IS THERE A POSITIVE/NEGATIVE CAUSAL RELATION BETWEEN GSM-900/UMTS-900 AND OBSERVED CHANGES IN PRION DISEASES ?

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Abstract: The annual number of deaths by Creutzfeldt-Jakob disease (CJD) in France in persons aged less than 45 years varied considerably over the period from 1979 to 2011. It is shown that these variations are correlated to changes in emissions of artificial electromagnetic waves at 900 MHz and are explainable under a model of Creutzfeldt-Jakob disease as a partly auto-immune disease, which also provides a mechanism for normal prion recruitment and transformation into the disease-causing form. 6 distinct correlations are established in the GSM-900 bandwidth: onset of TACS in the UK with the first BSE deaths, onset of GSM-900 in France with increase of yearly CJD deaths in men aged less than 45 years old and with the first BSE deaths, onset of UMTS-900 in France with decrease of yearly CJD deaths in the same age/sex category and with decrease of the BSE deaths, onset of UMTS-900 in the UK with decrease of yearly variant CJD (vCJD) deaths, all in agreement with basic theoretical predictions. The proposed explanation for these correlations is a positive/negative causal relationship between GSM-900/UMTS-900 and CJD in the less than 45 years old/vCJD/BSE. In view of the existence of a rational physical explanation, this positive/negative causal relationship cannot be rejected as "impossible".

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1 Introduction

It was shown in (Lauer 2013) and (Lauer 2014 a,b) that electromagnetic fields interact with the immune system, including at very low power. The analysis in (Lauer 2014b) shows that auto-immune diseases are particularly likely to react to electromagnetic waves starting from a very low power value. Whilst the interaction of electromagnetic fields with auto-immunity is confirmed by the increase of the risk of contracting multiple sclerosis or dying from it in mobile phone users (Poulsen et al 2012), this finding is attributable to rather high exposure power and does not confirm the possibility of an interaction at very low exposure power. The interaction of electromagnetic fields with cancer is shown in (Lauer 2013) to take place at low exposure power (in the order of a µW/m2) but this is only an indirect proof of an interaction with auto-immune diseases. Also in (Lauer 2013), the interaction of electromagnetic waves with heart diseases and chronic liver diseases is shown to occur at the same low power, which is attributed to an auto-immune aspect of these diseases, however these diseases have multiple causes so that the attribution of the observed interaction to an auto-immune effect is somewhat open to discussion. Additionally, auto-immune diseases could potentially react to electromagnetic waves at a much lower power value than cancer, i.e. much less than the about 1 µW/m2 discussed in (Lauer 2013).

A confirmation is thus needed that electromagnetic waves can interact with auto-immune diseases at an extremely low power. This confirmation is somewhat uneasy for the following reasons:

(i) most auto-immune diseases are long-term diseases and an event causing a worsening of such diseases is likely to yield a possibly anticipated death only years after the occurrence of the event, which makes it difficult to correlate the cause (the initial event) to the outcome (the statistical increase of death rates or long-term invalidity). This is worsened by the fact that new treatments developed in the interim may strongly modify the statistical outcome.

(ii) In many cases the action of regulatory systems (including regulatory T cells) may mitigate the pro-auto-immune consequences of exposure, and this occurs more easily in long term diseases where there is ample time for the elimination of abnormally aggressive lymphocytes.

(iii) Auto-immune effects depend on the contrast between maximum exposure and background exposure, rather than on an absolute exposure level. Since many exposure systems introduce both a background and a time-varying part, it can be uneasy to deduct absolute threshold levels from statistical observations.

Similar difficulties exist concerning most neuro-degenerative diseases, including Alzheimer's, which are also long term diseases.

Concerning Creutzfeldt-Jakob Disease (CJD), it is known that the disease is transmitted by, and due to, a prion, i.e. a protein in an abnormal conformation. This prion recruits normal prions and stimulates their conversion into the abnormal form. However, it is not known how this recruitment and stimulation take place, and an explanation of this phenomenon is needed.

In this paper, variations of CJD deaths in men aged less than 45 years (i.e.prior to thymus involution) are examined. It is shown that these variations are correlated to changes in the electromagnetic environment. These correlations are explained under a model of Creutzfeldt-Jakob disease as a partly auto-immune disease, which also provides a mechanism for prion recruitment and transformation into disease-causing form. CJD thus appears as a partly auto-immune disease which, unlike most diseases known to be auto-immune, is a short term disease evolving rapidly. This short term aspect makes it conceivable to establish short-term correlations between variations in exposure to electromagnetic fields, and variations in CJD death rates. Indeed, several correlations between changes in the electromagnetic fields and changes in CJD in the less than 45 years old/vCJD/BSE are established herein, for which a logical explanation appears to be a positive/negative causal relation between CJD in the less than 45 years old/vCJD/BSE and variations in electromagnetic fields.

These findings do not directly answer the questions as to threshold levels for the effects of electromagnetic waves on auto-immune diseases, because CJD in the less than 45 years old appears to be based mostly on a reaction of the immune system against non-self prion epitopes, rather than self in the case of a strictly auto-immune disease. However, these non-self prion epitopes are “near self”, so that there is a link between the present observations and auto-immunity. Further, similar non-self epitopes may be implied in other neuro-degenerative diseases.

2 Variations of deaths by Creutzfeldt-Jakob disease in men aged less than 45 in France.

The annual number of deaths by Creutzfeldt-Jakob disease (CJD) in France for men aged less than 45 (i.e. up to 44, see Figure 1) can be split in 3 distinct periods (Table 1). The p-value concerning the difference between periods is extremely low (Table 2) and no reasonable Benferroni corrections or other can reasonably affect the significance of the difference between these distinct periods. The probability that the transition between Period 1 and Period 2 occurs in 1992 is 94% (p=0.06, see Table 9 in appendix I) and the probability that the transition between Period 1 and Period 2 occurs either in 1991 or 1992 is 99.5% (p=0.005). The probability that the transition between periods 2 and 3 occurs in 2009 [i.e. that the first year of period 3 is 2009] is 93% (p=0.07, see Table 11 in Appendix I) and the probability that it occurs in 2008, 2009 or 2010 is 99.6% (p=0.004). The period of increased CJD deaths for men aged less than 45 years (period 2 in section 2) started in 1992, corresponding to the onset of GSM-900 networks, and ended in 2009, corresponding to the onset of UMTS-900 networks on the same bandwidth as GSM-900 (see Appendix II).

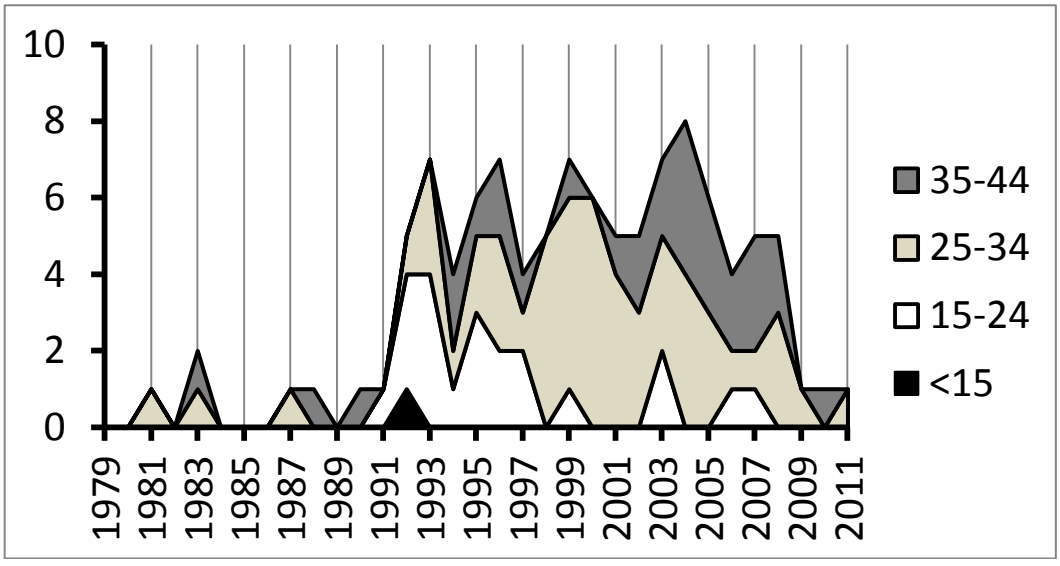

Figure 1: Number of deaths by Creutzfeldt-Jakob disease for men in France (data from CEPIDC).

Period identifier	start year	end year	years	deaths	deaths/year
1	1979	1991	13	7	0,54
2	1992	2008	17	96	5,65
3	2009	2011	3	3	1,00

Table 1: Splitting in 3 periods (men)

	z	p-value
Period 1 to period 2	7.48	7.26E-14
Period 2 to Period 3	-3.34	8.52E-04

Table 2: p-values characterizing differences between periods (men). Difference in proportions based on data in Table 1.

3 Model of Creutzfeldt-Jakob disease

Creutzfeldt-Jakob disease (CJD) is caused by a prion (Colby and Prusiner 2011). In mammals, prions reproduce by "recruiting the normal, cellular isoform of the prion protein PrP^{C} and stimulating its conversion into the disease-causing isoform PrP^{Sc} ". Prion diseases comprise a sporadic form (sCJD) most likely caused by spontaneous misfolding of PrP^{C} into PrP^{Sc}, and infectious forms including Kuru, iatrogenic iCJD and variant vCJD. Kuru is transmitted by eating infected human brains, and vCJD is transmitted for example by eating brains of infected animals. The vCJD epidemic in the United Kingdom, which is an infectious form, affected young subjects more often than other forms of CJD (15-34 years old may be typical). Sporadic forms affect essentially older subjects.

The statistical data in section 2 and the existing knowledge about prions can be reconciled based on the following simplified model:

- when restricted by the MHC inside a cell the normal prion PrP^{C} produces only “self” epitopes PS, i.e. epitopes which are also presented to lymphocytes in the thymus during negative selection. These epitopes do not cause a reaction of the immune system because lymphocytes that would recognize them are eliminated in the thymus.

- when restricted by the MHC inside a cell the abnormal prion PrP^{Sc} produces at least one “non-self” epitope PNS, i.e. an epitope which is not presented in the thymus during negative selection.

