanslighet mot mobiltelefoner: Resultat fran en dubbelblind provokationsstudie av metodstudiekaraktar", *Enheten for Experimentell Dermatologi, Karolinska Institutet, Stockholm, Rapport nr. 2, 1995; ISSN 1400-6111*

FEB:

The author and journalist Gunni Nordstrom has in an interview expressed herself in the following way: "The government seems to listen to those who have the right message, the message they wish to hear. Sometimes one wonders if the authorities have these reports custom-made or if someone in the background is masterminding all important positions and is handing out investigations to those with the correct beliefs or to the untalented. The independent thinkers get their heads chopped off as soon as possible at any rate." Do you find this to be true?

Professor Johansson:

This is, naturally, impossible to precisely know at this stage, but from a speculative point of view one must say that it is odd, very odd to say the least, that the appointed experts nearly always seems to be persons that, for instance, you in the FEB would not propose. And, also when it comes to representatives in international organizations only 'yes-sayers' are invited, and never any 'whistle-blowers'. From a philosophical point of view this can prove to be sad and badly wrong, since, without the latter, companies, authorities as well as governments can be fooled and tricked into the completely wrong corner. And, to

fool your own government is, as far as I know, high treason, right? Personally, if I were the prime minister, I would be very afraid never to listen to the 'whistle-blowers' since it could be a big, big mistake, from a public health point of view, not to!

FEB:

You mentioned "whistleblowers". There have been many attempts to wear you down. Most recently you were asked to move your laboratories to a corridor containing all the rooms for household garbage, radioactive waste, dead animal carcasses, etc.! Does it come a time when it is no longer worth being a "whistleblower"?

Professor Johansson:

For the future, I would like to propose to governments and likewise to ensure that scientists dealing with new, provocative research, even with a great impact on the general economy, that they should be given a 'safety net', i.e. their personal situation, their career possibilities, etc., must be protected and not in any way hampered by the fact that they deal with the 'wrong' kind of scientific field. How, otherwise, would you have future young scientists wanting to throw away all their personal possibilities? Otherwise, I am deeply afraid that there will come a time when it is no longer worth being a "whistleblower".

FEB:

Have you received sufficient funding?

Professor Johansson:

No, never. And if not the Swedish Cancer and Allergy Foundation would have been around, I do not think I would have had the strength to carry on. But they have always argued for the importance of new, courageous and daring science, and along the lines of cancer, allergy and their connection to the environment. This has also become a leading star for me.

FEB:

What if you suddenly got unlimited funds. What would you like to pursue?

Professor Johansson:

I guess, to begin with, that I would try to accurately characterize the electrosensitive patients from a clinical as well as cellular point of view. Depending on the results, I would then continue with more detailed studies based on theories emanating from the above data. It is, more or less, impossible to say at this point what such studies would be. One thing I would, for sure though, is to employ some additional personnel since I have been very much left alone through-out the years.

FEB:

What about the EU work for a safer electromagnetic environment?

Professor Johansson:

Within this context, one very interesting, and on-going, movement is the EC-based "The European framework for protection from exposure to electromagnetic fields". About it, to begin with, there are some general comments to be made. The EC does not seem to be interested in yet another 'BSE scandal', therefore they are carefully keeping an eye on the issues around health effects and health risks (N.B. Note the difference between health effects, identified and calculated health risks and unknown health risks) from electromagnetic fields, especially from high-frequency telecommunication, such as mobile telephony. Furthermore, the EC does not regard the above-mentioned irradiation systems to be proven safe. On the contrary, I believe they strongly understand it could be a major mistake to whole-body irradiate the whole European (as well as the world's) population, 24 hours around.

FEB:

We often hear about "safe levels" of exposure and that there is "no proof of health effects". What is your response to these seemingly reassuring statements?

