

# A Mobile Hypothesis of Neural Networks for Spinal Reflex and Linguistic Processing (Digital Linguistics)

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**Abstract** Digital Linguistics (DL) is an interdisciplinary study that identifies human language as a digital evolution of mammal analog vocal sign communications, founded on the vertebrate spinal sign reflex mechanism. The evolutionary process of linguistic humans and the in-brain mechanism for linguistic phenomena are the biggest enigma in human history. There is not a single hypothesis with a detailed location/timing or cellular/molecular level explanation. A comprehensive academic boycott against South Africa (1960s-1990s) gave rise to international academics overlooking a plethora of modern human archaeological sites and artefacts in that country, and the sensor-motor synaptic connection hypothesis on the neocortex for linguistic circuit hides the true mechanism. Pavlov [1927] had observed counter-evidence for the cortical synaptic connection hypothesis for conditioned reflexes. Although he did not report it like that in his lectures, he expressed his expectation to be corrected by subsequent generations. DL hypothesized inside the ventricular system immune cell networks for linguistic processing and mechanism of meaning. There are B-lymphocytes floating inside Cerebrospinal Fluid (CSF), which function as conceptual devices and network with epitope terminals of CSF-contacting neurons (CSF-CN) on the ventricle wall and of Microglia on the neocortex. Lymphocytes are evolved neurons which do not require fixed synaptic connections for networking, but they network in a mobile-ad-hoc manner with antigen/antibody terminals on the membrane surface. A mobile hypothesis of distributed and autonomous mobile neural networks fulfills the requirements for linguistic processing and intelligence. As sign reflex is involuntary and an ego-centric reflex mechanism, linguistic humans have to overcome its restrictions to enhance our linguistic ability and intelligence.

**Keywords** Immune Cell Networks inside CSF, Meaning of Daily and Scientific Concepts, B Lymphocytes, Cerebrospinal Fluid Contacting Neurons, Microglia, Evolutions of Linguistic Humans

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## 1. Introduction: Logical Properties of Phonemes and Morae for Digital Processing

The critical importance of the oldest modern human site, Klasies River Mouth Caves, South Africa, has been overlooked because research into the South African stone age had been sidelined and ignored by international academics following the severe international academic boycott against South Africa from the 1960s to 1990s. The author made his first visit to the Klasies River Mouth Caves in 2007, and his second in 2012, where the unique anatomical features of mandible development and laryngeal descent of modern humans seems to have taken place.

In the artefacts unearthed from Howiesons Poort layer, there were types of tools which were only known from 'advanced' Upper rather than Middle Palaeolithic contexts in Europe, and the stratigraphic position (66-58 KA = thousand years ago) of Howiesons Poort was highlighted by the excavation of the Klasies River Mouth main site. [Wurz 1999] This time-reversal has not been fully discussed and analyzed, as it requires a Copernican turn from a Eurocentric perspective. Nobody has imagined that the two distinctive Neolithic culture of Still Bay (72-71 KA) and Howiesons Poort (66-58 KA) should correspond to the two stage acquisition of discrete logical properties in speech sound, namely phonemes by click consonants, then morae by vowel accented syllables. Phonemes and morae provide frequency and time domain distinctiveness for automatic processing.

Digital Linguistics (DL) is an interdisciplinary study that identifies human language as a digital evolution of analog vocal sign communications of mammals. Digital system consists of autonomous logical networks to regulate information and generate complexity: computer networks and reproduction/evolution of living organism are digital. Inheritance and development of human collective/individual intelligence should also be

understood as digital.

The author investigated whether the human digital language and mammal analog vocal sign communications are supported by vertebrate spinal sign reflex mechanisms. Analog signs are memorized as frequency patterns and it is not easy to differentiate and share more than 100 signs by non-human animals, who do not need to communicate as much, and thus the number of signs is limited. On the other hand, digital signs are generated by discrete phonemic permutations and thus it is easy to generate an almost infinite number of unique and distinctive signs. Digital

signs can verbalize any tiny visible and invisible differences.

DL identified that there are three unique evolutions for linguistic humans: laryngeal descent for vowel vocalization (66 KA in South Africa), invention of a character set and literacy (5 KA in Mesopotamia), and computer networks (Now and global). Laryngeal descent was an anatomical evolution, but character set and computer networks exist outside of our body, and one has to be trained and skilled to make use of them. It is remarkable that the complexity of intelligence increases synergistically at each level.

**Table 1.** A Bricolage and 3 Breakthroughs in Linguistic Development of Modern Human: The difficulty of linguistic evolution lies in the fact that sophisticated and omnipotent digital language uses the involuntary sign reflex mechanism for linguistic processing.