- there are no or very few lymphocyte precursors capable of recognizing PNS as their cognate epitope and surviving thymus selection, because organisms producing such precursors have been eliminated by natural evolution. Lymphocytes capable of recognizing PNS may however appear after the end of thymus involution through evolution of other lymphocytes including modification of the hypervariable regions of the TCR.

- if enough PNS are presented in a lymph node and a mature lymphocyte LNS capable of recognizing PNS is also present, a primary reaction takes place and the lymphocyte recognizing PNS as its cognate epitope is replicated.

- the replicated LNS lymphocytes selectively attack cells presenting PNS and containing PrP^{Sc} , causing more PrP^{Sc} to be spread in the organism, but also more PrP^{C} since normal prions are expected to co-exist with abnormal ones in affected cells.

- the abnormal prions and normal prions re-enter other cells. In the process of re-entering a cell, a proportion of normal prions are denatured into abnormal prions PrP^{Sc} .

- different cells cause different denaturation of the prion. For example cell type C1 causes denaturation of PrP^{C} into PrP^{Sc1} but cell type C2 causes denaturation of PrP^{C} into PrP^{Sc2} where PrP^{Sc1} and PrP^{Sc2} are different isoforms (i.e. different strains). Some cells may not cause denaturation at all on their endocytic pathway.

- assuming the disease was initially caused by PrP^{Sc1} , there is a lymphocyte line LNS1 recognizing a non-self epitope PNS1 presented by cells that contain PrP^{Sc1} . LNS1 will specifically attack cell type C1. If cell type C1 is concentrated in a specific organ O1, then attacks of cell type C1 will cause prions PrP^{C} and PrP^{Sc1} to spread into organ O1. Prions PrP^{C} will be denatured into PrP^{Sc1} on re-entering other type C1 cells in organ O1. Preferential production of PrP^{Sc1} rather than PrP^{Sc2} is due to the fact that organ O1 contains mostly cell type C1 or that cells of type C1 are clustered, so that normal prions PrP^{C} spread due to the attack of cells C1 remain mostly in an area where cells C1 dominate and dominantly re-enter cells of type C1 rather than type C2.

This model is in agreement with knowledge that PrP^{Sc} formation occurs within the endocytic pathway (Prusiner 2004 p. 533, Borchelt et al 1992, Shyng et al 1994). It explains why the initial infectious prion directs prion replication to an analogous or identical isoform (“templating”) and why PrP^{Sc} can remain confined to a specific organ (Prusiner 2004 p. 32, Prusiner et al 1990, 1997, Telling et al 1996). It also explains why severely immunodeficient mice are less likely to develop the disease than immuno-competent mice (Lasmezas et al 1996).

4 Model of the interaction of CJD with electromagnetic waves (GSM-900, UMTS-900)

The reader is encouraged to keep (Lauer 2014b) and particularly its figure 1 and Table 1 as a reference for understanding the present section. The present section is focused on the interaction of CJD with UMTS-900 and GSM-900 because of the time correlations mentioned in section 2.

4.1 Characteristics of GSM-900 and UMTS-900 exposure

GSM-900 downlink emissions have a frequency and a bandwidth which vary over time. Bandwidth varies dependent on network load. Frequency varies due to frequency hopping. In a weakly loaded network, far from the emitters, the combination of signals from several emitters has a bandwidth which depends on the frequency of each emitter, so that frequency hopping of the emitters results both in frequency and bandwidth variations.

GSM-900 downlink can thus change from maximal exposure at a predetermined frequency and bandwidth, triggering maximal response of lymphocytes responding to the corresponding bandwidth and frequency condition, to zero exposure at the same predetermined frequency and bandwidth, triggering no response from the lymphocyte. This causes a strong response under Table 1 column E of (Lauer 2014b). In comparison, UMTS-900 downlink has a constant bandwidth and can have a constant power, depending on exact protocols being used, thus triggering no response under Table 1 column E of (Lauer 2014b). Therefore, in the present approach GSM-900 downlink will be treated as variable exposure and UMTS-900 downlink will be treated as permanent exposure.

GSM-900 and UMTS-900 uplink emissions have specificities which are comparable to the downlink emissions, but are likely less essential in the present problem because at onset of a network and for the general population, downlink emissions (which comprise at least signaling channels) dominate over uplink emissions (which can be near zero if the number of users is low).

4.2 Increased survival of LNS1 lymphocytes

Lymphocytes LNS1 capable of recognizing the PNS1 epitope and survive negative selection must have an affinity for PNS1 which is superior to a recognition threshold and an affinity for the self epitope PS which is below the recognition threshold. This is unusual because PNS1 resembles PS so that the affinity for PNS1 is normally not too different from the affinity for PS. Yet such lymphocytes may occur from time to time and trigger CJD in natural conditions.

Let us consider a supplementary lymphocyte precursor LNS1-A which recognizes both the PNS1 epitope and the PS epitope. Assume that recognition of the PS epitope by LNS1-A can be inhibited by GSM-900, at an appropriate frequency and bandwidth (mechanism INH). If the epitope PS is presented to the LNS1-A precursor during an exposure period for negative selection, this lymphocyte LNS1-A will survive instead of being eliminated.

4.3 Triggering of chain reaction.

In the absence of the electromagnetic wave this LNS1-A lymphocyte is abnormally aggressive against both PS and PNS1. Regulatory T cells or other regulatory mechanisms will recognize and eliminate LNS1-A based on its aggressiveness towards PS but if any PNS1 epitopes are presented in lymph nodes the capability of LNS1 to start a primary reaction and be replicated depends on its aggressiveness towards PNS1, so that if LNS1-A is more aggressive against PNS1 than against PS it has more chances of being replicated. LNS1-A may start a primary reaction and be replicated after encountering PNS1 in a lymph node, thus starting the chain reaction described in section 3. Temporary exposures to GSM-900 at the appropriate bandwidth and frequency to inhibit recognition of PNS1 by LNS1-A do not significantly slow down the reaction insofar as they occur during less than half the available time. Insofar as the chain reaction multiplies abnormal prions PrP^{Sc1} and their corresponding lymphocytes LNS1 faster than regulatory systems can control the lymphocytes, the disease quickly evolves towards death.

4.4 Basic effect of UMTS-900

If there is a permanent exposure at the same power/frequency which caused the survival of LNS1-A, LNS1-A is not abnormally aggressive because recognition of PNS1 by LNS1-A is permanently inhibited (i.e. thymus selection occurs under substantially the same exposure as epitope recognition on a target APC), and thus LNS1 does not cause disease. This can be viewed as the basic principle underlying the interruption of CJD deaths due to permanent exposure to UMTS-900. In essence, the above is very similar to the effect of electromagnetic waves on any auto-immune disease: exposure to varying power/frequency/bandwidth is pro-auto-immune, but exposure to a constant power, frequency and bandwidth is neutral.

In this “auto-immune” picture, one surprising aspect is that the start-up of UMTS-900 was sufficient to fully interrupt abnormal CJD deaths in corresponding age categories, whilst it was initially at a very weak power globally (there was no large-scale installation of UMTS-900 in France in 2009). This would be surprising if CJD was a theoretical “strictly auto-immune” disease because UMTS-900 raised the background but GSM-900 variations expected to yield an effect under Table [Lauer 2014b-1] column E remained much stronger than the raised background.

4.5 Explanations for the low power threshold of GSM-900

An explanation for the efficiency of low-power UMTS-900 in interrupting abnormal CJD deaths is as follows:

a) PNS1 is a non-self epitope. The presence of an appropriate electromagnetic wave during thymus selection can promote the survival of supplementary LNS1-A lymphocytes which would not otherwise have survived, but absent the electromagnetic wave these supplementary lymphocytes recognize PS more strongly than lymphocytes which would otherwise have survived. This implies that the Rabi frequency Ω_{ab} of the oscillations between wells (a) and (b) of figure 3 of (Lauer 2014b) is lower, and

thus that the energy path between wells (a) and (b) is more efficiently blocked, which based on the simple picture in figure 4 of (Lauer 2014b) implies that the recognition is more epitope-specific. This epitope-specificity relative to PS means that such supplementary lymphocytes tend to be more efficient in recognizing PS and less efficient in recognizing PSN1 as compared with any normal LNS1 lymphocytes which would have been selected without the presence of an electromagnetic wave, i.e. their affinity curves are shifted towards PS on Figure 2. The ability of the supplementary LNS1-A lymphocytes to recognize PNS1 results from a balance between diminished ability due to more epitope-specificity towards PS, and increased ability due to having survived negative thymus selection despite their abnormally strong aggressiveness towards PS.

b) Any supplementary LNS1-A lymphocyte capable of recognizing PNS1 in the absence of the artificial electromagnetic wave adds up to the normal LNS1 lymphocytes and contributes to an increased risk of starting a primary reaction and developing CJD when the GSM signal has periods of zero exposure in an appropriate frequency range.

