

Biology II

The Nervous System

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Part II

The Nervous System

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The Nervous System - Polarities –

Nerve cells function as "inductors" (*Mf p. 338*) and contributes to govern the development of organs during fetal stage. It seems quite natural with the general [view](#) on nervous and nutrition systems as primary opposite vector fields that it is the interplay between these fields that differentiate organs. They are fields from the animal and vegetative poles of the [gastrula](#), from 00- and 0-poles in terms of our model.

On the molecular level, the same peptides may function as both transmitter substances in the nervous system and as digestive enzymes.

As said about [glands](#) the two vector fields meet and combine in hypothalamus with hypophysis and adrenal glands with tissues from both fields. Information goes there from the nervous signals to the chemical ones and blood stream of the nutrition system, an expression for the first inward direction of the nervous system (Ns).

The origin of Ns from the 00-pole and inward direction seems revealed also in the fact that cortex of the brain primarily is a development of the sensory system (olfactory brain) - i.e. the inward directed signals.

The three kinds of stimuli, *chemical* → *electric* → *mechanical*, can be associated with matter → charge → motions → in dimension degree (shortened *d-degree*) steps 3 → 2 → 1 → 0/00 in the dimension chain.

In the propagation of nervous, electric signals the mediating chemical synapses can be interpreted as a binding force, as in the dimension model higher d-degree in relation to next lower one.

1. Polarizations within the nervous system:

The several polarities within Ns can be outlined in accordance with the elementary [physical qualities](#) interpreted as a dimension chain - with certain connections to the chain of levels in an organism:

<u>Level (l.)</u>	<u>Dimensions</u>	<u>Physical qualities</u>	<u>Ns- polarities</u>
Cell l.	1b - 0/00 - 1a		
		Distance/Time:	Frequency – Amplitude modulation
Contacts	2b - 1 - 2a		
		Charge +/-:	Stimulating – Inhibiting circuits
Tissue l.	3b - 2 - 3a		
		Mass/Space:	Somatic – Autonomous ns < <i>Parasympathetic ns</i> <i>Sympathetic ns</i>
Organ l.	4b - 3 - 4a		
		Vector fields:	Motor – Sensory ns
System l.	0 - 4 - 00		
		Center/Anticenter:	Ventral – Dorsal co-ordinate axis
Organism	5		

Fig Ns-1

First polarization, step 5 → 4, refers to the animal and vegetative poles of the embryo, commented above: Ns that develops from the animal pole (00) becomes the *front end*, position for brain - as the spinal cord stretches along the *dorsal* side - in opposition to vegetative pole, becoming back end and ventral side.

- Step 4 → 3 implies the polarization of vector fields in inward - outward directions, in Ns the sensory and motor systems.

- Step 3 → 2 as a polarization central - peripheral Ns follows mainly the differentiation of *organs* (level 3) and *tissues* (level 2): muscles versus guts, somatic versus visceral Ns. Cf. the interpretation of muscles, striated versus smooth ones as a polarization in step 3-2.

The polarization has features of both the preceding ones; the opposite origins of organs and the outward / inward directions.

Central Ns governs skeleton muscles, while the peripheral Ns governs not least the walls of blood vessels and intestines, walls as surfaces, and circumference of their inner space, an opposition also of the character mass - space, interpreted as polarity in step 3 - 2.

Secondarily the peripheral Ns gets polarized in the sympathetic and the parasympathetic Ns, an opposition which in function is related with both the main directions outwards/inwards and the next step: stimulation - inhibition.

- Step 2-1: Stimulation - Inhibition concerns charge over nerve cell membrane: hyperpolarization or depolarization of charge (proposed as a physical property of degree 2 in the model, relative mass when analyzed as of degree 3). It gets expressed in the design of different cell contacts in Ns.

- Step 1 → 0/00: Frequency - Amplitude modulation concerns the electric signals of individual nerve cells and is connected with the elementary physical concepts Distance (amplitude, ~ distance from a basic line) and Time (1/f, frequency).

[The nervous system develops in similarity with other organs, e.g. the blood system, from individual cells to threads, nets and layers, through concentration of nerve cells to ganglions and via tube-shapes to the centered structure of the brain: in shapes 0 → → 1 → 2 → 3.]

2. Motor - Sensory systems:

Direction between the organism as center and its environment as anticenter is polarized in inward direction, sensory stimuli from outside, and outward direction, motor stimuli from inside. These main directions are also expressed in vertebra of the backbone, where motor nerves depart ventrally while sensory nerves enter dorsally.

The 00-pole of the embryo becomes the dorsal side, its 0-pole the ventral side. The fact that sensory nerves enter from the dorsal side into the spinal marrow and that sensory areas are located dorsally in neural tube and brain is hardly a matter of course, sooner an expression of underlying dimensional rules. The principle in a vertebra:

Dimension degree 4: Directions out-in. 4 horns.

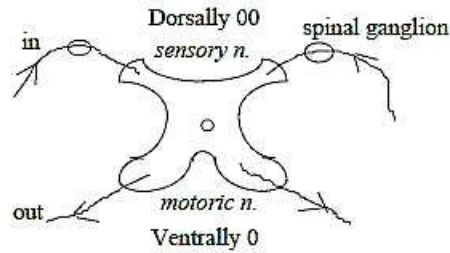


Fig Ns 02 - 73-1

In accordance with the same geometry sensory signals in "afferent" fibers up to the brain pass through the posterior tract, i.e. along the dorsal side, while the "efferent" motor ways go ventrally in the anterior cerebrospinal tract.