A Bricolage & 3 Breakthroughs (BTs)	Logical Properties and Circuit Logic	Results & Achievement
<b>Vertebrate Spinal Sign Reflex Mechanism</b> (Bricolage)	Dichotomy (non-linear, all or none), Dualism (If A then do B), (A+B=C)	Sign Reflex & Learning, Thought operations
<b>Laryngeal Descent for Vowel Accent</b> (72-66KA, BT1)	Phonemes and Morae (P&M) in Speech Sound	Infinite word signs, Concept (= sign thinking with word), Grammatical modulation
<b>Character Set &amp; Literacy</b> (5KA, phono/ideograms, BT2)	Externalized, Shared and Long-term P&M Memory	Abstract concept, Civilization (= rapid serial development)
<b>Computer Networks</b> (Now, BT3)	Electronically Networked Interactive P&M Database	Axiomatic thought, Interdisciplinary integration, Forward Error Correction

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## 2. Pavlov [1927] Recorded Counter Evidences for Cortical Synaptic Connection Hypothesis

The brain mechanism for linguistic processing has not yet clarified or even hypothesized. Scientists discuss the “Language Acquisition Device” or “Linguistic Brain” without identifying the organ and its cellular/molecular level memory and interaction mechanisms. As the neocortex anomalies in Broca / Wernicke areas were observed in the post mortem examination of patients with speech impediments, it is taken as granted that linguistic processing takes place on the neocortex by establishing sensor-motor synaptic connections.

### 2.1 Mutual Induction

Pavlov [1927] experimented with a single sign, or conditioned reflex, to change its meaning. For example, he established the Metronome 100 beat/minute as a ‘conditioned reflex’ for an ‘unconditioned reflex’ representing food. Then when he gave the same ‘conditioned reflex’ without ‘reinforcement’ (= food), the dogs stopped salivating. He named this phenomenon ‘internal inhibition’ or ‘extinction’. In Lecture-4, he explains as follows: *the positive conditioned stimulus itself becomes, under definite conditions, negative or inhibitory; it now evokes in the cells of the cortex a process of inhibition instead of the usual excitation. Conditions favouring the development of conditioned reflexes of the negative or inhibitory type are of frequent occurrence, and these reflexes are met with not less frequently than reflexes of the positive or excitatory type.* He did not consider that dogs learned the change of sign-meanings through experiences.

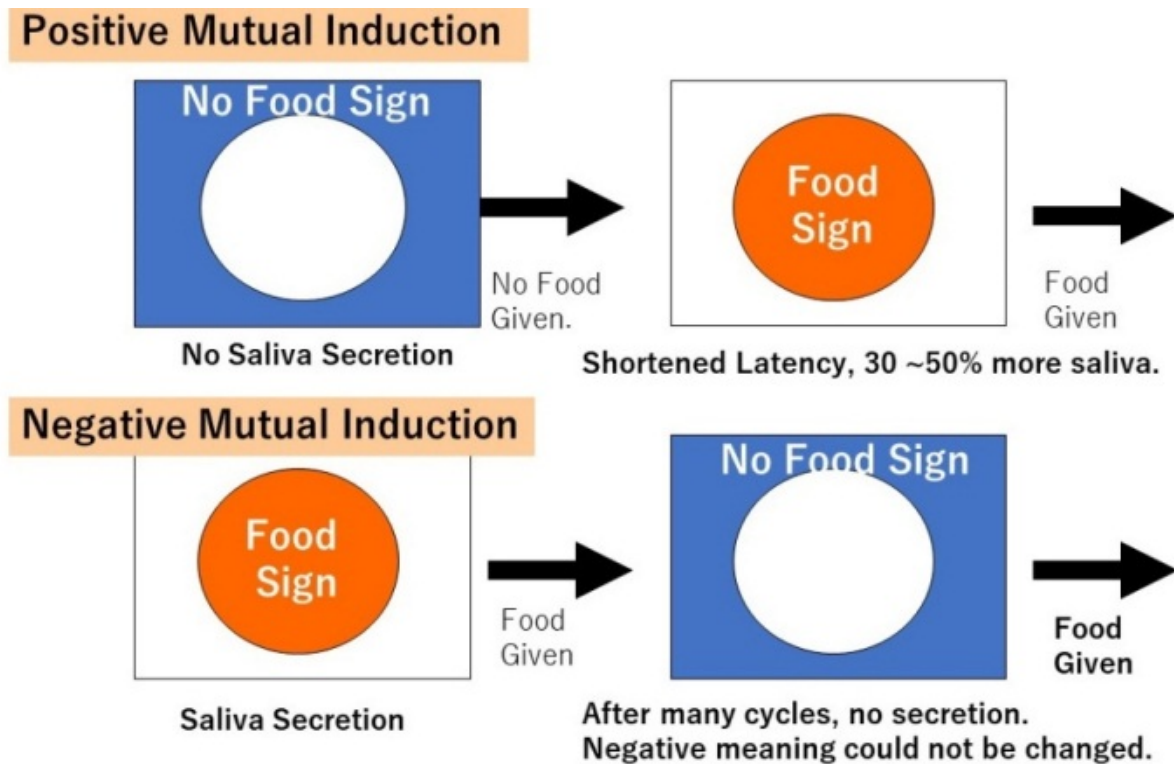
The author interprets the above explanation as follows: (1) Pavlov believed that the conditioned reflex is established as a synaptic connection from the sensor area to the motor area, and, that, therefore once it is established, the conditioned stimulus should trigger the secretion of saliva regardless of reinforcement (feeding). (2) Pavlov interpreted that, when dogs reduced or stopped salivating against a positive conditioned stimulus, the neuron should produce a negative or inhibitory signal instead of an excitatory one.