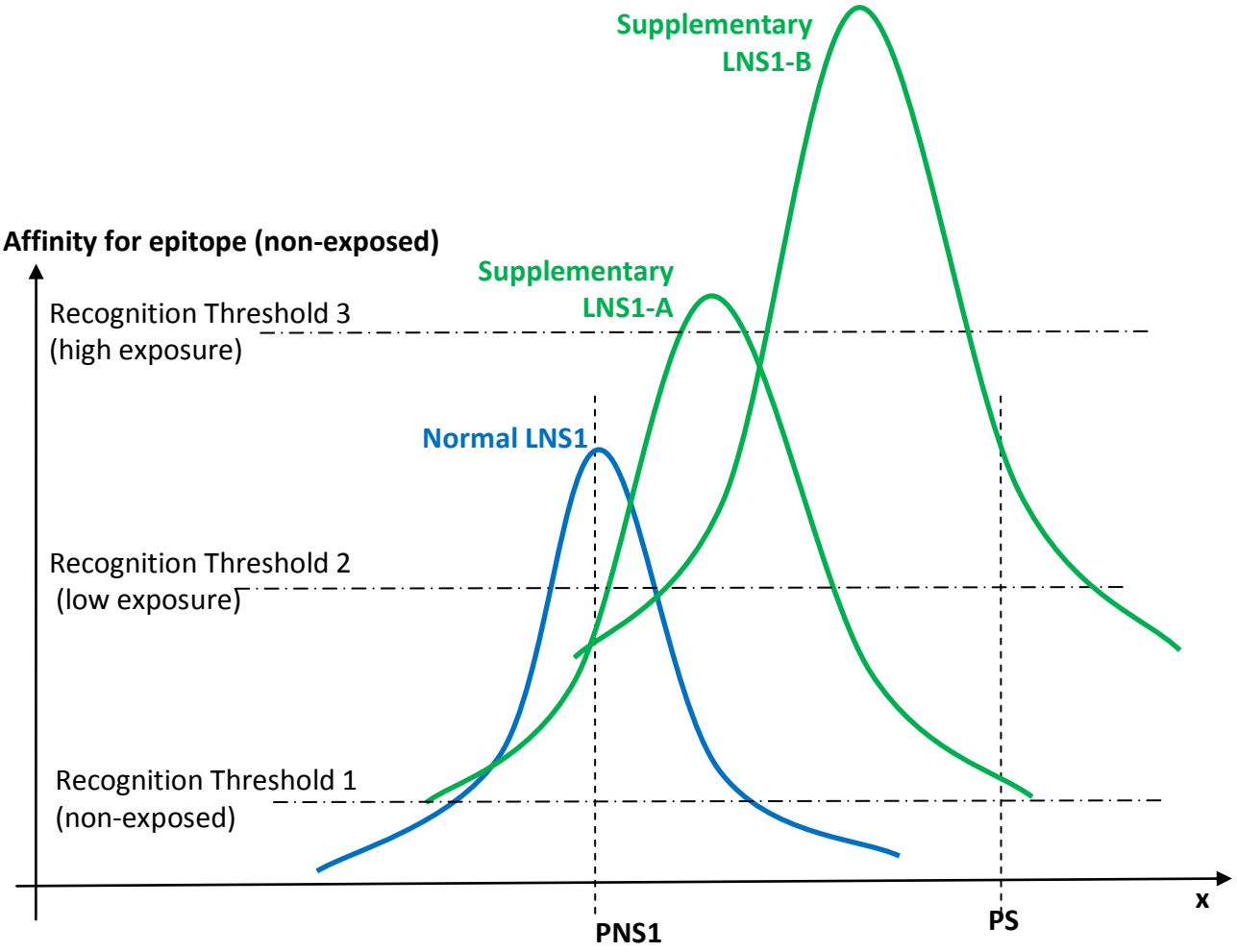

Figure 2: Positions of epitopes PNS1 and PS (dotted lines) along an arbitrary coordinate x is shown, together with curves representing the affinity of various lymphocytes for epitopes in the absence of exposure to an electromagnetic wave. Different exposure powers can be viewed as determining different recognition thresholds on the curves corresponding to the non-exposed affinity. The supplementary lymphocyte LSN1-A does not recognize PS at low exposure corresponding to the recognition threshold 2, so it can survive thymus selection at low exposure and requires only low exposure GSM power to appear. The supplementary lymphocyte LSN1-B recognizes PS at low exposure but not at high exposure, so it requires high exposure GSM power to appear. However, neither of them recognizes PNS1 at low exposure, so both of them are rendered inefficient by a low-exposure permanent signal, which is thus enough to stop the disease even when GSM exposure is at high power. Note that lymphocytes resembling the normal LNS1 do not recognize PS, thus they are un-affected by GSM exposure and they do not survive in higher numbers in the presence of GSM. Thus GSM exposure tends to promote survival of lymphocytes having decentered curves like LNS1-A, with more decentered curves for higher GSM powers, like LNS1-B. *Note that epitopes form a discrete space. The present representation of epitopes in a single-dimensional continuous space is useful to support reasoning but is only a partial approach of reality.*

c) In the presence of a constant background (UMTS-900) superimposed on the variable GSM-900 signal:

- the affinity of normal LNS1 lymphocytes for epitope PNS1 is diminished.

- the affinity of supplementary LNS1-A lymphocytes for the epitope PNS1 is also diminished. However, on average these lymphocytes have affinity curves de-centered with respect to the epitope PNS1, i.e. their “exact” cognate epitope is between PNS1 and PS. As shown on Figure 1, the affinity of these supplementary lymphocytes for PNS1 tends to be below the

recognition threshold at a low exposure power (threshold 2) even if these lymphocytes survived thymus selection at a higher power corresponding to a higher threshold (threshold 3) so that the number of supplementary LNS1-A lymphocytes contributing to the risk of CJD drops quickly even at low exposure power.

Therefore, overall the capability of the pool of lymphocytes (including normal LNS1 and supplementary LNS1-A lymphocytes) to recognize PNS1 and cause CJD can be strongly diminished in the presence of a constant low-power UMTS-900 background superimposed on the varying GSM-900 signal, which would not occur if PNS1 was a self epitope. Even if the background signal is low enough so that the normal LNS1 lymphocytes remain capable to recognize PNS1 (threshold 2 on Figure 2), the contribution of supplementary LNS1-A lymphocytes can drop to near zero Therefore, a constant low-power UMTS-900 background is enough to cancel the effects of a much higher-power GSM signal, which would not occur in a "strictly auto-immune" disease.

On Figure 2, supplementary lymphocyte LNS1-A has a higher affinity for PNS1 than for PS and is therefore more likely to trigger CJD than supplementary lymphocyte LNS1-B which has a higher affinity for PS than for PNS1 and is therefore more likely to be eliminated by regulatory T cells before it can trigger CJD (see section 4.3). Thus it is expected that most CJD-causing lymphocytes can evade normal thymus selection during periods of low exposure (as is the case of LNS1-A), and that having a relatively high GSM exposure power does not add much to the generation of such CJD-causing lymphocytes. This finding may explain why CJD in men aged less than 44 in France increased brutally with the initial onset of GSM (which resulted in at least a low power exposure country-wide) but did not increase anymore afterwards (when average GSM exposure power progressively increased).

4.6 Alternative CJD mechanisms.

Attack of "normal" cells (that express essentially PrP^{C} epitopes) can force normal prions into the extracellular space. When re-entering cells these normal prions become abnormal prions PrP^{Sc}. Cells then start to express more PrP^{Sc} epitopes, which can trigger CJD. The production of abnormal prions due to attack of "normal" cells can even remain the essential cause of abnormal prion formation throughout the disease, which then appears more typically auto-immune as compared to what was discussed in previous sections. In older persons, this auto-immune form of the disease may be significant because regulatory T lymphocytes may be less efficient in suppressing supplementary lymphocytes that also recognize the normal prion epitopes PS, so that lymphocytes such as LNS1-B which has stronger auto-immune effects may be dominant in disease progression.

However, such strictly auto-immune version of the disease is does not explain prion "templating". It is also unlikely to explain the near complete termination of the abnormally increased death rates after onset of UMTS-900: onset of UMTS-900 may have diminished the pro-auto-immune effects as a result of a diminished contrast between high and low exposure, but is unlikely to have canceled it entirely insofar as such contrasts remained highly significant due to the much weaker average UMTS-900 exposure as compared to GSM-900 exposure.

4.7 Simplified explanations.

The abnormal PrP^{Sc1} prion is non-self but closely resembles PrP^{C} which is self. The immune system sees the corresponding epitope NSP1 as something intermediate between a self and a non-self epitope. Reaction of the immune system to NSP1 is disease-causing, unlike reaction to usual pathogens, which prevents disease. Accordingly, the behavior of the immune system is intermediate between the "auto-immune" line in Table 1 of (Lauer 2014b) and the inversed "infectious disease" line (inversed because immune reaction to PNS1 is disease-causing). The effect of variable GSM downlink exposure is pro-auto-immune (thus pro-CJD) under Table 1 column E, and insofar as the minimum exposure remains zero in appropriate frequency ranges this is the dominant effect. The effect of essentially permanent UMTS-900 downlink exposure is pro-pathogen under Table 1 column B, which means here that the PrP^{Sc1} prion will be less efficiently recognized, which is anti-CJD. The threshold for the anti-CJD effect is low, so that the anti-CJD effect of permanent exposure (UMTS-900) can dominate over the pro-CJD effect of time-varying exposure (GSM-900) even at a very low power of the permanent exposure.

Thus in the presence of infectious prions and in men aged less than 45:

- increased CJD death rate is started by GSM-900 exposure like an auto-immune disease, even as very low exposure level as discussed in (Lauer 2014b).

- increased CJD death rate started by GSM-900 is stopped by UMTS-900, even at an exposure level lower than GSM-900, like an infectious disease can be started by permanent exposure as discussed in (Lauer 2014b).

5 Detailed explanation of the observations of CJD in men aged less than 45 in France.

The GSM-900 networks were authorized in march 1991 and the service was launched in july 1992. It is usual practice to start downlink emissions before commercial launch, so downlink emissions started, most likely progressively, between march 1991 and july 1992. Average survival time in CJD is typically 6 months (Gambetti 2013), so that the increase in CJD deaths in 1992 can reasonably be due to this start-up of downlink GSM emissions.

In the initial period after GSM onset, the bandwidth of a single GSM emitter was probably little variable due to permanently low workload. Bandwidth variations were most likely provided by frequency-hopping of signaling carriers, so that a signal received far from the sources was the superimposition of several signals at different – and regularly modified – frequencies, yielding regular changes in the resulting overall frequency and bandwidth distribution of the signal. It is also possible that uplink signals contributed to the effect.

The abnormally high death rates terminated in response to the onset of UMTS-900 which was authorized in march 2008 with service launch in Q2, 2009. This resulted in a diminished number of deaths in 2009, 2010, 2011 with an average of 1 death per year as compared to more than 5 deaths/year between 1992 and 2008 and to 0.5 death/year between 1979 and 1991.

At GSM-900 onset, the death rate increased first in the youngest age categories, after which it decreased progressively in these age categories (Figure 1). This is explainable as follows:

At onset of GSM-900 there was a limited number of existing prion carriers potentially able to develop the disease. These prion carriers would normally not have developed the disease, or would have developed it at a later age. After GSM onset the youngest age categories responded first because thymus output is stronger in these age categories so that a lymphocyte line capable to attack the abnormal prion PrP^{Sc} and cause the disease was found earlier in these categories. However there were also less prion carriers in these age categories, because infectious prions are more likely to have been received at a later age and endogenous prions are also more likely to have been accidentally produced at a later age. Thus all prion carriers in the younger age categories died in a few years, after which deaths in these age categories only occurred as new prion carriers appeared, i.e. rarely but more often than before onset of GSM-900.