Further, the switch-over stations in the sensory system are situated in ganglions outside vertebra, while motor ganglions lie inside in the spinal marrow: also a feature of the type anticenter versus center.

(It could be observed that the ventral horns are thicker, more massive than the dorsal ones.)

Outside the vertebra and spinal ganglions sensory and motor nerves run together in shared pathways, which thus illustrate two-way direction (as of not polarized, two-way directed d-degree 4). These branch, as on a superposed level, in agreement with the same, underlying fundamental polarity, to dorsal and ventral sides:

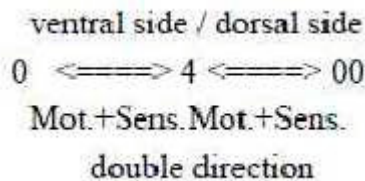


Fig Ns-3-73-2

It's a remarkable circumstance too that cortex of the brain, front end of the neural tube and secondary 00-pole of the embryo, develops out of the sensory regions.

(The layer furthest out in cortex is also dendrites, the inward conducting extensions of the nerve cells.)

The more ventral motor areas of cortex appear to be of a secondary kind with mostly a regulating function in relation to primary motor centers for movements deeper in the brain. This is another illustration of the underlying polarity center (0) and anticenter (00) and also to a certain degree of the polarity mass - shell in the brain, d-degrees 3-2.

Sensory and motor nerve cells:

In the dimension model step d-degree 4 → 3 is hypothetically connected with an angle step 180° to 90°, where outward direction gives the radial component in d-degree 3, the inward direction the circular component, in terms of elementary geometries.

These geometries can be found in the difference between motor nerve cells with axons, radially branched, outwards from the cell, and the sensory pseudo-unipolar cell which has its axon in straight angle to the cell:

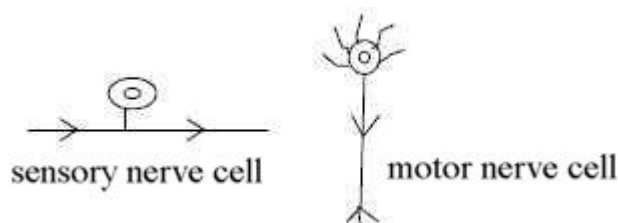


Fig Ns-4-75-1

Interneurons:

In this macrostructure of pathways the development of interneurons and reflex arcs may be interpreted as a result of a polarization towards a "perpendicular" relation in d-degree step 4 →> 3.

It can be noted too that the stretch reflex doesn't have any interneurons, while the flexor reflex passes via several interneurons. Cf. flexing, bending as a turn towards curved structure.

(Interneurons in the macrostructure of pathways have a certain similarity with dendrites on the cell level in its combining of signals from different directions - like an arc of a circle passes through a multitude of angles and coefficients of direction.)

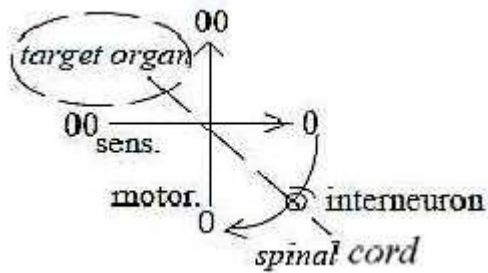


Fig Ns-5-75-2

The transition to circular structure and to rotation becomes most obvious in the "reverberating" circuits, closed chains of interneurons just in sensory, inward conducting pathways, where the signals can rotate self-propelled (*Nf p.108*).

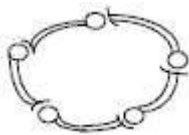


Fig Ns-6-75-3

Number of steps in transport of a signal:

Generally there seems to be about 4 neurons in the shortest sensory conductive pathways inwards to cortex of the brain, including the neurons in cortex. 5 with the receptor cell (*MF p. 360*): to compare with steps in a dimension chain 4 ←←←← 00.

Afferent pathways for sense of touch and proprioceptors:

- > 00: sensory receptor
- > 1: sensory neuron in spinal ganglion
- > 2: switch-over station in spinal marrow or in medulla oblongata
- > 3: thalamus
- > 4: cortex

Afferent pathways for sight and for hearing:

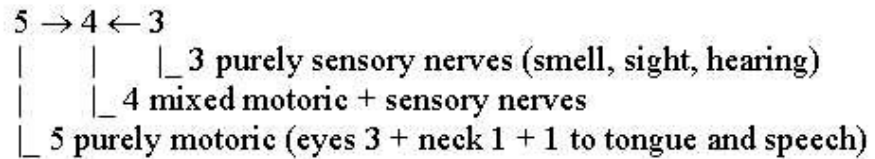
- > 00 receptor cells (cones and rods) and in the inner ear the hair cells
- > 1: bipolar cells* (sight) and from ear 1 nerve cell in a ganglion
- > 2: ganglion cell in retina and from ear 2 neurons in brain stem
- > 3: thalamus, sight and hearing
- > 4: cortex, sight and hearing

(*Apart from 2 layers of horizontally coupled cells moreover. See file [Sight](#).)