Pavlov observed that the once established relationship between “conditioned stimuli” and their meanings, food or poison, changed, and he concluded that the conditioned stimulus can change from excitatory to inhibitory and vice versa.

But, in some experiments he did not change the sign-meaning relationships: Positive Mutual Induction and Differential Inhibition. In Negative Mutual Induction, he tried to change the sign-meaning relationship but he could not. These experiments provide us with interesting insights, although he kept silent on the matter.

Mutual Inductions in Lecture-11 are cyclic experiments using both Excitatory and Inhibitory stimuli for the same meaning (=memory), i.e. food and no food. The Positive Mutual Induction is as follows: when Metronome 100 is the sign for food and Metronome 90 is the no food sign, at first the no food sign is given and no food is provided. Then the food sign is issued, and the dogs salivated without any delay and with 30 to 50 % more than when the sign is used independently.

The Negative Mutual Induction hoped to change the meaning of the Negative sign into a Positive one. Such change of meaning, i.e. from no-food to food, was very easy when the sign was used independently. It was implemented and results were: at first, the food sign is issued, then food is given. Then the *no food sign is presented and food is provided*. Although this cycle of {[food sign] ⇒ food ⇒ [no food sign] ⇒ food} was repeated many times, the dogs did not secrete saliva after the no food sign.



**Figure 1.** Experimental Flow of Positive and Negative Mutual Induction: Once a pair of signs for positive and negative meanings is established, they seem to communicate or network each other. This phenomenon was not explained with synaptic connection hypothesis.

## 2.2. Differential Inhibition

Pavlov explained how a set of Positive and Negative conditioned stimuli are generated in Lecture-7, “Differential Inhibition”. He reported. “*It was noticed that when, after a conditioned reflex to a definite stimulus (e.g. a definite musical tone) had been firmly established, the effect of another closely allied stimulus (a neighboring musical tone) was tried for the first time, the conditioned reflex which resulted from the new stimulus was frequently much weaker than that obtained with the original conditioned stimuli. On repetition of the stimulus of the neighboring tone, always, of course, without reinforcement, the secretory effect increased until it became equal to that given by the originally established stimulus, but subsequently on further repetition began to diminish, falling finally to a permanent zero.*” (Page 118) (Figure-2 and -3)

Pavlov described it such a matter-of-fact way that readers don’t pay special attention to this inexplicable phenomenon. Pavlov presented the entire sequence in two separate tables, so readers did not realize the enigmatic fluctuation, starting with “much weaker” to “increased until it became equal” then “a permanent zero”. This rise and fall cannot be explained, if it is a synaptic connection on the neo-cortex. Pavlov intentionally separated and hid it, but he was honest enough not to delete the results. (Figure-2 and Figure-3)

Time	Stimulus applied during 30 secs.	Amount of Saliva recorded by divisions of scale (5 div. = 0.1 c.c.) during 30 secs.	Remarks
<i>Experiment of 12th October, 1917.</i>			
12.28 p.m.	Tone	30	Reinforced.
1.0 "	Tone	35	Reinforced.
1.10 "	Semitone	9	Not reinforced.
<i>Experiment of 13th October, 1917.</i>			
12.54 p.m.	Tone	36	Reinforced.
1.5 "	Tone	36	Reinforced.
1.12 "	Semitone	32	Not reinforced.
2.1 "	Semitone	16	Not reinforced.
2.18 "	Tone	29	Reinforced.

The reflex to the semitone continues to fluctuate, gradually diminishing in strength until at the thirteenth repetition it has fallen to zero.

Figure 2. The results of Differential Inhibition presented in two separate tables [Pavlov 1927] Figure-2 demonstrates "much weaker" effect at the beginning, then "equal" on the following day.

### 2.3 Removal of the Cortex Entirely or Partly

It is not obvious that Lectures-1/2 and Lecture-19 constitute the hypothesis and the experimental results. Pavlov had supposed that conditioned reflexes are established as synaptic connections between sensory and motor areas on the cortex. To demonstrate that "(A) decerebrate dog would never have responded by salivary secretion to any stimulus of the kind," he removed the sensory areas or cerebral cortex entirely (Lecture-2, Page 22, Lecture-19 to 21 are the cases of decerebrate dogs.) However his writings in Lecture-19 contradicts his statement in Lecture-2. "The first change which follows the extirpation of some part of the cortex is the almost invariable disappearance of conditioned reflexes; but in the majority of cases it is only the "artificial" conditioned reflexes which disappear, i.e. those which were established in the laboratory, being therefore relatively recent and little practiced. If the "natural" conditioned reflexes have also disappeared, they are always the first to reappear; but usually no disappearance of the natural conditioned reflexes could be observed even though tested immediately after the recovery from the anesthetic administered during the operation. "As a rule the conditioned reflexes disappear after the operation, whether it is performed on one or both of the hemispheres and on whatever portion of them it is carried out. The absence of "artificial" reflexes persists for different lengths of time, varying from a single day to several months." (Lecture-19)