6 Variations of CJD deaths in women aged less than 45 in France.

Although showing the same trends, the situation is less contrasted for women than for men (Figure 3, Table 3). Some trends (although generally not reaching significance) are of interest:

- in 1994, there is a low. This low has a year-to-year significance level of p=0.02 single-tailed. This low is likely attributable to the very fast growth of the number of GSM users in 1994 (see Table 10), which caused a temporary anti-auto-immune effect as per Table 1 column C of (Lauer 2014b). This temporary auto-immune effect was detectable because there was a sufficiently high number of deaths in 1993.

- in 2008 there is a low (year-to-year significance p=0.1 single-tailed) , followed by an increase (year-to-year significance p=0.045 single-tailed) in 2009. The low of 2008 may be due to the temporary anti-auto-immune effect of the onset of UMTS under Table 1 column C of (Lauer 2014b). Ongoing diseases were temporarily slowed down, but finally yielded death in 2009.

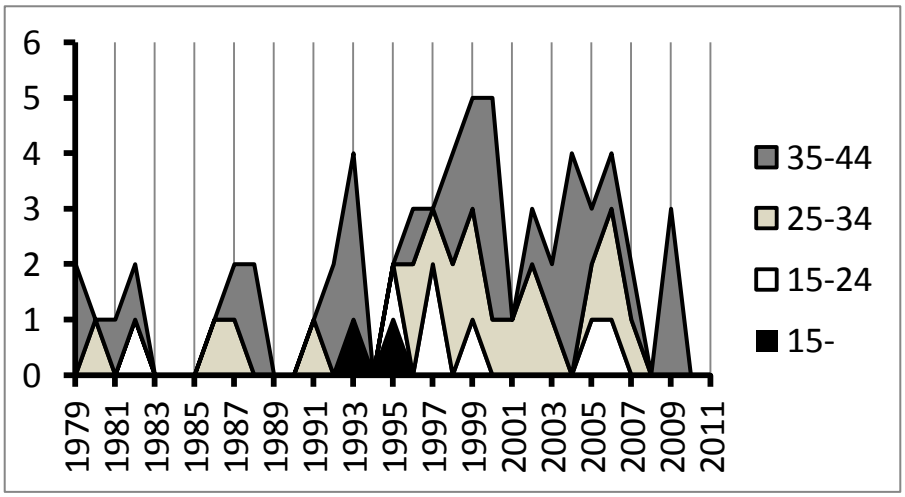

Figure 3: Number of deaths by Creutzfeldt-Jakob disease for women in France (data from CEPIDC).

start year	end year	years	deaths	deaths/year
1979	1991	13	12	0,92
1992	2008	17	47	2,76
2009	2011	3	3	1,00

Table 3: Splitting in 3 periods (women)

It is likely that the reaction to exposure in women was generally slower than in men, possibly due to a lower thymus output or to a qualitatively different lymphocyte production, yielding both a slower and more limited increase in 1992 and a stronger sensitivity under Table 1 column C of (Lauer 2014b), since the transient situation lasted long enough to be detectable in women but probably not in men.

However the death rate did not significantly respond under Table 1 column C of (Lauer 2014b) to the onset of DVB networks in 2005 (various frequencies mostly in the 490 to 790 MHz range) nor to the onset of UMTS-2000 in 2004 (at around 2 GHz). This shows that the effect was highly frequency-dependent. As discussed in (Lauer 2014a) the total power needed to trigger an auto-immune effect is proportional to the frequency range over which it occurs, so that in the present case the reduced frequency range results in a lower theoretical power limit for the effect, which may participate in explaining the early increase in CJD deaths: in 1992, the use of GSM was still marginal and the geographical extent of the network was limited.

7 Variations of variant CJD in the UK

In January 1985 a TACS analogue telephony system occupying the same frequency band as GSM began operating in the UK (Beddoes and Pinches 1987). It was an analogue system, each of the 890-915 MHz uplink and 935-960 MHz downlink band was split in 1000 sub-channels allocated on-demand and essentially causing the same sort of bandwidth and frequency variations as GSM. The license had been awarded in 1983. Downlink emissions started at an ill-defined time, probably during 1984, in any case before the beginning of operations.

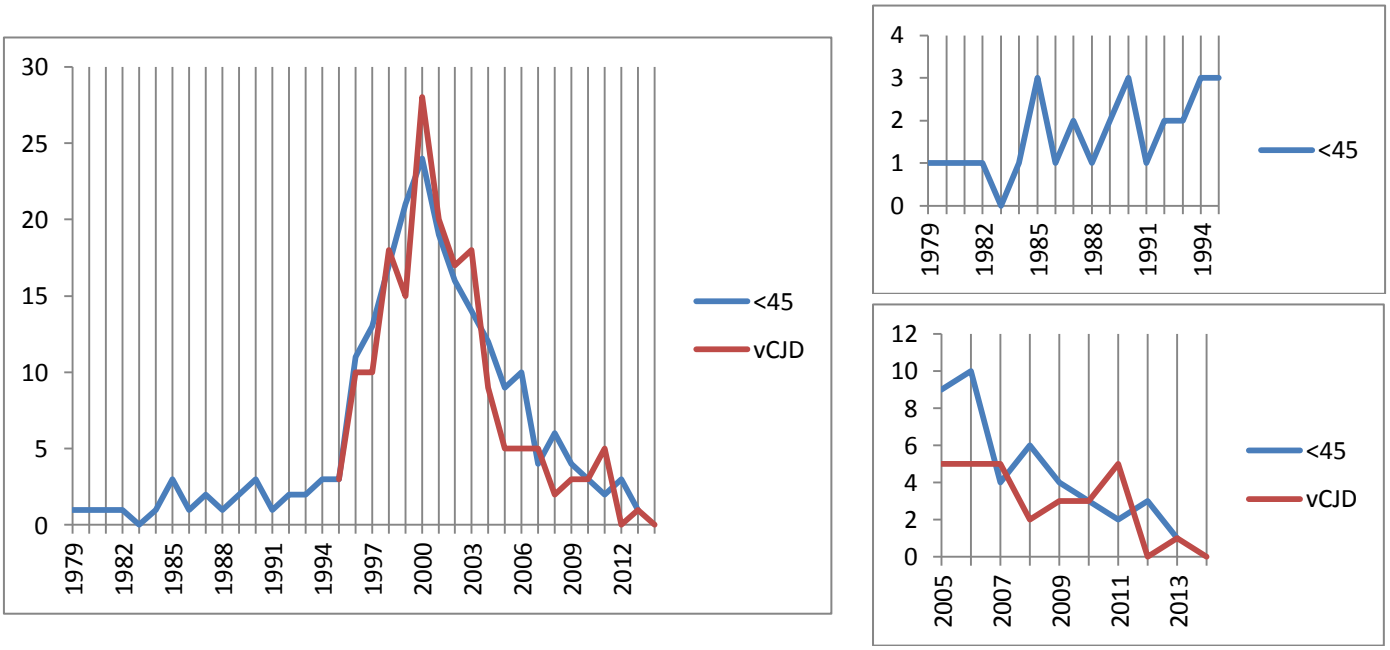

Figure 4: deaths by CJD in the less than 45 years old and by variant CJD in the UK. Data from NCJDRSU and ONS.

start year	end year	years	deaths	deaths/year
2005	2011	7	28	4.00
2012	2014	3	1	0.33

Table 4: last two periods for vCJD in the UK.

	z	p-value
Change from 2005-2011 to 2012-2014	-3.12	1.81E-03

Table 5: p-values characterizing differences between periods (men). Difference in proportions based on data in Table 4.

In the UK (Figure 4) there was an increase of the number of deaths by CJD in the less than 45 years old around 1985, possibly corresponding to the onset of TACS. Due to an extremely low number of deaths the timing of this increase is ill-defined. The GSM-900 network was installed progressively on existing TACS frequencies and the timing of this replacement is ill-defined so that it is uneasy to correlate changes in GSM-900 exposure with observed variations in CJD (unlike the case of France where the GSM bandwidth was initially empty). There was an epidemic aspect due to the large spread of BSE which existed before onset of GSM-900, which was not present in France to any comparable extent and which is part of the explanation for the high peak mortality. The number of deaths in the less than 45 years old age classes went down progressively and when the first

UMTS-900 was installed in 2011 the number of deaths per year in this age category was already too low to reliably observe or exclude an effect of the onset of UMTS-900.

Focusing the analysis on variant CJD (vCJD, known to occur more often in younger subjects than other forms of CJD), after stabilization of the epidemic there is a stable period from 2005 to 2011 at an average of 4 deaths/year followed by a stable period from 2012 to 2014 at an average of 0.33 deaths/year. The probability of the transition between these two periods occurring in 2012 is 97%. In France, taking into account the re-bounce of deaths in women in 2009, at the end of period 2 the overall number of deaths per year for men and women aged less than 45 went down only in 2010, the year following the onset of the first UMTS-900 network in Q2, 2009. In the UK, the onset of UMTS-900 took place in 2011 and the overall number of deaths per year for men and women for vCJD went down in 2012, so that the timing of the reduction in vCJD in the UK relative to onset of UMTS-900 was the same as the timing of the reduction of CJD in the less than 45 years old in France relative to onset of UMTS-900.

This is an indication that after termination of the epidemic the remaining vCJD deaths in the UK were analogous to the CJD deaths in persons aged less than 45 in France. However, the vCJD deaths that occurred during the epidemic may have been of a different nature, possibly corresponding to different prion strains as such strains are known to cause distinct phenotypes of the disease (Prusiner 2004 p.124). Also, in the period from 2005 onwards, deaths by vCJD did not coincide with deaths in persons aged less than 45.

8 A related problem: Bovine Spongiform Encephalopathy.

The first confirmed case of Bovine Spongiform Encephalopathy (BSE) was identified in England in the summer of 1985 (BSE Inquiry vol 16 chapter 2). A first suspected case occurred on 22nd December 1984 (BSE Inquiry vol. 3, 1.9) in the same farm, so that the disease can be traced back to 22nd december 1984. However at least 8 suspected cases also existed in 1985 (Nathanson et al 1997, Wilesmith 1991). Cases previous to 22nd December 1984 were “anecdotal” (BSE Inquiry vol. 2, 1.41). The disease spread rapidly from 1985 onwards (Figure 5). Cattle had been fed with Meat and Bone meal (MBM) since the early 1950s (Wikipedia), although changes in the MBM rendering process in 1981 in the UK may have contributed to prion contamination (Nathanson e al 1997).