A note about cranial nerves:

An invertebrate as the bristleworm has 6 pairs of cranial nerves. An early species of chordates as cyclostomes, whose brain already is divided in regions typical for vertebrates, has 10 pairs. From reptiles on there are 12 cranial nerves:

Cranial nerves in humans:



F

ig Ns-7

3. Somatic - Autonomous (Visceral) nervous system:

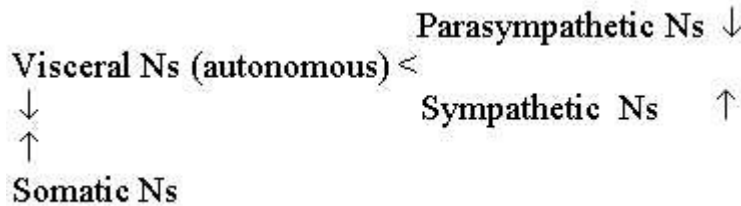


Fig Ns-8

The polarization into somatic and visceral, autonomous Ns concerns directions in relation to governed organs in the body as a 3-dimensional whole:

- the somatic Ns innervates striated muscles, i.e. in direction outwards in the chain of organs,
- the visceral or peripheral nervous Ns innervate heart as center of the blood system and the smooth musculature in digestive canals, glands, blood vessels and so on, i.e. mostly organs in directions inwards the body.*

The somatic Ns concerns external body posture and movements and external locomotion, the relation to environment, while the visceral Ns concerns the inner milieu of the body.

* The autonomous Ns innervates also such things as sweat glands in the skin and e.g. the pupils.

Muscles have in preceding files been proposed as derived in step 3-2 in the level chain of systems (s):

Relative positions in the gastrula:

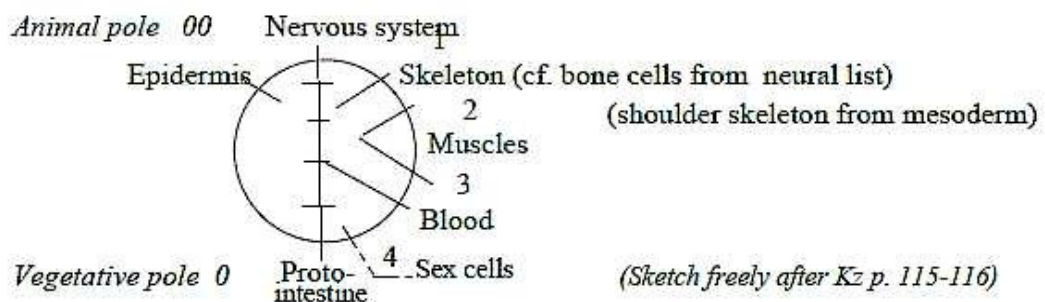


Fig Ns-9

In the chain of organs the polarity somatic - visceral muscles becomes a kind of border between "outward / inward" directions in the middle step:

1 - skeleton, tendons - 2 - muscles - 3 - blood s. - 4 - nutrition s.

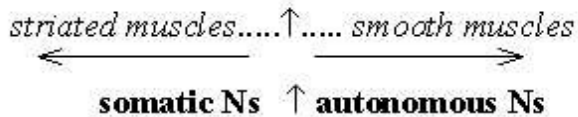


Fig Ns-10

The visceral system as inward directed in the mentioned sense cooperates with the sensory = inward directed system of the somatic one: visceral, preganglionic nerves get activated by inward conducting afferent nerves from both visceral and somatic organs

The autonomous system is in several respects secondary or "peripheral" in relation to the central one (CNS) - as a lower d-degree in relation to a higher one implies a further driven differentiation and a relation of the type anticenter to center in the dimension chain:

The nerve cells in the sympathetic part of the peripheral system, sympathetic ganglion cells and chromaffin cells derive from the neural wall of the embryo, i.e. the anticenter to the neural plate and invaginating neural tube (*Kz p. 116*).

Further, in the history of evolution the peripheral system is weakly developed in early chordates as cyclostomes and cartilaginous fishes, while it becomes more developed in bony fishes (*Fc*).

It has also been shown that animals can manage without the sympathetic Ns, although less well (*Nf p. 344*).

Intestines with origin from the vegetative 0-pole are as such primary in relation to skeleton musculature (from mesoderm), but from the aspect of the animal 00-pole the innervation of the inner organs comes later than that of the skeleton muscles, in this sense representing a later step.

Typical for the autonomous system is also that all motor pathways go via intermediate synapses, in this sense act more indirectly.

In addition, the preganglionic motor neurons in the autonomous system corresponds in their function to interneurons in the central, somatic nervous system (*Zf p.202*), which gives one more reason to see the autonomous (or "vegetative") system as a secondary development according to the interpretation of interneurons above.

The position of visceral sympathetic neurons in the spinal chord between dorsal and ventral somatic centers may perhaps also be an expression for the secondary character of the autonomous system.

The autonomous system is to a great extent governed from hypothalamus and the marrow of adrenal (suprarenal) **glands**, organs out of the polar meeting between the nervous and the nutrition systems as primary vector fields (4a →> 4b).

Hypothetically then the autonomous Ns could eventually have a deeper root than somatic Ns as a "resting", potential possibility, although developed later?

4. Sympathetic - Parasympathetic nervous systems:

The peripheral Ns polarizes in its turn in a corresponding way as the polarization somatic - visceral Ns into directions outwards - inwards in the body and also along the coordinate axis *forwards - backwards*:

- the sympathetic system (SNS) is outward directed in promoting outer activity, preparation for defense, activated by stress and favors blood flows to skeleton muscles, heart, brain etc.,

- the parasympathetic Ns (PNS) is inward directed towards intestines, favors blood flows to the digestive organs and depresses the heart activity etc.

Hence, the sympathetic Ns stimulates mostly organs from mesoderm and ectoderm, outwards towards the 00-pole and environment, the parasympathetic Ns mostly organs from endoderm, inwards the 0-pole, seen from the aspect of tissue origins.

Regarding the spinal cord as a coordinate axis between head and tail, the parasympathetic nerves depart from the "outer" poles, from head and sacrum, in this sense from anticenters, while the sympathetic nerves depart from the central region:

It's hard to find any natural cause for this arrangement, unless underlying dimensional aspects on directions are included.