The author surmised that Pavlov should have modified his presuppositions in Lecture 1/2 according to his experimental results in Lecture-19-21, instead he placed the experimental results some distance from Lecture 1/2. Probably he did not want to make things complicated, and honestly confessed in Lecture-22: "Indeed I have no doubt

Time	Stimulus applied during 30 seconds	Salivary Secretion in drops during 30 secs.	Remarks
<i>Experiment of 8th June, 1911.</i>			
2.5 p.m.	Tone	10	Reinforced.
2.35 "	Semitone	0	Not reinforced.
2.38 "	Semitone	0	Not reinforced.
2.39 "	Tone	7	Reinforced.
2.50 "	Tone	12	Reinforced.
<i>Experiment of 14th June, 1911.</i>			
1.45 p.m.	Tone	12	Reinforced.
2.0 "	Semitone	0	Not reinforced.
2.2 "	Semitone	0	Not reinforced.
2.4 "	Semitone	0	Not reinforced.
2.6 "	Semitone	0	Not reinforced.
2.7 "	Tone	1.5	Reinforced.
2.30 "	Tone	13	Reinforced.

Figure 3. shows a stable "permanent zero" situation at the end. Pavlov did not present any table for the queerest process: "increased until it became equal ... but subsequently on further repetition began to diminish falling to a permanent zero,"

that the presentation of the subject- matter attempted in these lectures will in the future still be corrected in many details. Errors in interpretation, and errors sometimes in the methods of observation, are naturally to be expected in a study of such astounding complexity." (P379) It is our responsibility to identify his mistakes, correct them and enhance collective human intelligence.

## 3. A Mobile Hypothesis of Neural Networks for Linguistic Processing

### 3.1. Ventricle System (VS)

If word memories are not stored or processed on the neocortex, where are they? By integrating interdisciplinary researches, DL came to the conclusion that our consciousness exists as autopoietic and distributed microbiological immune cell networks inside the Ventricle System (VS). It is a microbiological phenomenon regulated by the logic of individual mobile neurons (= B lymphocytes) taking place inside the very low noise environment of Cerebrospinal Fluid (CSF) which is filtrated, purified and regulated by the Choroid Plexus. If we want to enhance our intelligence, we had better understand the logic and mechanisms of microbiological immune cell networks and the CSF environment so that autopoietic microbiological phenomena should develop and enhance our intelligence.

"The ventricle system is filled with CSF. CSF is weak alkaline and transparent aqueous solution. This fluid is filtered at choroid plexus and fills the ventricle system, circulates CNS, goes through hindbrain median opening and hindbrain outside parts of the fourth ventricle and arrives at subarachnoid space to be absorbed by vein

system.” [Tamotsu et al 2006] CSF is the third circulatory system next to the blood and lymph systems. The size of the VS is approximately 150 – 160 ml and about 500 – 600 ml CSF is filtered every day by the Choroid Plexus at each ventricle: CSF changes 3 – 4 times every day. CSF is secreted blood sent via the Choroid Plexus artery. The Choroid Plexus filtrates the blood and prevents large molecules from entering into the ventricular system, making a so-called Blood Brain Barrier (BBB). Until recently, thanks to the BBB, lymphocytes and immunoglobulins were not supposed to be in CSF. It now becomes clear that they exist at the rate of 0.5% of their amount in the blood, and perform active immune responses.

The route of CSF is through the Frontal Lobe, Corpus Callosum, Fornix, Ventriculi Lateralis (Hippocampus), Temporal Lobe, Thalamus, Hypothalamus, Cerebellum, Medulla Oblongata and the Cortex in the Subarachnoid Space. CSF is in contact with almost all parts of the brain, and connects the Limbic System to the Neocortex. This route is the “Information Super Highway” inside the brain system, but there is no route map available with a detailed molecular structure of the ventricle wall probably because its importance has not yet to be realized. This route demonstrates that lymphocytes floating inside CSF can network with any part of the brain system.

VS of vertebrates started at so-called Cambrian Explosion 530MA (Million years ago) with the coincidental birth of CSF and mobile neurons, currently designated as B- and T- lymphocytes, which seem to function as sign reflex. [Kourilsky 2014] B/T lymphocytes are categorized as immune cells in contemporary sciences, because scientists had discovered their immune activities before their mobile neural activities and created prejudice for them. It is plausible that the mobilization of neurons took place inside CSF/VS earlier than immune activities. Mobile neurons were born inside CSF/VS and then expanded their activity area into blood vessels to work for pathogen patrol. It is plausible that inside a very low noise environment of CSF/VS, they function as mobile neurons.