Thus the onset of the TACS telephony system, which with respect to effects on the immune system was very nearly the same as the GSM system, is correlated with the start of the BSE epidemy in the UK much like GSM-900 is correlated to the increase in CJD deaths in the less than 45 years old in France. Abnormal prions were probably widespread prior to 1984 in British cows, probably because of MBM feeding, but did not cause disease.

The epidemy was stopped by eliminating prion carrier cows and MBM until the number of yearly cases stabilized to about 12 in 2009-2010. The lowering of the number of yearly cases from 7 to 3 in 2012 has a year-to-year significance level p=0.1 single-tailed. The transition from the relatively stable 2009-2010 period to the 2012-2013 period is 2011-2012, dominantly 2012 in terms of percentage decrease. In the UK, the onset of UMTS-900 took place in march 2011 (O2 2011) and the overall number of deaths per year for BSE went down in 2011-2012, so that the timing of the reduction in BSE in the UK relative to onset of UMTS-900 was nearly the same (perhaps somewhat faster) as the timing of the reduction of CJD in the less than 45 years old in France or of vCJD in the UK relative to onset of UMTS-900.

Thus there is evidence that the onset of UMTS-900 in march 2011 in the UK caused the number of BSE cases to drop in 2011-2012. This evidence is however blurred by the shortness of the 2009-2010 stabilization period.

In France, the first cases of BSE occurred in 1991, corresponding to the onset of GSM-900, prior to the commercial launch in 1992 but most likely after the authorization in march 1991, i.e. in the period of building the network and starting downlink emissions. The very first case occurred on march 2, 1991 in Côtes-d’Armor (INRA) shortly before the authorization on march 26th (Journal Officiel, arrêté du 26 mars 1991). The Laboratoire d’Essais des Télécommunications is in Lannion, Côtes d’Armor, and necessarily made some GSM tests prior to authorization, likely explaining this early start. The change from 0 to 5 yearly cases in 1991 has a year to year significance level p=0.025 two-tailed. This is consistent with the start of BSE in France having been caused by the onset of GSM. The lack of cases in 1992 is likely due to non-declaration following the Arrêté du 16 décembre 1991 fixant les measures de police sanitaire relative à l’Encéphalopathie spongiforme bovine (Journal Officiel).

After a moderate epidemic episode, cases of BSE stabilized in France from 2006 to 2009. They dropped again in 2010-2011. The change between the 2006-2009 stable period and the 2011-2013 stable period is significant to p=0.0003 (Table 6, Table 7) and the probability that the change occurred in 2010 or 2011 is 94% (Appendix 1, Table 10). This change has essentially the same timing as the change in CJD deaths for men and women (pooled) aged less than 45 in France, which dropped in 2010. This is evidence that this final drop, like the change in CJD deaths, was caused by the onset of UMTS-900. Unlike the case of the UK, this evidence is not blurred by an insufficient prior stabilization period.

start year	end year	deaths	years	deaths/year
2006	2009	35	4	8.75
2011	2013	6	3	2

Table 6: BSE cases in France in the stable periods 2006-2009 and 2011-2013.

	z	p-value
change from 2006-2009 to 2011-2013	3.65	0.0003

Table 7: significance of the change between the stable periods of 2006-2009 and 2011-2013.

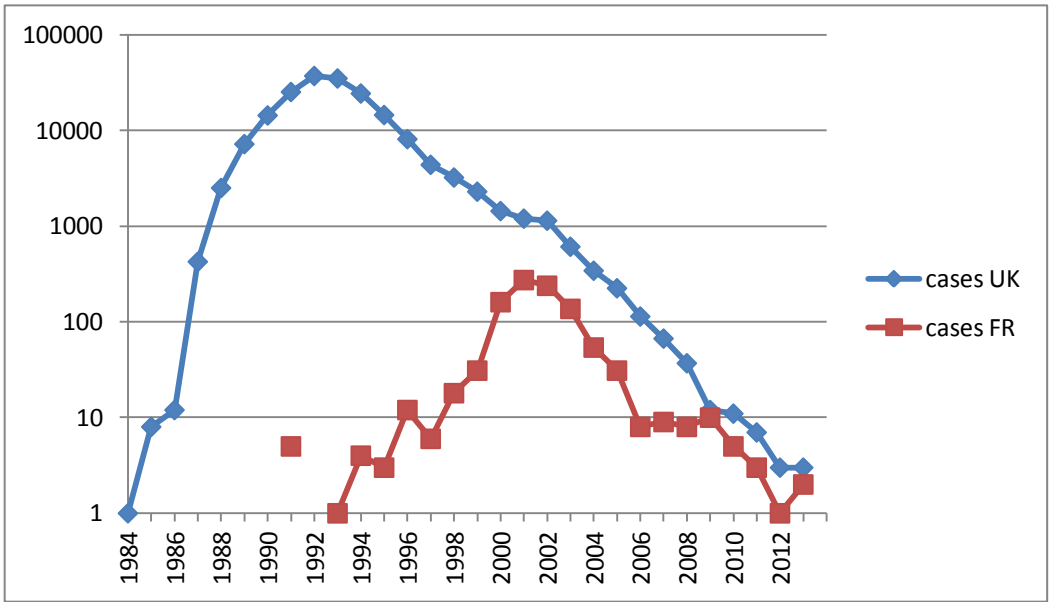

Figure 5: BSE cases in the UK and France, yearly cases, from (OIE). Early cases in the UK in 1985 are from (Nathanson et al 1997) and in 1986 from (BSE Inquiry 1996). Late cases in France are from (Ministère de l'Agriculture). There are uncertainties as to exact figures for the UK in 1984/1985. Log scale.

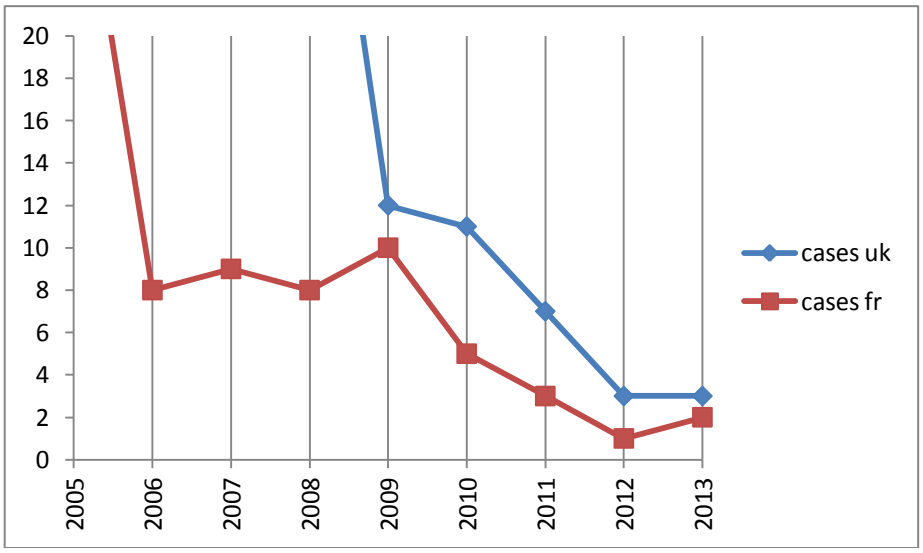

Figure 6: BSE cases after end of the epidemic episode in the UK and in France. Linear scale.

9 Joint probability analysis.

The joint probability analysis is based on the following considerations on individual events:

a) The transition between period 1 and period 2 in France for CJD deaths in men aged less than 45 (i.e. start of abnormal CJD) could have taken place any time between 1979 and 2011, but took place within a 2-year allowable time window (1991-

1992) based on onset of GSM-900. The probability of this event having taken place by chance in the allowed time window is pa=2/33.

b) The transition between period 2 and period 3 (i.e. termination of abnormal CJD) in men aged less than 45 in France could have taken place any time between 1993 and 2011, but took place in a 2-year allowable time window (2008-2009) based on onset of UMTS-900. The probability of this event having taken place by chance in the allowed time window is pb=2/19.

c) The 2012 transition in the UK (termination of abnormal vCJD) could have taken place any time between 2005 and 2014 but took place in a one-year allowable time window (2012) based on the onset of UMTS-900. The probability of this event having taken place by chance in the allowable time window is pc=1/10.

d) The appearance of BSE in the UK could have taken place at any time between 1960 and 2014 but took place in a 2-year time window (1984, 1985) based on the onset of TACS. The probability of this event having taken place by chance in the allowed time window is pd=2/44.

e) The appearance of BSE in France could have taken place any time between 1960 and 2013 but took place in a 2-year time window (1991, 1992) based on the onset of GSM. The probability of this event having taken place by chance in the allowed time window is pe=2/43.

f) The 2010-2011 transition in BSE deaths in France could have taken place any time between 2006 and 2013 but took place in a 3-year time window (2009-2011) based on the onset of UMTS-900. The probability of this event having taken place by chance in the allowed time window is pf=3/8. This is severely over-estimated due to termination of the period in 2013.