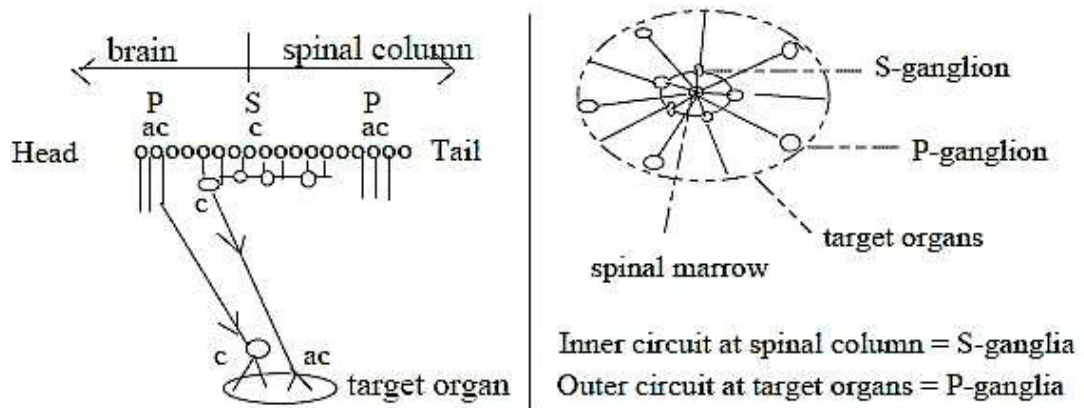


Fig Ns-11-79

Parasympathetic ganglia have few mutual connections and their effect is local, limited to one organ (*Nf p. 343*). Cf. inward direction towards one 0-pole = towards one target. While sympathetic ganglia are mutually united through the sympathetic chains (or trunks) on each side of the spinal cord, and their effect is more general and unspecified - as outward direction from a 0-pole.

Position of ganglia as stations for transmission illustrates the same geometry, the typical center - anticenter relation: they lie in the sympathetic Ns near the vertebra, in the parasympathetic Ns further out, at the target organs as illustrated in the figure above.

In pupil reflexes of the eye the complementary effects of S- and P-systems show the radial versus circular polarity of d-degree 3 in the dimension model:

- the parasympathetic nerves go to the ring-formed iris sphincter muscle for constriction of the pupil,
- the sympathetic nerves go to radial muscles that widen the pupil.

It's perhaps the most typical illustration of the "postulates" in the model: of inward direction, equivalent with contraction (convergence) leading to circular structure in lower d-degree, and of outward direction as divergence (widening), leading to radial structure in lower d-degree.

However, both P- and S-systems have double effects of widening - contraction, but mostly then divided on different, more or less complementary organs.

Further, the P-system increases secretion of electrolytes, the S-system increases secretion of organic substances (*Mf*).

This difference could be regarded from the aspect of **chemical phases**: organic molecules as a 3-dimensional phase versus fluids as a 2-dimensional one with regard to bonds in the molecules. There is also a connection with the concepts mass versus charge as a d-degree relation of type 3 to 2 in the fundamental chain of physical qualities.

Number of departing S- and P-nerves from neck and backbone in humans:
(According to a figure in *Kz p. 257*. Accidental or not?)

S = 18

P 5+3 = 8

The $2x^2$ -chain behind the periodic system:

$$\begin{array}{ccccccc} 5^2 & 4^2 & 3^2 & & 2^2 & 1^2 & \rightarrow \times 2 \\ = 50 & - 32 & - 18 & \rightarrow & 8 & - 2 & - 0 \\ & & S & & P & & \end{array}$$

Fig Ns-12-18-8

5. Stimulation - Inhibition:

This polarity concerns [charge](#), the quality that has been assumed defined in d-degree 2 in the dimension chain of physical properties. It works through hyper- or depolarizations over cell membranes. The quantity permeability as inversely proportional to charge gets localized to different canals in the membranes (d-degree 2) for different ions. Stimulation occurs through inflow of Na⁺ ions, inhibition probably through inflow of Cl⁻ (*Nfp. 111 f, 114*). Hence, it would be a polarity between charges of the ions (or size?), not of directions.

According to the loop version of a dimension chain we could have a connection between the polarization motor $\rightarrow \leftarrow$ sensory signals in step 4 $\rightarrow > 3$ and "the other way around" the stimulating-inhibiting system in step 2 $\leftarrow 1$.

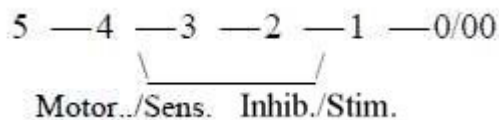


Fig Ns-13-81

Inhibition is in several respects characterized by features from the 00-pole - from anticenter.

In the history of evolution certain facts indicate that the polarization first concerns the membranes of *receiving* cells, i.e. in inward direction of the cells: the same transmitter, e.g. Acetylcholine, can have inhibiting effect on one cell, stimulating on another. It implies that the same sender cell can have activating or hampering effect on different cells, so in certain mollusks (*Nfp. 118 f*). (With the postulate in the model that the 00-pole and inward direction is the first polarizing force this circumstance could be taken as another indication that dimensional polarities are underlying the biochemical expressions for them.)

In mammals a division of functions is carried through so that certain cells are inhibiting, other stimulating in their outward activity - with different transmitters for stimulation and inhibition. It could be interpreted as a substantiation of polar functions towards superposed levels in accordance with the dimension model.

