How tall can be a Swiss Guardian,
before he loses control?
About wave interference properties in nerve system

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Abstract: Behind Boolean[1] algebra and bus-protocols that carry the informatics of our micro-electronic devices like smart phones or personal computers there is an unknown, different type of information processing used by animals and human. Although the research about nerves has brought lots of advances in detail, neuro-computing lacks the great break-through. The author successfully investigates since 1992 wave interferences in nerve-like networks. Some examples of measurable properties in nerve-system shell give an impression, how valuable the theory of interference networks can be for an understanding of information processing in nerve systems. Behind a hyperbolic projection [H1, Kap.3], producing the Homunculus, we will discuss holistic properties of wave interference systems as shown by Lashley's rat experiments [11]. MacDougall's nerve circuit shows the *impossibility to learn with weights*. At hand of Hebbian weights learning we discuss the general problem of current neural network theory. The paper assumes a substantial understanding of interference systems and interference networks. Find introductions in [H0], [H2] or [H9].

1. Introduction

Information can be processed only, if the inputs are at the same time at the same place. Nerves carry the information very slowly and pulse-like. Compared to microelectronic information propagation it is one million times slower. But

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[1] Gottfried Wilhelm Leibniz investigated binary logic and binary algebra in the way, modern microelectronics uses them, 170 years before Georg Boole's remarks. We should better call it Leibniz-Algebra (omnia ad unum).

the cortical number of nerve cells is comparable very high. Men have around 100 billion cortical nerve cells. Any synchronisation of this giant supercomputer using clocks fails because of the slow transfer velocities of signals (pulses) ranging from µm/s to 120 m/s. The supercomputer has neither D-latches nor bus-protocols. But nerve systems work, but how? Modern brain research seems to be farther away from answers then ever before. Modern informatics gives no answer. Is there an unknown second informatics? Any nerve impulse tries to creep into each branching of nerve, exciting each destination. Communication can not work this way. Where is the solution?

Ionic signals in nerve systems can be electrically measured as pulse-like time-functions, flowing slowly through different nerve cells, through many stages of information processing. Compared to electron- velocity in organic materials the flow-velocity of ionic pulses in nerve is slow. Why nerves use slow moving pulses? Isn't it necessary for survival to be fast?

Because nerve pulses creep into any branch, any communication needs interference of lots of pulse-waves that reaches the destination location per coincidence exact at the same time. Researching in this field, we find information transfer that reminds to an optical style; we find mirrored interference projections, holograms, frequency and code matching circuits, all with nerve-like properties [H0].

In opposite to optical or acoustical wave-theories, we use single Gaussian waves (not sinoidal waves) for simulations. Only for demonstration purposes we plot neuro-projections on homogeneous 2-dimensional fields (nerve nets are supposed to be inhomogeneous).

Data addressing needs the *self-interference* condition [H1, Kap.2, p.42], frequency or code detection needs an understanding of *cross-interference* [H1, Kap.2, p.53]. Like projections with optical lens systems, neural projections can occur under certain circumstances and at defined places, which are the locations of self- and cross- interferences [H7].

The term *self-interference* is used, if any pulse wave meets itself on a certain place in the net again. Like an optical lens system, self-interferences produce *mirrored* projections, see the cover of [H1]. We talk about *cross-interference*, if subsequent pulse waves meet a following or a preceding pulse wave, necessary to detect sounds, codes or frequencies.

At hand of some examples we will demonstrate, that interference systems and wave interference networks (IN) can give a better understanding of nerve nets.

Starting 1992 with the thumb experiment [H1, Kap.6], [H6] the author wrote different papers about nerve-like wave interference systems. The book “Neuronale Interferenzen” [H1] has 2018 its 25. Birthday. Next year I’m retired. I hoped all the years, to get grants in this field. I tried different times, but failed. So I investigated them like a hobby behind the job. A first application of a simplest, technical interference network, called “Acoustic Camera” got lots of reports, radio-talks and TV-shows [H8]. The acoustic photo- and cinematography was born, but did not push the IN research.