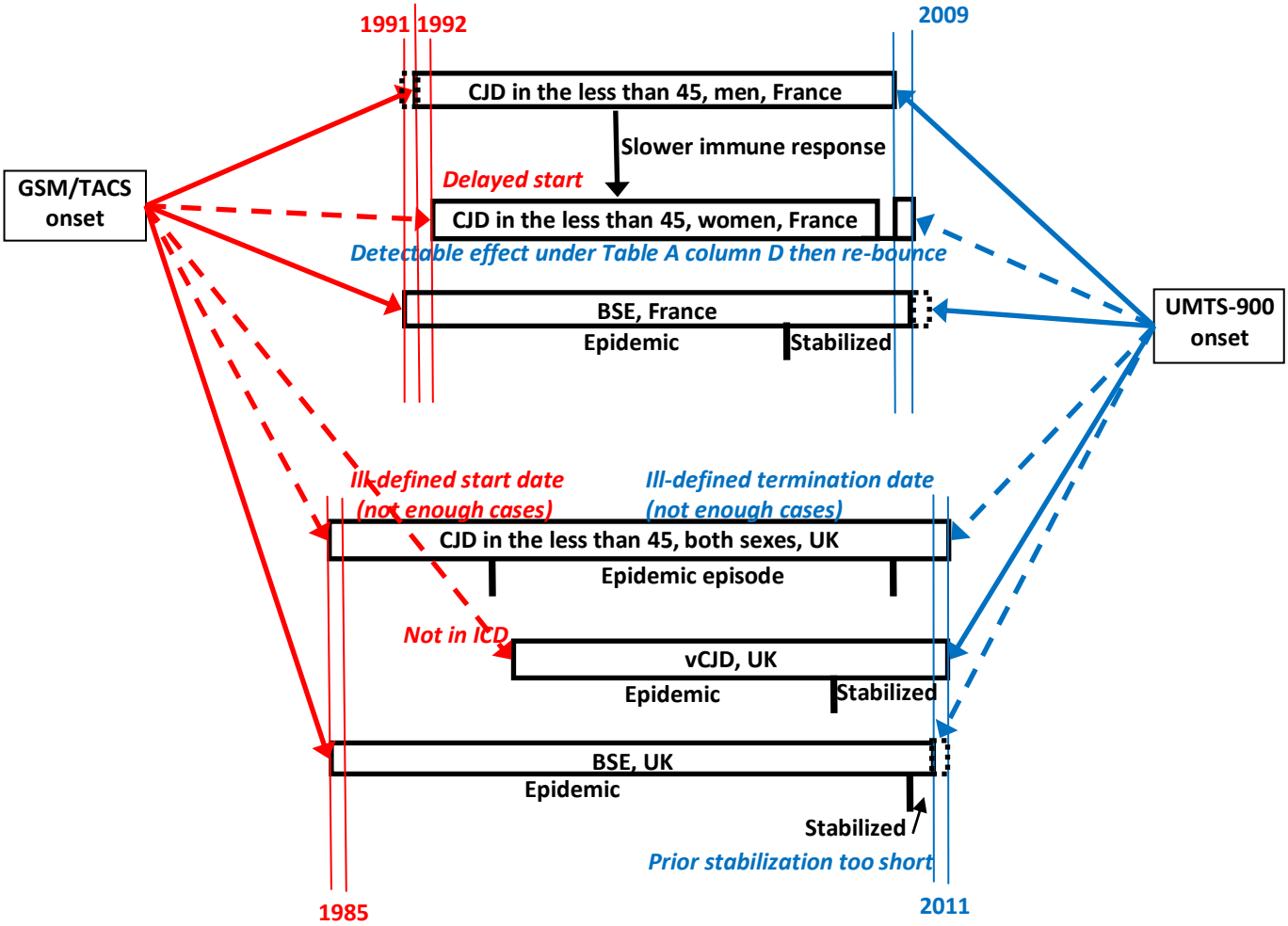

Figure 7: synopsis. Onset of TACS/GSM (resp. UMTS-900) is in time correspondence with every start-up (resp. termination) of observed diseases. In some cases the time correspondence could not be properly verified, due to insufficient number of cases. Relations with a well-defined time correspondence are shown as plain lines. Relations with an ill-defined time correspondence are shown as dotted lines.

The overall probability of the observed changes having taken place in the corresponding time windows by chance, assuming all events are independent of each other, is P=pa.pb.pc.pd.pe.pf, ie. $P=5.10^{-7}$. This is extremely low, and it is still over-evaluated because changes that occurred at an ill-defined time were not taken into account at all (see Figure 7).

However the above calculation implies that the theory was known *ab initio*. An alternative view, less dependent on theoretical aspects, is that variations of CJD in men in France made it possible to conclude that frequency-varying waves in the GSM frequency range can cause an increase in death rates in CJD in the less than 45 years old/vCJD/BSE and that waves having essentially a permanently flat power spectrum in the same range can stop this increased death rate. In this view the timing of

events (c) to (f) are the verification of the logical deductions made on men aged less than 45 in France, and the probability of the logical deductions being wrong is thus P=pc.pd.pe.pf=7.10^{-5}, which remains very low.

The joint probability analysis thus yields to a conclusion that there is a positive [resp. negative] causal relation between GSM-900 [resp. UMTS-900] and the observed increases of death rates in CJD in the less than 45 years old/vCJD/BSE.

This joint probability analysis can additionally be supported by a list of "first cases" (Table 8).

country	Commercial launch of variable-frequency telephony network in GSM-900 band.	First BSE case	First CJD case in men aged less than 25 (since 1979).
United Kingdom	january 1985 (TACS)	1984*	1984
France	July 1992(GSM-900)	1991	1991

Table 8: First cases and commercial launches. *:likeliest date.

10 Conclusions

The sole increase of CJD disease in 1992 in France would not have been entirely convincing as to a possible causal relation between CJD in the less than 45 years old and GSM-900. But the observations of 6 transitions in good correspondence with corresponding changes in emissions in the GSM-900 bandwidth cannot reasonably be explained by a coincidence. In a one approach, the rules linking CJD/BSE with exposure changes in the GSM-900 bandwidth are established based on the start and stop of CJD in men aged less than 45 in France and the verification of these rules relies on other related events in the UK and in France, yielding a probability P<0.0001 of the rules being wrong. The logical explanation for the observed positive [resp.negative] correlations between TACS/GSM-900 [resp. UMTS-900] and CJD in the less than 45 years/ vCJD/BSE is thus a positive [resp. negative] causal relation between TACS/GSM-900 [resp. UMTS-900] and death rates in CJD in the less than 45 years/ vCJD/BSE. In view of the scientific and economical implications of this finding it will be necessary to reach a reasonable level of scientific consensus, which could possibly be obtained by appropriate experimentation on cows in the presence of prions and with appropriate exposures to electromagnetic fields.

This positive/negative causal relation would occur at an extremely low power, possibly less than the power required for a mobile phone to receive signals from the base station, because GSM-900 coverage in 1991/1992 and UMTS-900 coverage in 2009 were both low in France, corresponding to the early onset of these networks. Yet this positive/negative causal relation is supported by a rational scientific explanation, including for the low power threshold, and thus cannot be rejected as "impossible".

The present paper also brings an answer to the question of how disease-causing prions replicate in the organism in the absence of any dedicated replication mechanism and to several related questions including the "templating" mechanism. However whilst the proposed explanations are viewed as logical in view of existing knowledge and epidemiological results, they may need to be improved or corrected as the understanding of CJD and of its link with exposure to electromagnetic waves progresses.

With regards to the general principles of interaction of the immune system discussed in (Lauer 2013,2014a,b), although CJD in the less than 45 years old, vCJD and BSE share some features with auto-immune diseases, they are a type of disease which was not discussed and which would add a line in Table 1 of (Lauer 2014b). Whilst both these prion diseases and auto-immune diseases are favored by time-varying waves, permanent waves appear to have an anti-prion effect which is probably not matched, or at least not matched to the same extent, by an anti-auto-immune effect.

CJD in the less than 45 years old and vCJD are rare diseases. This paper is limited to these diseases because their death statistics show instantaneous reactions to changes in exposure, thus making it easier to study the link between disease and exposure. However the present paper clearly has implications concerning CJD in general and concerning other neuro-degenerative diseases.

11 References.

Beddoes E and Pinches M (1987) Cellular Radio Telephony – the Racal-VODAFONE Network in Great Britain – Ericsson Review, p.130.

The BSE Inquiry (1996) http://webarchive.nationalarchives.gov.uk/20060715141954/http:/bseinquiry.gov.uk/index.htm

Borchelt D R, Taraboulos A and Prusiner S B (1992) Evidence for synthesis of scrapie prion proteins in the endocytic pathway. J. Biol. Chem. 267: 16188-16199.

Center for food safety - www.centerforfoodsafety.org/issues/1040/mad-cow-disease/timline-mad-cow-disease-outbreaks , retrieved december 2014.

CEPIDC, Centre d'Epidemiologie sur les Causes Medicales de Deces, Institut National de la Sante et de la Recherche Medicale , indicateurs de mortalité, www.cepidc.inserm.fr , retrieved 2014.

Colby D Q and Prusiner S M, Prions, Cold Springs Harbor Perspectives in Biology, 2011.

Gambetti, P (2013) Creutzfeldt-Jakob disease, The Merck Manual, www.merckmanuals.com (retrieved December 2014)

GSA (2014) GSM/3G market/ Technology update, UMTS 900 Global Status, Global Mobile Suppliers Association.

INRA http://www7.inra.fr/dpenv/vfol___2.htm#apparition retrieved january 2015

Journal Officiel de la République Française, www.legifrance.gouv.fr

Lasmezas C.I, Cesbron J Y, Delys J P et al (1996), Immune System-dependent and Independent Replication of the Scrapie Agent, Journal of Virology 70, 1292-1295.

Lauer V (2013) A quantum theory of the Biological effects of radio-frequencies and its application to cancer, HAL-00877298, https://hal.archives-ouvertes.fr/hal-00877298.

Lauer V (2014a) A model of the interaction of T lymphocytes with electromagnetic waves, HAL-00975963, https://hal.archives-ouvertes.fr/hal-00975963.

Lauer V (2014b) An introduction to the interaction of the immune system with electromagnetic fields, HAL-01093349, https://hal.archives-ouvertes.fr/hal-01093349.

Lauer V (2015) Resolving apparent inconsistencies in effects of electromagnetic waves on cancer and auto-immunity, HAL-01093600 version 2, https://hal.archives-ouvertes.fr/hal-01093600.

MEFI (2001) Rapport sur la couverture du territoire par les réseaux de télécommunications mobiles. Ministère de l' Economie, des Finances et de l'Industrie.

Ministère de l'agriculture http://agriculture.gouv.fr/Recapitulatif-nombre-cas-ESB retrieved january 2015.

Nathanson N, Wilesmith J, Griot C (1997) Bovine Spongiform Encephalopathy (BSE): causes and consequences of a common source epidemic. American Journal of Epidemiology 145, 959-969.

NCJDRSU, National CJD Research and Surveillance Unit, www.cjd.ed.ac.uk, retrieved December 2014.

O2 (2011) http://news.o2.co.uk/?press-release=o2-first-to-switch-on-new-superfast-3g-900mhz-network retrieved January 2015.