Another example is the polarization that seems to occur in the brain during evolution between inhibiting and stimulating nuclei as *striatum* and *pallidum*.

Inhibition is mediated via interneuron between sensory and motor nerve cells (as if it were a polarization of the interval from sensory to motor cell, cf. the preceding figure).

Geometrically it implies a development towards circular structure and loops in the conducting lines S - M, dimensionally as in steps 4 $\rightarrow > 3 \rightarrow > 2$,

Such structures polarize further into stimulating and inhibiting interneurons.

The shortest, closed loop seems to be the self-inhibition of the motor α -neurons via interneurons (Renshaw-cells) to their own incoming signals.

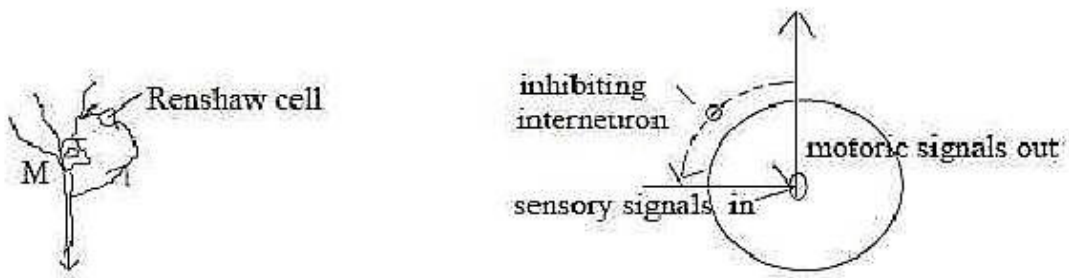


Fig Ns-14-82-1

The polarization of muscles into antagonists, such as flexor- and stretch-muscles on opposite sides of limbs, seems expressed in mutual, reciprocal inhibition between the antagonists via interneurons. (Compare inside/outside as one geometrical definition of poles of d-degree 2 in the model in arrangement of muscles with stimulation - inhibition as a polarization in step 2 - 1.)

What is called "lateral inhibition" sideways exists on all levels in the nervous system and is principally perpendicular to in- and outgoing signals. (Cf. angle steps $\rightarrow 180^\circ \rightarrow 90^\circ \dots$, associated with d-degree steps $4 \rightarrow 3 \dots$)

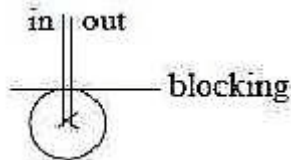


Fig Ns-15- 82-2

It's said that there exist few connections between columns that register different sensory types in cortex in the brain. Those that exist seem to be inhibiting ones. Branches from pyramidal cells in layer 5 go to star cells in layer 3 and 2, which sends inhibiting threads to pyramidal cells in adjacent columns, i.e. sideways (Nf p. 237, 254).

In a corresponding way purkinje cells in the cerebellum inhibit one another via basket cells, whose threads are transversal to the espaliers of purkinje cells (Nf p. 300).

The structure serves discrimination that implies sharpening of contrasts, borders, lines: cf. surfaces, d-degree 2 and lines 1. So for instance in retina in the eye.

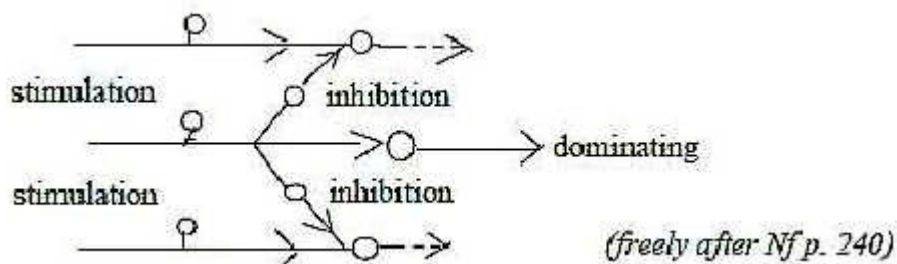


Fig Ns-16-82-3

We can find a similar principle in the vegetative world, where top shoots hamper the growth of side shoots through the substance auxin.

Lateral inhibition appears not only in eyes but also in other senses as in hearing and in skin (Nf p. 183): stimulation of the skin around the domain of a certain nerve cell hampers the signals from this. It's then an inhibition from anticenter inwards a center.

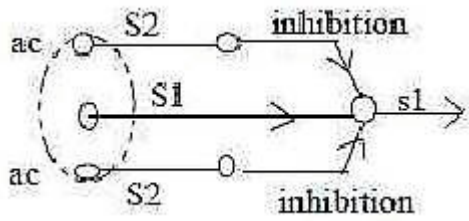


Fig Ns-17-83-1

The inhibition between different kinds of sensory signals, i.e. between qualities, was mentioned above. One example is that touching can hamper signals of pain. Possibly however, this type could be a question of positions too, since they concern the same domain in the skin, although between different kinds of receptor cells. There is reason to suspect that the different senses are differentiations, mutually connected. (See about [senses](#) with aspects from the dimension model.)

A primary type of inhibition, where signals from anticenter via synapses hamper a motor signal from center is exemplified by the sensory **Golgi organs** in tendons *at* insertions of a muscle. (Cf. tendons as connective tissue on a tissue level referred to d-degree step 2 - 1 in earlier interpretations here.).