### 3.2. Immune Cells Have Logic of Dichotomy and Dualism

The DL owes a lot to Noll [2003], in particular for his extensive interdisciplinary references not only in linguistics but also Information Theories, Quantum Mechanics, Brain Sciences, Molecular Biology, Primatology, Archaeology, Mathematics, Immunology, Genetics, etc. The idea of digital language seems to have been inspired and conceived by Jerne and Noll promoted Jerne, who identified that immune cells are neurons with mobile ad-hoc networking functions, and verified that B-lymphocytes have all the necessary functions to behave as concept devices. [Jerne 1974] [Jerne 1984]

According to Noll, “*Jerne, in his classical paper*

*‘Towards a network theory of the Immune system’ was also the first to point out the close analogy between the immune and the nervous system; (the) immune system, when viewed as a functional network dominated by a mainly suppressive Eigen-behavior, but open to stimuli from the outside, bears a striking resemblance to the nervous system.*” [Noll 2003] [Jerne 1974]

“*Both systems display dichotomies and dualisms. The cells of both systems can receive as well as transmit signals. In both systems the signals can be either excitatory or inhibitory.*” [Jerne 1974] Dichotomy divides the world into two, All or None, A or not-A, and executes pattern recognition. Dualism allows us to formulate a logic which receives any two arbitrary signals and produces an output.

### 3.3. B lymphocytes are Mobile Neurons and Fulfill the Requirements for Conceptual Devices

The following sentences in Jerne [1974] are also very important to understand what immune cells are and to envisage neuro-immune cell interactions (=networking) inside VS. “*The two systems penetrate most other tissues of our body, but they seem to be kept separate from each other by the so-called blood-brain-barrier. The nervous system is a network of neurons in which the axon and the dendrites of one nerve cell form synaptic connections with sets of other nerve cells. In the human body there are about  $10^{12}$  lymphocytes as compared to  $10^{10}$  nerve cells. Lymphocytes are thus a hundred times more numerous than nerve cells. They do not need connections by fibres in order to form a network. As lymphocytes can move about freely, they can interact either by direct encounters or through the antibody molecules they release. The network resides in the ability of these elements to recognize as well as to be recognized.*” If Jerne had lived in the mobile communication era of the 21<sup>st</sup> century, he would have called immune cells “Mobile Ad-hoc Networking (MANet) Neurons” or simply “Mobile Neurons”.

In 1974, Jerne deliberately chose the expression of “seem to be kept separate”, but it is now confirmed that there are not separated. There are lymphocytes inside CSF/VS and they perform active immune responses. Some scientists suppose that immune cells are working inside CSF on pathogen patrol, but the author surmises that lymphocytes function as mobile neurons and interact with antigen terminals on the ventricle walls as well as with other lymphocytes floating inside CSF, for reflexive behavior, sign communications, thought, intelligence, etc. The CSF is a very low noise environment where the amount of proteins is only 1/200 compared to the blood regulated by the Choroid Plexus at each ventricle (Left, Right, 3rd and 4th). It is plausible that active immune responses represent neuro-immune cell phenomena to construct our consciousness. Word and meaning memories seem to be stored as immune cell memories inside VS.

The idea that linguistic activities could be controlled by

the Immune System was first indicated by Jerne [1984]. In his Nobel lecture “The Generative Grammar of the Immune System”, Jerne pointed out the analogy between language and the immune system. “*Looking at languages, we find that all of them make do with a vocabulary of roughly a hundred thousand words, or less. These vocabulary sizes are a hundred-fold smaller than the estimates of the size of the antibody repertoire available to our immune system.*”

Jerne demonstrated that the vocabulary of the immune system is a variety of specificity sets by antigens and antibodies, and that it is a hundred times bigger than vocabulary in languages and that it can cope with new signs. “*I should now like to introduce some numerology into this discussion. How large is the number of different antibodies that the immune system of one single animal (be it a human or a mouse) can make? This number, during the past few decades, has been estimated, on more or less slender evidence, to exceed ten million, and this enormous diversity has been designated as the 'repertoire' of the B lymphocytes. Such a 'repertoire' has been characterized by Coutinho as 'complete'. 'Completeness' means that the immune system can respond, by the formation of specific antibodies, to any molecule existing in the world, including, as I said earlier, to molecules that the system has never before encountered.*” [Jerne 1984]

B Lymphocytes provide essential biological mechanisms required for a conceptual device: (1) more than 10 million of specificity pairs can be generated between antigens and antibodies, (2) plasticity to cope with new stimulus, (3) networking with antigens through mutual recognition, (4) conversion between analog physical shapes of speech waveform to three modules of predetermined amino acid sequences which constitute CDR (complementarity defining regions).

In the author’s tentative definition, “concept” is “an in-brain device to represent a word memory and to network (or connect) in-coming stimulus and word memory, word memory and sensory memory, word memory and other word memories, word memory and thought memory. At each networking occasion, it executes a thought operation to determine or evaluate by itself. Concept is a product of thought at the same time it is a source of thought. This vicious circle mechanism has a potential to increase the complexity order of concept”. [Vygotsky 1935][Tokumaru 2018a] On the molecular biological level, it can be the microbiological immune cell with antibody networking with antigen/antibody terminals of other neuro-immune cells.

As B lymphocytes have all the necessary functions to behave as concept device, linguistic humans did not have to invent new organ optimized to process digital language, but we used sign reflex mechanism as *bricolage* to cope with hundred thousand of word signs.