2. Origins of Interference Networks

Different researchers found lots of views on interfering networks between holography and experimental sciences. With his rat experiments Karl Spencer Lashley found a direct visible holographic property of the brain. Independently, which part of the brain he removed, rats could remember a way through a labyrinth. Holograms are reasoned by signal interferences. So Lashley [11] used the terminus “interference” mutually for the first time, Karl Pribram [7] sent me this excerpt of one of his books:

> Lashley (1942) had proposed that interference patterns among wave fronts in brain electrical activity could serve as the substrate of perception and memory as well. This suited my earlier intuitions, but Lashley and I had discussed this alternative repeatedly, without coming up with any idea what wave fronts would look like in the brain. Nor could we figure out how, if they were there, how they could account for anything at the behavioral level. These discussions taking place between 1946 and 1948 became somewhat uncomfortable in regard to Don Hebb’s book (1948) that he was writing at the time we were all together in the Yerkes Laboratory for Primate Biology in Florida. Lashley didn’t like Hebb’s formulation but could not express his reasons for this opinion: “Hebb is correct in all his details but he’s just oh so wrong.” (Karl Pribram in 'Brain and Mathematics', 1991, [7])

Lloyd A. Jeffress [5] was the first, who showed an interference circuit of the inner ear and Mark Konishi [6] was 1993 the one, who brought the Jeffress model of sound localization to a wide audience. Penfield [10] investigated body projections into the cortex - the so called ʹHomunculusʹ was found as a coupling port between brain and body. We will discuss this finding later. Hodgkin and Huxley [12] investigated the ionic and electric behavior of nerve cells. Karl Pribram [7] and Walter Freeman [9] characterized nerve nets to be holomorphic and Andrew Packard found color waves on animals (squids) [8], showing the wave-like nature of pulse-propagation in nerve nets. The author found projections in IN to be “image-like” mirrored and holomorphic. He analyses interference circuits on nerve-like networks since 1992 [H0]. Basic properties of IN can be investigated with simple circuit configurations.

3. An idea behind Penfield’s Homunculus

Wilder Penfield [10] found the so called motoric and sensory body projections in the gyrus precentralis of the human cortex, see Fig.1, left. As neuro-surgeon he used electric stimulation to excite specific parts of the body. Nerve cells in gyrus precentralis map the whole body surface in all details; the drawing was mutually called ‘Penfield’s Homunculus’ by Love & Webb 1992 [16] see Wikipedia.