Contraction of the muscle, implying stretching of tendons, leads to inhibiting signals via interneurons in the spinal chord to α -neurons of the muscles (*Nf p. 206 f*):

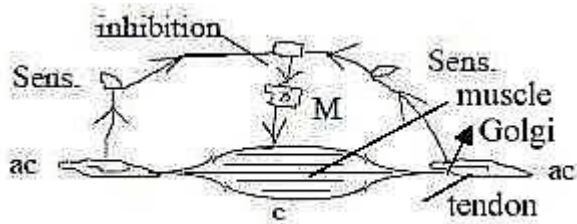


Fig Ns-18-83-2

Muscle spindles, in the center of the muscle, are much more complex and directions of signals from center and anticenter the complementary ones: Outgoing (afferent) from the center of the spindle, to alpha-neurons in spinal chord, while incoming signals (efferent, from gamma-neurons) go to the ends at anticenters of the spindle. The central part of these fibers are not even contractile, only the ends at anticenter. Cf. contraction as directions inwards from 00-poles, outwards from 0-poles.

The inhibiting function of the anticentric gamma-neurons seems not yet fully understood but is expressed as effecting the sensitivity of the spindle (*Nf, Aph, Mf*).

With the coordinate axes of the body in mind, Front - Back from Animal - Vegetative poles, there are several examples showing that inhibiting signals originate from the 00-pole or from secondary, superposed levels, which also as such represent anticenter in relation to underlying ones.

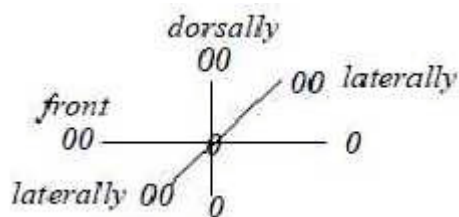


Fig Ns-19-84

We have the already mentioned example that motor areas in cortex mostly have the

function to regulate sensory inflow and therewith indirectly modulate motor outflows (*Nf p.* 264-265). While the essential stimulation to movements comes from inner centers in the brain and brainstem, from there to cortex and back.

Inhibiting impulses from cortex have disappeared at spastic movements and released exciting impulses from the reticular formation and vestibular nuclei in the brainstem (*LEL p.* 133).

The motor pyramidal pathways that go from cortex in the brain directly down to the spinal cord are physiologically younger than the other "extrapyramidal" pathways from inner centers in the brain, and they seem mostly to have a function to regulate distal fine motor ability (*Fz p.* 355). A big part of them go to interneurons from sensory spinal ganglia in the dorsal horns of the spinal cord.

The pyramidal pathways can be cut off without loss of movability, not even loss of movements governed by the will. Only precision and velocity become weaker and slower (*LEL p.* 160).

In cerebellum (note its dorsal ~ anticenter location) the inhibition processes are dominating, while pathways for stimulation come from inner nuclei in the brainstem (*Fig. Nf p.* 282).

The polarity stimulation - inhibition can be regarded also as a specialization of the underlying polarity within the autonomous system in sympathetic - parasympathetic polarity, concerning stimulation - inhibition of blood flows to different organs.

According to certain observations (1978) inhibiting transmitters should lie in elliptic granules in the ends of axons, stimulating ones in round granules (*Nf p.* 117). Ellipses are polarized circles with two centers. Hence, also in such a detail, if the observation is correct, we could find a trait of the 00-/0-polarity.

6. Frequency - Amplitude modulation:

Amplitude and frequency are coupled entities in a sine wave, complementary energy forms as potential energy and kinetic energy. Potential energy = distance from a zero-line as 0-pole, kinetic energy passage through the zero-line per time unit. Hence the quantities are connected with distance and time respectively and this polarity is suggested as last step in polarizations within the nervous system.

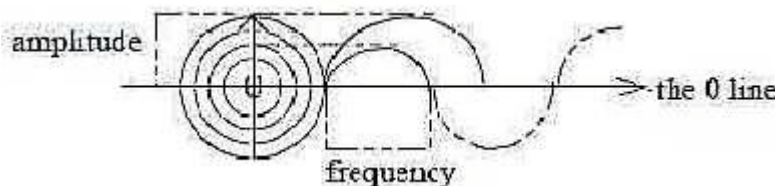


Fig Ns-20-90-2

In an atom the two energy forms are transformed into one another at absorption and re-emission. The amplitude of an electron orbit, distance from the nucleus, increases at absorption of radiation (inward direction) and becomes a measure of its energy. It translates into frequency of emitted radiation (outward direction) when the electrons fall back again to an inner orbit, the frequency depending on radial distances between different orbits.

In the nerve cell there is the same principle: incoming chemical signals become amplitude modulated in the cell membrane; outgoing electrical signals in the axons become frequency modulated.

Geometrically it illustrates the poles circular - radial structure out of d-degree 3 in step

3 - 2 in the model: circular structure from inward direction connected with amplitude, radial structure from outward direction connected with frequency.

(From the electrons point of view the description can seem reversed: outward jumps defining amplitudes, ~ distances, d-degree 1, inward jumps giving the frequency, ~1/Time. Thus, we have a kind of pole exchange out/in between electrons and EM-waves as assumed in "d-degree 0/00" of motions in our model.)

*

Nerve cells and the nerve impulse

1. Cell types in the nervous system (Ns):

Besides nerve cells there are several other additional cells around them in nervous tissue, with a generic term called glial cells. They correspond to anticenter in relation to central nerve cells in a polarization of neural tissue, also representing higher dimension degree (shortened *d-degree*) versus next lower one.

If on the cell level nerve cells illustrate d-degree 4 in our model, with their long axons and their dendrites (directions outwards/inwards), glial cells will represent 3 (mass) and 2 (surfaces).

The glial cells derive from the neural crest, anticenter to the invaginating neural tube.