Professor Johansson:

It is very important to realize, from a consumer's point of view, that "no accepted proof for health effects" is not the same as "no risk". Too many times, 'experts' have claimed to be experts in fields where actually the only expert comment should have been: "I/we just do not know". Such fields were e.g. the DDT, X-ray, radioactivity, smoking, asbestos, BSE, heavy metal exposure, depleted uranium, etc., etc., etc., where the "no risk"-flag was raised before true knowledge came around. Later on, the same flag had to be quickly lowered, many times after enormous economic costs and suffering of many human beings. Along those lines, it is now (regarding "the protection from exposure to electromagnetic fields" issue) very important to clearly identify the background and employment (especially if they sit, at the same time, on the industry's chairs) of every 'expert' in different scientific committees, and likewise. It is, of course, very important (maybe even more important?) to also let 'whistleblowers' speak at conferences, to support them with equal amounts (or even more?) of economical funding as those scientists and other 'experts' who, already from the very beginning, have declared a certain source or type of irradiation, or a specified product, to be 100% safe.

FEB:

Should the precautionary principle always be our guide?

Professor Johansson:

In the case of "protection from exposure to electromagnetic fields", it is of paramount importance to act from a prudence avoidance/precautionary principle point of view. Anything else would be highly hazardous! Total transparency of information is the key sentence here, I believe consumers are very tired of always having the complete truth years after a certain catastrophe already has taken place. It shall be noted, that today's recommendation values for mobile telephony, the SAR-value, are just recommendations, and not safety levels. Since scientists observe biological effects at as low as 20 microWatts/kg, is it then really safe to irradiate humans with 2 W/kg (i.e., with 100.000 times stronger radiation!), which is the recommendation level for us? And, furthermore, it is very strange to see, over and over again, that highly relevant scientific information is suppressed or even left out in various official documents, as high up as at the governmental level of society. This is not something that the consumers will gain anything good from, and, still, the official declaration or explanation (from experts and politicians) very often is: "If we (=the experts) would let everything out in the open, people would be very scared and they would panic." Personally, I have never seen this happen, but instead I have frequently seen great disappointment from citizens who afterwards have realized they have been fooled by their own experts and their own politicians...

Another misunderstanding is the use of scientific publications (as the tobacco industry did for many years) as 'weights' to balance each other. But you can NEVER balance a report showing a negative health effect with one showing nothing! This is a misunderstanding which, unfortunately, is very often used both by the industrial representatives as well as official authorities. The general audience, naturally, easily is fooled by such an argumentation, but if you are bitten by a deadly poisonous snake, what good does it make for you that there are 100 million harmless snakes around?

FEB:

In her book " Morklaggning - Elektronikens rattslosa offer " (10), the author and journalist Gunni Nordstrom has identified a group of Swedish obfuscators, mainly Lidén, Berg, Hillert, Arnetz and Bergkvist, who have attempted to put a psychological stamp on what you would term "screen dermatitis". These people have, Gunni Nordstrom claims, written a series of articles in international journals, always quoting one another, always making sure not to mention your findings. This has, as FEB has evidence of, hindered doctors and others to understand the electrically sensitive in other countries, causing them much suffering. How can one prevent a similar scenario for future health risks, or does one always have to go through an obfuscating or denying phase before admitting to the true facts?

Professor Johansson:

Well, I certainly hope not! According to the work of professor Klas Amark at the Stockholm University this has, unfortunately, always been the case previously, but, of course, this tendency must be completely

altered in the future. No democratic and humanitarian society can hold up such principles as you indicate in your question. We have to meet the future health problems in a much more 'grown-up' fashion!

FEB:

What do you see in the future?

Professor Johansson:

The future is not dark, not at all, but bright for all kind of "human-friendly technologies", including low-irradiation and low-emitting products. For, after all, who could sell a computer screen today with the slogan: "THIS IS A HIGH-LEVEL IRRADIATION SCREEN"!?

Professor Johansson will gladly answer your questions, but due to a heavy workload, he might not be able to answer all questions. Therefore, try to be as brief as possible.

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