### 3.4 Other Immune Cells inside Ventricles

Reticular formation is located at the center of our CNS. It “*is known from embryology that most of the leftover cells of the brain stem and spinal cord which are not concerned in the formation of motor root nuclei and purely sensory relay nuclei are utilized in the production of the formatio reticularis.*” [Allen 1932]

There are neurons inside the VS named as CSF Contacting Neurons (CSF-CN). Neither neurologists nor immunologists study the CSF-CN, and the papers of Vigh were published in the journal of Histology. [Vigh et al 2004] CSF-CN are neurons connecting the retina/cochlea and ventricle wall, and their terminals at the ventricle wall constitute epitopes (= antigen terminals) with cilium of motor protein on the top. CSF-CN function to generate a new antigen terminal at the Brainstem Ascending Reticular Activating System (ARAS) corresponding to a new external sign stimulus.

On one hand, about 90 % of brain cells are immune cells. The grey material which covers the surface of the neocortex is microglia, very similar to macrophages which present various communicating molecules on the surface of the cell membrane. Pavlov [1927] reported that signs should be given prior to meaning to successfully establish the reflex: “*it is also and equally necessary that the conditioned stimulus should begin to operate before the unconditioned stimulus comes into action. If this order is reversed, the unconditioned stimulus being applied first and the neutral stimulus second, the conditioned reflex cannot be established at all.*” (Lecture 2) It is possible that, when a microglia is newly matured in the Hippocampus with the memory of food to be coded in the DNA double helix in the nuclei, antigen 3-dimensional structure representing sign waveform is presented on the cell membrane surface as an index. [Ming Guo-li et al. 2011] [Neuberger et al. 2000]

### 3.5. Networking Terminal Morphology for Phonetic Word Signs

Now let us imagine how ambient speech sound can be represented by antigen and antibody molecular structure. Phillips [2001] is also reluctant to admit that the cortex is involved in speech sound processing and stated that “*the representation in the cortex of speech sounds is acoustic rather than phonetic, and is independent of voice pitch.*” And, “*insofar as human speech sounds are concerned, it is unlikely that cortical neurons are able to entrain spikes to the glottal pulses that set the voice pitch, but there is no doubt that they can indicate the timing of the phonetically important components of the speech signal. In this regard, there is recent evidence that the most important temporal components of the speech signal are the slower, amplitude envelope fluctuations, rather than the waveform’s fine time structure.*”

The comparison between the slower amplitude envelope fluctuations and the waveform's fine time structure is available in Chiba [1935, Figure-4] After having measured the fine time structure of frequency and amplitude, Chiba outlined the envelope. It seems that the envelope derives from multiplexed waveforms of amplitude and frequency, and thus represents an energy curve. It is plausible that the

3-D structure of antigens should represent such envelope shapes. A critical function of an amplitude envelope was confirmed when I said the word "Pakistan", then Ms. "Takeshita" (to pronounce with Japanese flat intonation) reacted as she felt that she had heard her name being called. The similarity between Pakistan and Takeshita should be in the envelope shape.

a) 先づ強さの曲線を見るに、ある幾つかづつの音節を團體として考へれば、その内部には隣接する音節間の強さの差は小さく、又差の大なる時には時間的距離が大きい、そして各音節の強さの曲線の頂點を連結すれば滑かな曲線が得られる。Fig. 32は jusqu'à la révolution の強さの曲線の一部を示す。

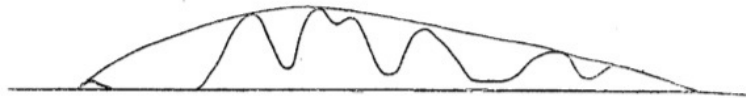


Figure 4. The envelope fluctuations (above) and the waveform's fine time structure (below) According to Chiba, this curve represents a part of linked intensity peaks of French expression "jusqu'à la révolution" [Chiba 1935]

### 3.6. Network Requirement Analysis for Word Phonetic Sign Networking Inside VS/CSF

The slower amplitude envelope fluctuations can be shaped as an antigen presentation at the Brainstem Reticular Formation by CSF-Contacting Neurons, the same antigen structure on the membrane surface of the microglia cell on the neocortex, and antibody molecule with specificity pair to antigen should be formulated on the membrane surface of B lymphocytes. [Vigh et al 2004]

Table 2. Network Requirement Analysis for Inside Ventricle System (VS) Immune Cell Networks © Kumon Tokumaru 2018

Network Requirement Analysis for Inside Ventricle System Immune Cell Networks for Word Sign Reflex					
Nomenclature	Memory Type	Activation	Molecular Structure	Location	Mobility
CSF (Cerebro-spinal Fluid) Contacting Neuron	Sound Waveform of word phonetics (& Instinctive Reflex)	Activation	Antigen terminal with cilia vector	Brainstem Reticular Formation	Fixed
B lymphocyte (= Concept Device)	Word Networking Results and Waveform Receptors	Active / Passive	Antibody (= 3 Antigen CDRs)	Floating inside CSF (Cerebro-spinal Fluid)	Mobile
Microglia Cell (= Meaning of Daily Concept)	Sensory Memories with Sound Waveform as indexes	Passive	Antigen terminal to be recognized	Neocortex	Fixed