They are further about 10 times as many, i.e. make up most of mass in the brain, a multitude versus nerve cells. This information concerns humans (*Mf*). (One hypothesis in the dimension model has been that d-degree steps are connected with 10-power steps.)

Moreover, glial cells develop later in the fetus and in the history of evolution. They are absent in certain simply organized organisms, and myelin sheaths for instance, formed by glial cells, are mostly missing in invertebrates (*Fz*).

Additionally, the relation between nerve cells and glial cells is expressly said to be of the complementary type in their internal processes: changes proceed in opposite directions. Increase of a substance in the one type gives a decrease in the other and the reverse (*Kz p. 264, BA p. 115*).

Apart from the immense amount of new knowledge, there are 5 types of glial cells mentioned in older references here: 3 in central Ns (CNS), 2 in peripheral Ns (PNS) and among these it's possible to identify steps towards lower d-degrees.

Central types: astrocytes, oligodendrocytes and microglial cells.

Central glial cells:

Astrocytes are star-shaped (*fig, Nf p. 293*) and have functions and geometries illustrating both d-degree 3 and 2 in our model with outer poles 4a - 4b of directions and radial and circular poles of d-degree 2. Their extensions form "radii" (~ pole 3b) between nerve cells and blood vessels and are thought to be responsible for transport of nourishment to the nerve cells. Circularly (~ pole 3a) they tightly surround nerve cells. They are a filling material with supporting functions and in addition make up surfaces, lining all membranes and surfaces of mesodermal origin in the brain. Astrocytes exist both in the gray and the white substance of the brain.

Oligodendrocytes are mostly found in the white substance of nerve fibers - as if representing a step-displacement from astrocytes. They seem to enclose the nerve cells in a more ring-shaped way at their extensions. They form myelin sheaths around axons in the central Ns through fusion; cf. fusion as out of inward direction. It's a polarity of the type nucleus - shell, a relation d-degree 3 to 2 in structure. Cf. about peripheral Schwann-cells below.

Microglial cells, the 3rd type in central Ns, have been considered not to belong to the real neuroglial but to originate from mesoderm.

The cells are phagocytes and have an amoeboid mobility. Thus, they seem to be a kind of wandering mesenchyme cells, the final step in the chain of tissue kinds.

To summarize, these three kinds of glial in central Ns have features that can be associated with last three steps in a dimension chain: $3 \rightarrow 2 \rightarrow 1 \rightarrow 0/00$.

Peripheral types of glial cells: Schwann cells and Satellite cells:

Satellite cells are small cells whose short projections surround the cell bodies of the big nerve cells: a typical anticenter as periphery and also a multitude in relation to the unit of the nerve cell (*Photo Kz p. 162*).

Finally, the **Schwann cells** form myelin sheaths around the long extensions (projections) of nerve cells, the axons, in PNS.

In opposition to the cells that surround the very nerve cell bodies in CNS and in opposition to the similar role of oligodendrocytes that surround axons in CNS, these sheaths are formed through a rolling up their *membranes* (d-degree 2) around the axons as a kind of spiraling rotation. This opposition could be taken as an example of how the 0-00-relation center - anticenter changes character towards PNS and lower d-degrees: the rotational motion as 2-dimensional an expression for debranched degrees in lower steps.

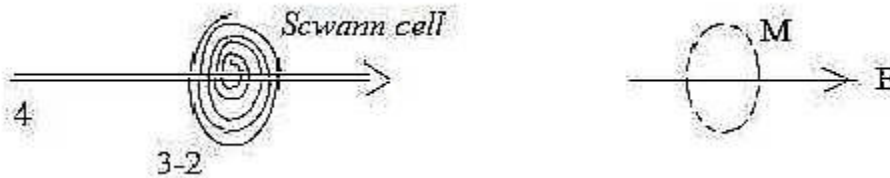


Fig Ns-21-85

They give also an illustration of how a magnetic field, surrounding an electric wire, may be substantiated towards higher, superposed levels. Or geometrically an analogy to this. The relation becomes perpendicular as proposed in step 3 - 2, the radial versus circular poles.

In their function it's possible to see a parallel to the polarity inhibition - stimulation but rapidly repeated on the same signal, a quantifying of a line. They maintain membrane polarization, equivalent with inhibition, with nodes between them for depolarizations, ~ stimulation. Also a form of pacing out a distance as we have described the last d-degree step $1 \rightarrow 0/00$ in the model.

And the physical quantity velocity increases through this arrangement.

2. The nerve cell:

Nerve cells and sex cells are in certain respects opposites as 00- and 0-poles:

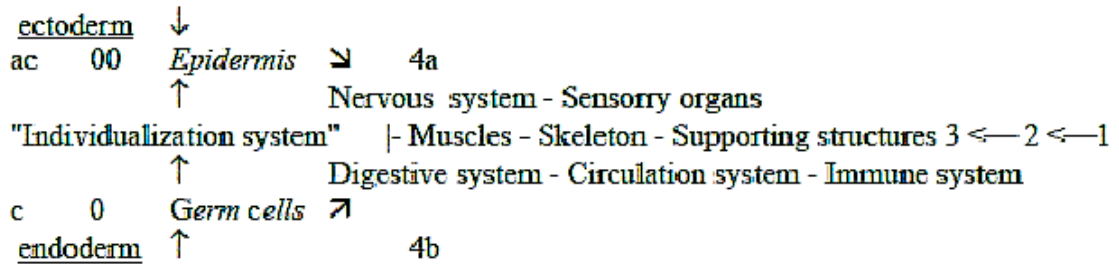


Fig Ns-22-31-2

Sex cells have potential for maximal differentiation while nerve cells are fully developed at start - and earlier thought not capable to divide. Sex cells are haploid before fertilization, nerve cells often tetraploid, so for instance in cerebellum.- a relation 1/4 in number of chromosomes.