OIE world organisation for animal health www.oie.int/fr/sante-animale-dans-le-monde/donnees-specifiques-sur-lesb/nombre-de-cas-au-royaume-uni/ retrieved December 2014.

ONS, Office for National Statistics, www.ons.gov.uk. Retrieved December 2014.

Perez J P (1965) Les émetteurs de radio et de télévision, Le Haut-Parleur octobre 1965 p.17-23.

Pickrell, J (updated by) (2006) Timeline: BSE and vCJD. New Scientist. www.newscientist.com/article/dn9926-timeline-bse-and-vcjd.html#VI793fluNBW . retrieved december 2014.

Prusiner S B, Scott M, Foster D et al (1990) Transgenetic studies implicate interactions between homologous PrP isoforms in scrapie prion replication. Cell 63: 673-686.

Prusiner S.B. (2004) Prion biology and diseases second edition, Cold Spring Harbor Laboratory Press.

Renaud L (2007) Dix ans de discours sur le téléphone mobile, Thèse, Université Lumière Lyon 2.

Schoop (2013) www.schoop.fr, anciennes fréquences, retrieved in 2013.

Shyng S L, Heuser JE and Harris D A (1994) A glycolipid-anchored prion protein is endocytosed via clathrin-coated pits. J.Cell. Biol. 125:1239-1250.

Telling G C, Scott M, Hsiao KK et al (1996) Transmission of Creutzfeldt-Jakob disease from humans to transgenic mice expressing chimeric human-mouse prion protein. Proc. Natl. Acad. Sci. 91: 9936-9940.

Wikipedia, Rendering(animal products), retrieved December 2014.

Wilesmith JW (1991) the epidemiology of Bovine Spongiform Encephalopathy. Semin Virol 2, 239-245

Appendices

Appendix I: Calculation sheets for the determination of transition years

year	deaths	1987		1988		1989		1990		1991		1992		1993		1994		1995		1996		1997	
		H	P	H	P	H	P	H	P	H	P	H	P	H	P	H	P	H	P	H	P	H	P
1986	0	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58
1987	1	5.6	0.02	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31
1988	1	5.6	0.02	5.6	0.02	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31
1989	0	5.6	0.00	5.6	0.00	5.6	0.00	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58	0.5	0.58
1990	1	5.6	0.02	5.6	0.02	5.6	0.02	5.6	0.02	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31
1991	1	5.6	0.02	5.6	0.02	5.6	0.02	5.6	0.02	5.6	0.02	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31	0.5	0.31
1992	5	5.6	0.17	5.6	0.17	5.6	0.17	5.6	0.17	5.6	0.17	5.6	0.17	0.5	0.00	0.5	0.00	0.5	0.00	0.5	0.00	0.5	0.00
1993	7	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	0.5	0.00	0.5	0.00	0.5	0.00	0.5	0.00
1994	4	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	0.5	0.00	0.5	0.00	0.5	0.00
1995	6	5.6	0.16	5.6	0.16	5.6	0.16	5.6	0.16	5.6	0.16	5.6	0.16	5.6	0.16	5.6	0.16	5.6	0.16	0.5	0.00	0.5	0.00
1996	7	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	0.5	0.00
1997	4	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15
PE		3.2E-15		5.0E-14		7.9E-13		1.3E-10		2.1E-09		3.3E-08		4.3E-11		5.1E-16		6.9E-18		8.6E-22		1.0E-26	
PTY		9.1E-08		1.4E-06		2.3E-05		3.8E-03		5.9E-02		9.4E-01		1.2E-03		1.4E-08		2.0E-10		2.5E-14		2.9E-19	

Table 9: Calculation sheet for the transition year between Period 1 and Period 2 for CJD for men aged less than 45 in France. H: hypothesis in deaths/year. P: probability of observed number of deaths, using Poisson's law. PE: total probability of observed number of deaths each year. PTY: probability of each transition year (PE/total PE). "deaths": CJD deaths in men aged less than 45 years in France.

year	deaths	2006		2007		2008		2009		2010		2011		2012		2013		2014	
		H	P	H	P	H	P	H	P	H	P	H	P	H	P	H	P	H	P
2006	8	2.00	0.00	8.75	0.14	8.75	0.14	8.75	0.14	8.75	0.14	8.75	0.14	8.75	0.14	8.75	0.14	8.75	0.14
2007	9	2.00	0.00	2.00	0.00	8.75	0.13	8.75	0.13	8.75	0.13	8.75	0.13	8.75	0.13	8.75	0.13	8.75	0.13
2008	8	2.00	0.00	2.00	0.00	2.00	0.00	8.75	0.14	8.75	0.14	8.75	0.14	8.75	0.14	8.75	0.14	8.75	0.14
2009	10	2.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	8.75	0.11	8.75	0.11	8.75	0.11	8.75	0.11	8.75	0.11
2010	5	2.00	0.04	2.00	0.04	2.00	0.04	2.00	0.04	2.00	0.04	8.75	0.07	8.75	0.07	8.75	0.07	8.75	0.07
2011	3	2.00	0.18	2.00	0.18	2.00	0.18	2.00	0.18	2.00	0.18	2.00	0.18	8.75	0.02	8.75	0.02	8.75	0.02
2012	1	2.00	0.27	2.00	0.27	2.00	0.27	2.00	0.27	2.00	0.27	2.00	0.27	2.00	0.27	8.75	0.00	8.75	0.00
2013	2	2.00	0.27	2.00	0.27	2.00	0.27	2.00	0.27	2.00	0.27	2.00	0.27	2.00	0.27	2.00	0.27	8.75	0.01
PE		2.57E-18		4.03E-16		2.78E-13		4.36E-11		1.31E-07		2.46E-07		2.41E-08		1.24E-10		2.77E-12	
PTY		6.39E-12		1.00E-09		6.91E-07		1.09E-04		3.27E-01		6.13E-01		6.01E-02		3.08E-04		6.90E-06	

Table 10: Calculation sheet for the transition year between Period 2006-2009 and period 2011-2013 for BSE in France. H: hypothesis in deaths/year. P: probability of observed number of deaths, using Poisson's law. PE: total probability of observed number of deaths each year. PTY: probability of each transition year (PE/total PE). "deaths": BSE deaths in France.

year	deaths	2004		2005		2006		2007		2008		2009		2010		2011		*2012*		*2013*		*2014*	
		H	P	H	P	H	P	H	P	H	P	H	P	H	P	H	P	*H*	*P*	*H*	*P*	*H*	*P*
2003	7	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	5.6	0.13	*5.6*	*0.13*	*5.6*	*0.13*	*5.6*	*0.13*
2004	8	1.0	0.00	5.6	0.09	5.6	0.09	5.6	0.09	5.6	0.09	5.6	0.09	5.6	0.09	5.6	0.09	*5.6*	*0.09*	*5.6*	*0.09*	*5.6*	*0.09*
2005	6	1.0	0.00	1.0	0.00	5.6	0.16	5.6	0.16	5.6	0.16	5.6	0.16	5.6	0.16	5.6	0.16	*5.6*	*0.16*	*5.6*	*0.16*	*5.6*	*0.16*
2006	4	1.0	0.02	1.0	0.02	1.0	0.02	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	5.6	0.15	*5.6*	*0.15*	*5.6*	*0.15*	*5.6*	*0.15*
2007	5	1.0	0.00	1.0	0.00	1.0	0.00	1.0	0.00	5.6	0.17	5.6	0.17	5.6	0.17	5.6	0.17	*5.6*	*0.17*	*5.6*	*0.17*	*5.6*	*0.17*
2008	5	1.0	0.00	1.0	0.00	1.0	0.00	1.0	0.00	1.0	0.00	5.6	0.17	5.6	0.17	5.6	0.17	*5.6*	*0.17*	*5.6*	*0.17*	*5.6*	*0.17*
2009	1	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	5.6	0.02	5.6	0.02	*5.6*	*0.02*	*5.6*	*0.02*	*5.6*	*0.02*
2010	1	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	5.6	0.02	*5.6*	*0.02*	*5.6*	*0.02*	*5.6*	*0.02*
2011	1	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	1.0	0.37	*5.6*	*0.02*	*5.6*	*0.02*	*5.6*	*0.02*
2012	*1*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*5.6*	*0.02*	*5.6*	*0.02*
2013	*1*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*5.6*	*0.02*
2014	*1*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*	*1.0*	*0.37*
PE		4.3E-18		4.3E-14		1.3E-11		1.3E-10		7.1E-09		3.9E-07		2.1E-08		1.1E-09		*6.2E-11*		*6.2E-11*		*6.2E-11*	
PTY		1.0E-11		1.0E-07		3.1E-05		3.1E-04		1.7E-02		9.3E-01		5.0E-02		2.7E-03		*1.5E-04*		*1.5E-04*		*1.5E-04*	

Table 11: Calculation sheet for the transition year between Period 2 and Period 3 for CJD for men aged less than 45 in France. H: hypothesis in deaths/year. P: probability of observed number of deaths, using Poisson's law. PE: total probability of observed number of deaths each year. PTY: probability of each transition year (PE/total PE). Figures in italics based on hypothetical numbers of deaths for the following years. "deaths": deaths by CJD in men aged less than 45 in France.