Table-2 is the result of network requirement analysis for inside VS immune cell networks for the word sign reflex. Antigen terminals of CSF-CN and microglia represent "amplitude envelope fluctuations" of individual phonetic stimuli of words. Antibody of B lymphocyte constitutes a specificity pair with the antigen terminal. Word phonetic stimulator (= CSF-CN) and sensory memories related to that word (=microglia) are mediated by the concept device (= freely moving B lymphocytes inside CSF) for daily spontaneous concept. The meaning of scientific concepts is established as a network of dualistic thought operations among B lymphocytes inside the CSF. This is a brief overview on the meanings of daily and scientific concepts. [Vygotsky 1935] [Tokumaru 2018b]

The table shows that sensory memories stored in microglia cells are passive and can be recognized by B lymphocytes. For example, when we happen to see our old friend in the street, we can recognize their face, but we cannot remember their name. It is because sensory memories are fixed in the neocortex and recognized by mobile concept devices.

#### 4. Conclusion: To Overcome Restrictions of Involuntary Sign Reflex

The author has been proposing this immune cell networking hypothesis inside CSF in VS since 2012 in Japan and since 2013 internationally. [Tokumaru et al. 2013a, Appendix-1] [Tokumaru 2013b, Appendix-2] To date, not a single opposite opinion or disproof has been raised. The author continued his study of DL and clarified that a civilization is a linguistic phenomenon of linguistic humans: at the end of their biological life, they can write their accumulated knowledge with a character set, so that subsequent generations can share their thoughts and experiences. This linguistic phenomenon enabled rapid and serial innovations which we call Civilization. [Tokumaru 2018c]

The author is more and more convinced with the importance of inheritance, correction and development of collective human intelligence. If linguistic processing is operated by the sign reflex mechanism, which is stubborn, involuntary, reflexive, ego-centric and memory based mechanism, we can recognize only the words which are already memorized in our brain and we overlook unknown words. When we are initiated or educated with wrong information, as there is no self-diagnosis mechanism in our brain, we take right information as wrong. It is time for linguistic humans to overcome the restrictions of sign reflex to enhance our intelligence, as we now live in the era of computer networks.

When we see any unknown words, we can inquire their meanings through search engines using our handy smart phone terminals. We are flooded with linguistic information with an uncertain quality and reliability. Forward Error Correction (FEC) is a technology in digital information processing to correct errors without having to contact information senders or the original authors. It differentiates errors in two, channel coding errors, for which authors are not responsible, and source coding errors for which they are responsible. They constitute the excluded middle, and after channel and source coding error corrections, we can get error-free information.

At the time of receiving information, we should verify its authenticity as the author originally desired. Biographies and other works by the author are auxiliary information which can confirm the reliability of authors. Manipulated and apocryphal information are channel coding errors, which should be eliminated. The author can protect his text from forgery by adding additional analytical data as error correction codes.

Readers should verify the correctness of an authors' idea by following a step-by-step learning and thinking process, as demonstrated in this paper of Pavlov, i.e. associating themselves with the author. Without fully understanding the author's knowledge and way of thinking, readers

cannot detect the authors' errors and correct them. Through continuous efforts to correct errors in texts, human intellectual genomes should be established for linguistic humans to inherit, share and improve the collective human intelligence.

If people know the profound and infinite capability of our digital language, they will desire to know the truth and devote themselves to improve collective human intelligence. The future development of the modern human depends on how we correctly use language. The Cartesian expression "Cogito ergo sum" should be translated into molecular level biochemical/biophysical phenomena and rectified. In reality, it is concept devices (or words) which network each other and think. Thought is a networking phenomenon of individual word memories represented by mobile neurons inside the CSF/VS. If we want to think correctly, we have to rectify word memories through ceaseless learning and thinking. Then we will become "true human beings" with the correct and appropriate use of the logical language. "Words think: Concept devices representing individual word signs network with other word memories as well as sensory memories inside the brain CSF, which is thought. The more correct, accurate and appropriate concepts we use, the more correct our thoughts are and the further we advance."

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In Mallorca at the GALA13 (13<sup>th</sup> Generative Approaches to Language Acquisition) and at Belgorod at the ICLC (2017 International Cognitive Linguistics Congress), both in September 2017, I talked on the brain mechanism for grammatical processing. These lectures are now published as "Digital Linguistics: The Brain Mechanism for Grammatical Processing." [Tokumaru 2018d] I am grateful to GALA 13 Organizing Committee who allowed me to publish my paper independently from GALA 2017 Proceedings. In the definition of concept (3.3), I added one phrase for the vicious circle mechanism for complexity order, reflecting my last lecture delivered at the VIII<sup>th</sup> International Congress on Cognitive Linguistic, organized at Moscow State University, where L. Vygotsky studied and worked. I am sincerely grateful to the congress secretariat for extensive and friendly support for my stay in Moscow.



# Appendix-2 Poster Presented at the 19<sup>th</sup> ICL [Tokumaru 2013b]

## The Digital Language operated by Logical Syllables (Clicks and Vowels, 2 Stage Evolution of Language in South Africa) - Hypotheses for the Origin and Mechanism of Human Language Kumon Kimiaki TOKUMARU (Natural Philosopher, Japan)

Human activities have caused the Global Environmental Crises. Is human evil creatures? Or, human nature is good, but just we don't know how to use language yet.