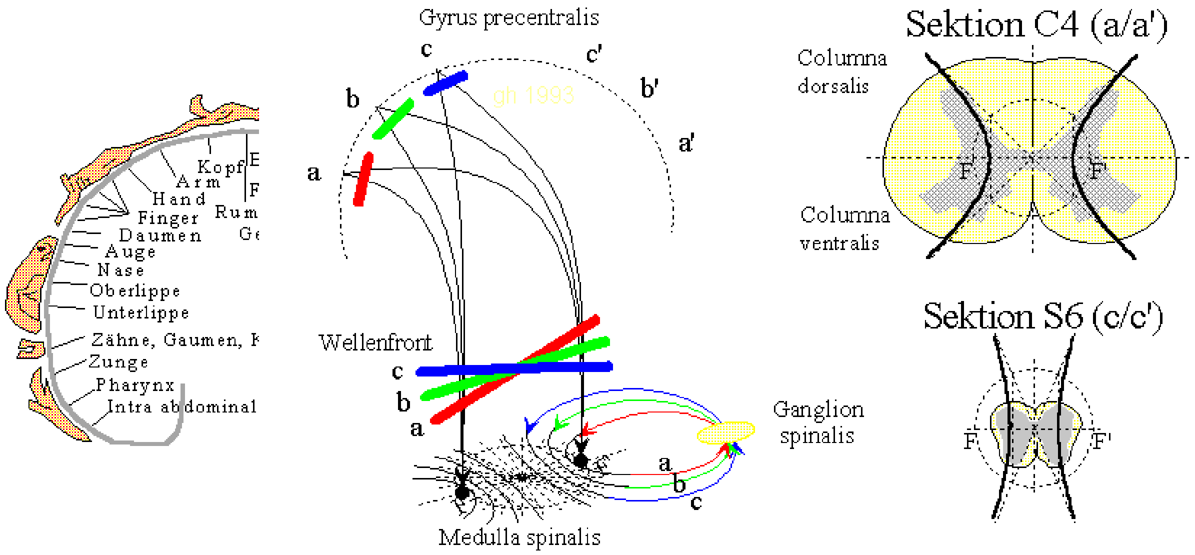

Fig. 1. Penfield’s Homunculus in gyrus precentralis left. Middle and right: A hyperbolic projection [H1, Kap.3, p.76] creates the Homunculus [H1, Kap.12]

To analyze the wave theoretical nature of the Homunculus, let’s have a look on the middle figure. If we mark three different wave fronts of the model with red, green and blue, we find a relation between the entrance points into the medulla spinalis and the output to the gyrus precentralis. The thickness of the spinal cord varies. Section C4 (image right) is bigger then section S6. If we suppose, that the projection type ‘a’ corresponds to S6 and type ‘c’ corresponds to type C4 of the spinal cord, this simple interference model produces the Homunculus.

In the evolution of nature nothing is without sense. What could be the sense of cortical body projections? If we read the thumb-experiment [H6], we get an idea. Is it possible, that the flexibility of the spinal cord makes problems to carry (straight) projections?

The spinal cord is very flexible and interference projections running through the spinal cord become shifted, if we turn the head. Reasoned by delay shifts (movement of projections, see Bionet 1996, Fig.8, [H4]) it is not simple to "hold the screen". It is the same, if we try to project an image through a long Berliner U-Bahn train, it is impossible if the train is in a curve. The single solution is, to use semi-transparent projection screens between all wagons and to transfer the image wagon by wagon through the whole train. This way the Homunculus appears as the last station – the projection screen in front of the train. On the other hand the correction of the projection field is simpler as with lens systems. We only need to control potentials at the embedding glia cells to make a neuron faster or slower – so we can shift the projection dependent of control potentials [H1]. Warning: Because the model is not verified by experts, these findings can be pure coincidence!

4. Understanding Lashleys rat experiments and Pribram's holonomy

Subsequent pulses flow with the specific velocity v, the width of the pulse and pause interval ($T = 1/f$) corresponds to a geometric distance, the *geometric wave length* $\lambda = vT$. Inspecting the nerve system, we do not find any nerve connection with negligible delay; each signal needs time to reach any destination. Thinking about projective interference systems we find answers [H1]: the cross-interference distance must be greater than the field size, thus the pulse velocity has to be slow. Because pulses expand in each direction, we will call them discrete waves on wires that flow in inhomogeneous nets of wires, so called "Interference Networks" (IN). Excitement locations - interference integrals (I^2) are coupled to places, were lots of waves interfere at the same microsecond. Part of the solution is that all the different pathways (dendrites, axons) have different length and velocities – thus they have different delays.

The average distance between self- and cross interference pattern is reasoned by the average delay between the waves. We call the corresponding distance *cross-interference radius R* of a plain field

$$(1)\ R = v\,T/2$$

Here, the average nerve velocity is v, the pulse interval is T = 1/f and the average fire frequency of generating neurons is f [H2]. The results of Lashley's rat experiments demanded a holomorphic memorization of brain content. (If a holographic glass plate is broken, we find the whole information on every glass fragment). Beginning 1994, the author made first simulations of this hologram-like behavior [H4] using pulse waves.