year	deaths	2007		2008		2009		2010		2011		2012		2013		2014		2015		2016		2017	
		H	P	H	P	H	P	H	P	H	P	H	P	H	P	H	P	*H*	*P*	*H*	*P*	*H*	*P*
2005	5	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	*4.0*	*0.16*	*4.0*	*0.16*	*4.0*	*0.16*
2006	5	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	*4.0*	*0.16*	*4.0*	*0.16*	*4.0*	*0.16*
2007	5	0.3	0.00	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	4.0	0.16	*4.0*	*0.16*	*4.0*	*0.16*	*4.0*	*0.16*
2008	2	0.3	0.04	0.3	0.04	4.0	0.15	4.0	0.15	4.0	0.15	4.0	0.15	4.0	0.15	4.0	0.15	*4.0*	*0.15*	*4.0*	*0.15*	*4.0*	*0.15*
2009	3	0.3	0.00	0.3	0.00	0.3	0.00	4.0	0.20	4.0	0.20	4.0	0.20	4.0	0.20	4.0	0.20	*4.0*	*0.20*	*4.0*	*0.20*	*4.0*	*0.20*
2010	3	0.3	0.00	0.3	0.00	0.3	0.00	0.3	0.00	4.0	0.20	4.0	0.20	4.0	0.20	4.0	0.20	*4.0*	*0.20*	*4.0*	*0.20*	*4.0*	*0.20*
2011	5	0.3	0.00	0.3	0.00	0.3	0.00	0.3	0.00	0.3	0.00	4.0	0.16	4.0	0.16	4.0	0.16	*4.0*	*0.16*	*4.0*	*0.16*	*4.0*	*0.16*
2012	0	0.3	0.72	0.3	0.72	0.3	0.72	0.3	0.72	0.3	0.72	0.3	0.72	4.0	0.02	4.0	0.02	*4.0*	*0.02*	*4.0*	*0.02*	*4.0*	*0.02*
2013	1	0.3	0.24	0.3	0.24	0.3	0.24	0.3	0.24	0.3	0.24	0.3	0.24	0.3	0.24	4.0	0.07	*4.0*	*0.07*	*4.0*	*0.07*	*4.0*	*0.07*
2014	0	0.3	0.72	0.3	0.72	0.3	0.72	0.3	0.72	0.3	0.72	0.3	0.72	0.3	0.72	0.3	0.72	*4.0*	*0.02*	*4.0*	*0.02*	*4.0*	*0.02*
2015	*0,3*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*4.0*	*0.03*	*4.0*	*0.03*
2016	*0,3*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*4.0*	*0.03*
2017	*0,3*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*	*0.3*	*0.52*
PE		1.4E-18		9.0E-15		3.3E-14		1.5E-12		6.4E-11		4.1E-07		1.0E-08		3.2E-09		*8.2E-11*		*8.2E-11*		*8.2E-11*	
PTY		3.3E-12		2.1E-08		7.8E-08		3.4E-06		1.5E-04		9.7E-01		2.5E-02		7.6E-03		*1.9E-04*		*1.9E-04*		*1.9E-04*	

Table 12: Calculation sheet for the transition year between Period 2005-2011 and Period 2012-2014 for vCJD in the United Kingdom. H: hypothesis in deaths/year. P: probability of observed number of deaths, using Poisson's law. PE: total probability of observed number of deaths each year. PTY: probability of each transition year (PE/total PE). Figures in italics based on hypothetical numbers of deaths for the following years. "deaths": deaths by CJD in men aged less than 45 in France.

Appendix II: Changes in the electromagnetic environment in France

In this section, known variations of artificial electromagnetic waves in France are examined so as to be used in the interpretation of statistics.

permanent waves

The history of radio and TV broadcasting in France is summarized in Table 13.

1960-1961	finalization of national TV network (1 channel VHF 52 to 212 MHz)
1963-1966	Progressive geographical coverage of 2nd TV channel, VHF (470-790 MHz). In 1966, 2 TV channels and 3 radios emitting both in AM and FM.
1972	Creation of a 3rd TV channel in color (december, 25% initial coverage).
1976-1978	Creation of a few “free FM radios” in France
1979	Emissions from most free FM radios are interrupted.
1980	Start-up of “Radio 7” (june) and new free FM radios in Paris.
1981	may: Tolerated FM radios.
1983	Authorized FM radios; black & white VHF TV emitters stopped.
1984	November : Canal+ color TV, VHF (strong initial coverage).
1986	February: la 5 (arte) color TV, UHF, 45% initial coverage.
1987	March: M6 color TV, UHF
2005	March: DVB start-up, population coverage 35% incl. Paris. September: coverage increases to 50% incl. Nantes.
2006-2010	Increase of DVB geographical coverage: 58% (june 2006); 66% (October 2006) ; 70% (march 2007); 85% (end 2007) …
2010	May: analog TV shut down in Pays de la Loire

Table 13 Permanent artificial waves in France (Wikipedia 2013a,b, Schoop 2013).

Permanent artificial electromagnetic waves after the last war comprised one black and white TV channel and a few radios. TV coverage ramped up progressively with a major effort in 1961-1962 so that in 1962 national coverage was achieved. A second TV channel was added, starting in Paris in 1964 and first using color broadcasting in 1967. A third TV channel was created in 1972. In january 1976 the first (oldest) TV channel started color broadcasting in Paris. This quite progressive ramping up of TV and radio broadcasting had taken 30 years finally yielding 3 TV channels and about 3 FM and 3 AM radios.

In 1976-1978 a few free (unauthorized) radios started broadcasting. Most unauthorized radios were not permanently broadcasting, and had low broadcasting powers. In 1979 most unauthorized radios had to interrupt broadcasting. Then in 1980 in Paris a new official radio station was added ("Radio 7") emitting from a suburb but with an unusually high broadcasting power. A number of unauthorized radios began broadcasting on a more regular basis. In 1981 a new government was elected which had decided to tolerate unauthorized radios, and immediately after the election tolerated radios appeared in high numbers everywhere in France. In 1983 the radios were regulated, each broadcaster was assigned frequencies, radios began broadcasting on a fully permanent basis at higher powers. The 1980 change was essentially in Paris, the 1981 change was less felt in Paris because it had partly happened ahead of time in 1980.

In november 1984 a new TV channel (Canal +) started broadcasting analog color TV with powerful emitters in frequency bands between 55 and 64 MHz and between 174 and 223 MHz, which are near to the FM band (88 to 108 MHz). In february 1986 the "5e chaine" started broadcasting analog color TV in the UHF frequency range between 470 and 790 MHz, reaching 45 % of the population initially. In march 1987 a further TV channel (M6) started broadcasting. The latter had few emitters initially and ramped up progressively.

Following this initial 1981-1987 period, terrestrial TV broadcasting was unchanged until 2005 (except for the ramp up of M6 and marginally the "5e chaine") and FM radio increased only marginally. In 2005 DVB broadcasting was set up in addition to the existing analog broadcasting in Paris and major cities. DVB broadcasting ramped up further until 2010. In 2010 the first extinctions of analog TV emitters occurred.

In addition to these known changes, power increases also took place the timing of which is not well known. In 1965 the power of the TV emitters on the Eiffel tower was 20 kW (UHF) and 20 kW (VHF) and the overall power of the FM radio emitters was 12 kW (Perez 1965) In 2004 the "Canal+" UHF emitter had a power of 104 kW , 2 VHF emitters had a power of 100 kW and 3 VHF emitters had a power of 215 kW (Vignault 2011, Journal Officiel).

time-varying waves

Time-varying artificial waves underwent deep changes from 1986 onward (Table 14).

Pre-existing analog car phone networks were replaced in 1986 by "Radiocom 2000" which was analog for the voice and digital for signalling and operated by France Telecom. In 1988 a newly created company SFR started a similar service based on Nordic Mobile Telephone, very similar to Radiocom 2000 which was quickly successful. Increased competition boosted traffic on both networks in 1988. GSM started very slowly in 1992 because the operators were not eager to compete with their own respective Radiocom and NMT-F networks. It is somewhat unclear when exactly the first base stations became operational, since they may have started earlier than the opening of the network to the general public. 1994 was the real year when GSM seriously started and at the end of 1994 the number of GSM customers was higher than the number of Radiocom and NMT-F customers. A further boost of GSM networks occurred in 1997-1998 when geographical coverage increased quickly due to increased competition by a new operator, Bouygues Telecom, which initially operated only a GSM1800 network whilst France Telecom and SFR essentially operated GSM900 networks. There was also a CT2 network "Bi Bop" which except for the Strasbourg experiment started later than GSM. UMTS networks were first opened in 2004 but ramped up very progressively by lack of a specific demand for this new technology.

Other considerations

In Table 13and Table 14 all waves which yield important time variations for most persons were classified as time-varying. Radiocom and NMT-F were considered time-varying because they are switched on/off regularly as telephone conversations are either started or terminated. Wi-Fi was considered time-varying because it is switched on/off from time to time, because of its very short range which implies that persons passing by or spending some time near an emitter are momentarily submitted to unusually high power, and because it regularly changes frequency. GSM is considered time-varying both because it is switched on/off regularly, because it is pulsed, and because its frequency changes regularly. UMTS is considered time-varying essentially because it is regularly switched on/off and because of its power changes.

The distinction between time-varying and permanent waves is not entirely clear-cut and in certain (rare) cases time-varying waves can have effects similar to permanent waves and vice-versa.

	Radiocom 2000 + NMT-F (400 MHz analog voice+ digital signalling) and RHS 900 (Radiocom 2000 at 900 MHz)	GSM900, UMTS 900 (900 MHz)	Bi-Bop (CT2, Pointel) (800 MHz)	Others (>1800 MHz)
1986	launch of Radiocom [9,500]			
1987	[39,000]			
1988	launch of NMT-F; [98,000]			
1989	[179,500]			
1990	Launch of RHS 900 [283,000]			
1991	[373,000]	Authorization of GSM (march)	launch in Strasbourg	
1992	[435,000]	July: start of FT network (Itineris). December: start of SFR network.		DECT: publication of DECT standards and first product made
1993	[463,000]	April : (9,000) [66,000 ; 25%]	launch in Paris	
1994	[345,000]	june: (215,000) [485,000]	may: (50,000)	
1995	[296,000]	[1,000,000; 75%]		
1996	[212,200]	[2,000,000 ;85%]	[92,000]	GSM1800: launch; June: (12,000; 15%) [90,200]
1997	[124,900]	strong increase of geographical coverage. [5,100,000; 95%]	Network shut down [0]	GSM1800: [505,000; 50%]
1998	Radiocom network shut down. [47,200]	increase of geographical coverage. [9,800,000; 97%]		GSM1800: [1,400,000; 90%]
1999	NMT-F network shut down. [0]	[20,000,000; 98%] incl. GSM1800		Wi-Fi: formation of WECA
2000		[29,000,000] incl. GSM1800		Wi-Fi: brand name
2001				
2002				Wi-Fi: WECA renamed "Wi-Fi alliance"
2003				UMTS-2000: first downlink emissions
2004		[44,000,000] incl GSM1800		UMTS-2000 (december) commercial launch
2005				
2006				
2007				
2008		UMTS-900: march: authorization		
2009		UMTS-900 Q2: commercial launch		

Table 14: Changes in time-varying waves. Bracketed figures are number of customers at the end of the year (Renaud 2007) and coverage in percentage of the population (MEFI 2001). Also data from (GSA). Parenthesized figures are numbers of customers at other date.