Digital Communications are complex, sophisticated and invisible. We need to use Reference Model (Axiomatic System) and differentiate Physical Layers and Logical Layers. Antigen-Antibody responses seem to be operating mechanism.

Modern Human's roots is now identified in Middle Stone Age at Indian Ocean Coast of South Africa, where many MSA caves exist

Naked Mole Rats, living underground in East Africa, are highly vocal but have only 17 acoustic signs.

Signs of Naked Mole Rats are repetition of same chirps

What makes the significant difference in sign variety between humans (>100,000) & NMR (17)?

Human words are created as Syllabic Permutation, thus numerous

Japanese Syllabic blocks visualize syllabic permutation of word structure

In Japanese writing, cells are used to fill in individual characters or syllables. Cells visualize moras.

Chomsky's conundrum, "a mature speaker can produce a new sentence of his language on the appropriate occasion, and other speakers can understand it immediately, though it is equally new to them" (Chomsky 1964) should be divided into two parts: Channel Coding and Source Coding, in accordance with Digital Communication Theories:

1) Channel Coding for Error Free Reception

2) Source Coding: Why can a speaker speak out a linguistic message just once and listeners receive that message without a single syllabic (or word) error?

3) Critical Importance: Logical Mechanisms to pick up words from speech voice

4. Antigen-Antibody responses (digital networks) are model pattern to recognize and activate related antigen structures.

The human unique anatomy is Laryngeal Descent for phonation of vowels. The author surmises that it took place in Coastal Area of South Africa between 70 and 66 KA.

Laryngeal Descent is the human unique anatomy for Vowel Phonation

South African archaeology has been isolated from international academy in name of APARTHEID

Geographical Expansion of Neolithic Artifacts: Still Bay and Howieson's Poort

Two Meteoritic Impacts seem to have celebrated the birth of modern humans. There are many caves and rock shelters with Neolithic artifacts along Southern Coast.

Jerne indicated in 1984 that Immune Network System inside CSF (Cerebrospinal Fluid) is the biological mechanism for automatic language memory networks.

Keywords "human, digital, language" in web-search discovered "Digital Origin of Human Language: A Synthesis" by H. Noll (2003)

Are WORD MEMORIES B Lymphocytes in CSF and its antibody structure?

Biological features of Immune Cells fulfill the requirements of Language

Two Meteoritic Impacts seem to have celebrated the birth of modern humans. There are many caves and rock shelters with Neolithic artifacts along Southern Coast.

The Oldest Modern Human Site: Klaises River Caves in South Africa

2 meteoritic impacts in South Africa just before the birth of Modern Human

250KA Large Meteorite Impact "Kalkkop" 150km north of Klaises River Caves

Language is Neuro-Immune Interactions. Speech stimuli are brought to Brainstem Reticular Formation where Immune Cell Memories inside CSF are activated.

Reticular Formation is a very old structure phylogenetically but has been overlooked

Afferent and Efferent Pathways and CSF-CN Terminals on Ventricular Surface

Immune Cells inside CSF react against Neuro-terminals and serve for Language

Immune Mechanism is invisible=quantum

Klaises River Caves face to the meeting point of Atlantic and Indian Oceans. The author proposes a two-stage evolution hypothesis of human language in this region.

Klaises River Caves were bored by strong waves at meeting point of two Oceans 60 Ka 10

A two-stage acquisition process of human language in the Late Pleistocene

1. Click consonant phonemes generate inflexible concepts by permutation of phonemes in Sibibay Technocomplex (77-70KA) era.

2. Then laryngeal descent took place and enabled to phonate accented vowels with micro-energy and grammatical articulation of concepts for complex communication, generating Howiesonpoort Technocomplex (66-56KA) era.

Safe and Comfortable Living Environment

2 Stage Evolution took place with stressful and favorable environmental conditions.

Emotions can be logically generated as dualism of Memory and Movement

In some of Khoisan languages, most content words begin with clicks, but very few function words do. (E.O.J. Westphal (1971))

Content words (= concepts) are enabled by permutation of distinctive phonemes. The mechanism of grammars is operated by vowel accents, given by lung airflow as a consequence of laryngeal descent.

Idiotypic Networking mechanisms among immune cells (Lymphocytes, Glial Cells, CSF-Contacting Neurons) seem to constitute human consciousness.

Linguistic Memories are not a Neocortex

Immune Network Requirement Analysis for Consciousness Networks

Word Memories can communicate with Stimuli, Sensory Memory and other Word Memories

CONCLUSION: 2 Stage Evolution of Language Acquisition of Phonemes and Syllables

Penfield experimented more than 700 patients and concluded:

1. Although there are doubtless many, many garrulous patterns in the temporal cortex, only one pattern is activated by the stimulus and only one recollection is presented to consciousness.

2. But the record is not that of an event alone. With it is stored a record of the substance of the individual's thinking concerning that experience and the attendant emotion of fear that may have accompanied it. (p143 Penfield 1954)

The Molecular Structure of the Concept

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