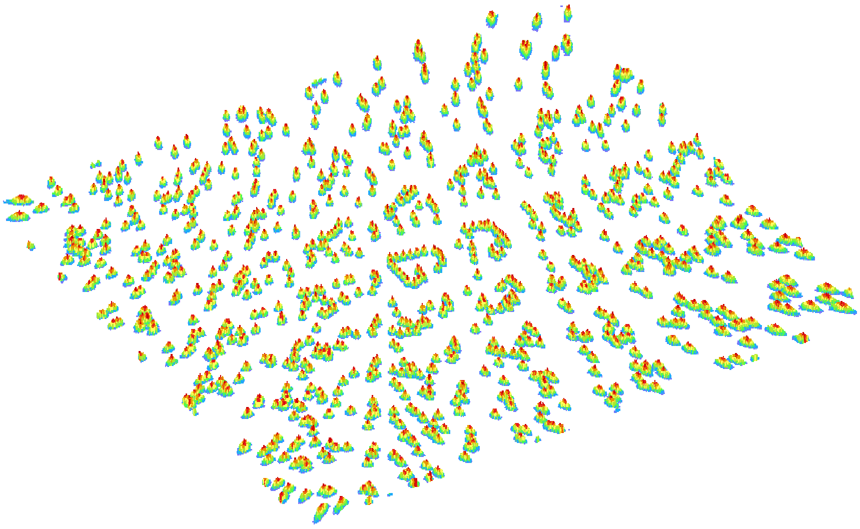

Fig. 2. Cross-interference pattern around the central self interference figure 'G' in a 3-channel, mirrored interference projection [H3], [H2] with holographic properties – all figures around have partial properties of the 'G'. (Simulation with PSI-Tools [H0]. The pulse generator field had permanent firing neurons in form of an mirrored 'G')

If many pulses flow through different nerves and re-combine, a specific pattern shows the so called cross-interference distance: Around a self-interference figure (the 'G' in the middle) subsequent following pulses form a cross-interference pattern, which has a distance (the cross-interference distance) to the self-interference figure. Fig.2 implies, that each learning task produces a comparable holographic pattern, the labyrinth of Lashley's rat training could be found in each region of the brain. So independent of which part of the rats brain he removed, the rats could remember the way through the labyrinth. Again, because the model is not verified by experts, these findings can be pure coincidence.

5. How tall can be a Swiss Guardian - Nerve velocity calculated by cross-interference distance

Changing the view, we can ask for the velocity for a cross interference distance of a two meter long Swiss Guardian [19].

The cross interference distance R can be used to calculate the velocity v [H9]:

(2) $v = 2\ R/T = 2\ f\ R$ with

(3) $R = 2$ m; $f = 30$ Hz we get

(4) $v = 2\ f\ R = 2 * 30\ \mathrm{Hz} * 2\ \mathrm{m} = 120$ m/s.

Because of pure coincidence this is the value of the maximum velocity measurable in myelin-isolated nerves of the human body! So, if the Swiss Guardian likes to be a fast boy ($f = 30$ Hz), he should never be taller than two meters. If he will become faster, he has to reduce his lengths! Otherwise he can not address his feet's very well, cross interferences would produce an effect that remembers on Parkinson disease, the cross interference figures overlay the self interference figure, so every excitation into the self-interference area produces wrong excitements at unwanted locations.

A look to Leonardo da Vinci's "Vitruvianian Men" shows an arm length of approximately the half body length. That means: for R = 1 m and v = 120 m we get $f = v/(2\ R) = 120\mathrm{m/s}\ /\ 2\mathrm{m} = 60$ Hz, that means, the maximum fire frequency of sensory neurons of the hand can be two times higher. It seems, the peripheral nerve system can be calculated as an interference network! Is this pure coincidence again?

6. MacDougall's impossible reflex pathway

The inventor of the term "synapse" Charles Scott Sherrington wrote in 1906 about a discovery of MacDougall [2]. He published the drawing Fig.3, where a reflex pathway was investigated. Lots of discussions followed about the possibility or non-possibility of this circuit, ending with: "No axon makes Type1 synapses (exciting) at some sites while making Type2 (inhibiting) at others." [H5]. The circuit has to work with only one kind of synapses; they have to be inhibiting or exciting. This implies, if the neurons have only one type of synapses the circuit can not work.

If we observe the circuit as a *delaying, pulse-interference circuit*, Fig.4, we need only exciting synapses of AND-type with a threshold to make it work. If the threshold of neuron N1 and neuron N2 is 3/2, and we suggest pulses of unity high = 1, then each neuron needs two pulses, arriving exactly at the same time to open the pathway. If we suggest delays on nerves proportional to the length, the network delays play the rule of the decoder. The patterns of Fig.4

address the flexor or the extensor of Fig.3 by delay shifts. Like lots of others, pure coincidence let us solve this problem again?

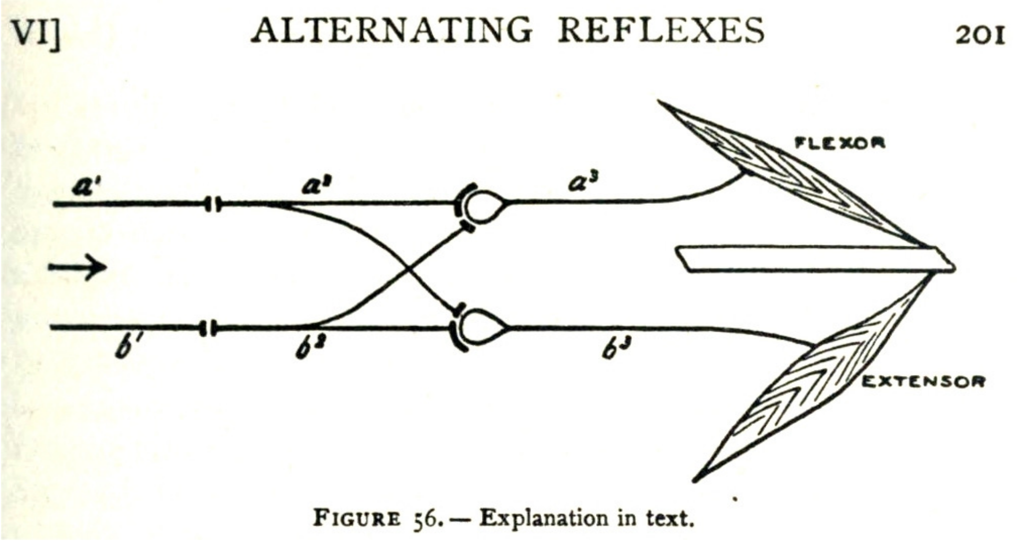
VI] ALTERNATING REFLEXES 201

FIGURE 56.— Explanation in text.

Fig. 3. MacDougall's reflex pathway, published by Sherrington 1906, source [3].

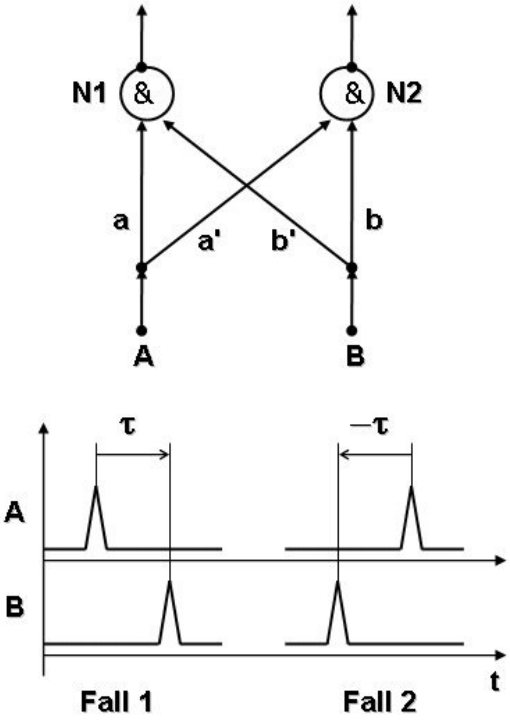

Fig. 4. Addressing the extensor (N2, Fall1) or the flexor (N1, Fall2) [H5] with pulse interferences. Attention: Nerve wires have length proportional delays (not drawn). Wires a' and b' are longer then a and b, they show by τ higher delays.

7. Weight or delay learning – why the Hebbian rule is “oh so wrong”

If we have a look into the giant field of neuro-science carried of *synaptic weights*, we find learning weights from Hebb’s rule over McCulloch-Pitts neurons over different Perzeptrons to Kohonens SOM, for example in [14]. McCulloch/Pitts neurons [18] and Hebb’s rule [13] dominated fundamentally the new field of Artificial Neural Nets (ANN) [15] over 60 years with millions of papers and thousands of books. Everywhere we find the same introduction: “It is generally believed, that Hebbian learning …”.

It was Donald Hebb, who introduced the most popular static learning rule in neuro-science, called Hebb’s rule [13]. Learning was for Hebb the learning of synaptic weights with threshold gates. In general speaking we agree.

But in the case of MacDougalls reflex pathway we can learn and learn and learn weights, and nothing happens! The pathway needs pulses and pulse-interference. If the pulse timing is different to the delays of the receiver circuit, it is absolutely impossible to learn anything with weights! That means, *learning is never only weight learning*! It is delay learning first; only the fine-tuning can be done with weights. Please listen again what Karl Pribram told us over his teacher and the teacher of Donald Hebb:

> “Lashley didn’t like Hebb’s formulation but could not express his reasons for this opinion: “*Hebb is correct in all his details but he’s just oh so wrong*.””

Our simple flexor/extensor example shows, that Lashley had the right feeling:

Delays dominate over weights!

Only, if the delay structure of a network is well established for the solution, it will be possible to learn some details with weights: *Form codes behavior.*

So billions of dollars have been burned for millions of scientific works on weight learning. This was mutually on of the *greatest disasters in modern science*. It is the disaster of an international science policy, that is dominated by political correctness and majority believe.

Today we know that dendrites grow and find the path through a soma in a way, that biologists directly could call “delay learning” [1]. On the other hand, by changing the thickness any axon or dendrite can change its velocity [2]. These questions will get the greatest relevance for future research in the age of wave interference network theory.

8. Summary

Karl Spencer Lashley observed directly holographic properties in rat's brain. He was mutually the first, how asked for interferences. Reported by Mark Konishi, Lloyd A. Jeffress had drawn mutually the first interference circuit. Andrew Packard was mutually the first, who filmed pulse waves on animals (squids).

A look to Penfield's Homunculus shows, that a simple interference network models the Homunculus in the gyrus precentralis over hyperbolic interference projections coming from the spinal cord.

The calculation of the cross interference radius of a tall Swiss Guardian with help of interference networks theory shows measurable pulse properties. It shows the peripheral nerve system can be calculated as an interference network.

MacDougall's reflex pathway cannot work as a threshold circuit. It works only with pulses and correct delays. For wrong delays, we can modify the weights without of the possibility, to make the circuit working.

So we found: *Delays dominate over weights*. If the delay structure of a network is not established for the solution, it will not be possible to learn anything with weights. McCulloch/Pitts "neurons" and Hebbian weights learning fails mutually for all delaying circuits (for example for nerve nets). It is not possible, to model interference systems (nerve nets) with weights learning only.

Details about biological delay learning could become the great advantage for interference network research in the future.

Asking for the problems in the middle of the 1990th the name of the scientific field was changed: The name "Neural Networks" (with weights learning) today are called "Artificial Neural Networks" (ANN). Now, we find this name also confusing. Weights' learning has nothing to do with delay-learning, nerve-like systems.

Warning: All findings can be pure coincidence!

9. Acknowledgments

Thanks for the invitation to the organizers of the 2018 conference “Autonomous Systems”, especially Jutta Düring, Dr. Mario Kubek, Prof. Dr. Herwig Unger and Prof. Dr. Dr. Wolfgang Halang, FU Hagen.

> *„Es ist schwierig, jemanden dazu zu bringen, etwas zu verstehen,*
> *wenn er sein Gehalt dafür bekommt, daß er es nicht versteht.“*
> *Upton Sinclair*

> *„Phantasie ist wichtiger als Wissen.“*
> *Albert Einstein*

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11. Related publications of the author

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[H1] Heinz, G.: Neuronale Interferenzen. Eigenverlag, 300 S., 1993, http://www.gheinz.de/publications/NI/index.htm

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12. Quotation

Heinz, G.: How tall can be a Swiss Guardian, before he loses control? About wave interference properties in nerve system. Proceedings of the 2018 GI conference on “Autonomous Systems”, 28.Oct.-2.Nov. 2018, Cala Millor, Mallorca, Spain.