The earliest nerve cell in history of evolution seems to have been a combined sensory and motor cell, a sensory receptor cell with motor axon. Indications of such cells have been found in the tentacles of sea anemones for instance (*Ez p. 385 f*).

Then, the development has gone towards further polarizations, a division of functions on sensory cells and motor cells etc.

In the nerve cells from neural plate and neural tube the inward conducting projections, the dendrites, are many, the outward conducting projection one, the axon, as the 00-pole represent multitudes versus unity of the 0-pole.

A nerve cell: dendrites and axon:

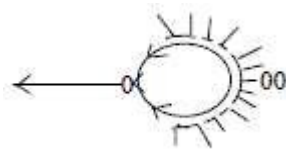


Fig Ns-23-87

In the macrostructure of Ns it's the motor neurons that first gather to centers in invertebrates - possible to see as an example of the primary function of the 0-pole.

Arrangement of dendrites can have different structure but is generally more or less circular around the cell body (inward direction transformed to circular structure in 3rd d-degree according to the dimension model). While the axon outwards branches radially at target organs, an example of radial structure in d-degree 3 originating from 0-pole in the model.

(Diameter of a nerve cell is about 5 - 100 μ , the one of an axon about 1 - 20 μ (*LEL p. 27*). Thus, the quotient should be circa 5/1.)

Other types of nerve cells are the bipolar and "pseudounipolar" ones which develop from the neural crest, i.e. from anticenter in relation to the neural tube.

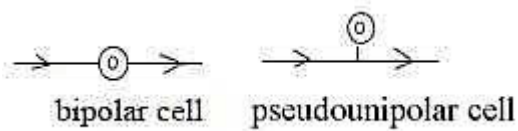


Fig Ns-24-88-1

These cell types are possible to interpret as secondary in relation to the multi-dendritic ones. They belong to the inward-conducting sensory, peripheral system, the bipolar one for instance found in the retina.

The pseudounipolar type develops from the bipolar, which can be regarded as expression for a center displacement, the conducting fiber displaced out from body of the cell. Center displacements towards lower degrees and higher levels are one principle in the dimension model. Thus, the series multi-dendritic \rightarrow bipolar \rightarrow pseudounipolar cells could be described in terms of angle steps of their extensions, from 360° to 180° in/out to 90° in relation to the cell body:

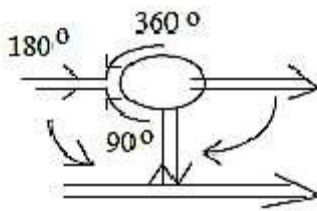


Fig Ns-25-88-2

Nerve cells contain much of protein filaments and tubuli in the cell body and out in plasma extremities, dendrites and axons as well as in [cilia](#). Such organelles are common in other cells too as cell skeleton in the cytoplasm. A coordination of motions is also found in unicellular organism without a nervous system as protozoans (*Ez p. 385*) - organelles with conductive ability.

Hence, nerve cells seem to be a specialization in this respect of primary radial transport structures and vector fields.

3. Nerve signals:

a) Two-way \rightarrow one-way direction:

Some information indicates that nerve signals in an earlier stage of evolution were two-way directed - first later become one-way directed through chemical one-way direction over synapses. One has for instance found a "mirror symmetry" over synapses in jellyfishes with synaptic bladders on each side of the synapse (*BA p. 114*).

In the early evolution of Ns dendrites and the very membrane of the cell body seem to have had an ability to react on *electrical* impulses, while they later only are *chemically* excitable. According to another source (*Ez p. 385*) nerve impulses in invertebrates sometimes seem to go in all directions in diffuse nerve nets.

Such observations, if still valid, indicate an evolutionary polarization from double-direction to differentiation of functions and directions as in step 4 \rightarrow 3 \rightarrow 2 in our model. Cf. a similar polarization regarding stimulation - inhibition above.

b) Two phases in signal transportation, chemical and electric:

The synapses could be described as a discontinuity, an "energy gap" with a term from plasma physics. Such energy gaps should correspond to a transition from one physical quantity to another according to suggestions here, ultimately a change between d-degrees in a fundamental underlying dimension chain.

The "carriers" of the nerve signal as a force changes from electric to chemical to electric again.

From the viewpoint of [biochemical phases](#), defined by types of chemical elements and bonds, the chemical phase with organic transmitters with bonds in 3 dimensions may be defined as phase 3 in relation to the electrolytic phase with metal ions, carriers of the electric signal.

Underlying these two phases we have the elementary physical quantities Mass - Charge, assumed as a relation d-degree 3 - 2 in the dimension model.

D-degree 3 may be regarded too as a deeper, underlying level, a *binding force* between charges on the superposed level, appearing in the synapses. To compare with how hormones were carrier of the information system before a nervous system developed. (In the dimension model higher d-degree is defined as binding force in relation to next lower one.)

In addition, transport of the transmitters occurs in the center of axons, transport of charge along its surface, its membrane, also showing on the polarity 3 - 2 with its roots in the 0-00-polarity.

c) Charge - electromagnetic waves (EM-waves):

Charge as a physical quality in d-degree 2 according to presumption in the dimension model becomes connected with surfaces. An axon of a nerve cell is excitable even without cytoplasm. The electric potential should then be located to the border layer at membrane (d-degree 2) of the axon (*Zfp. 182*).

The electric current follows from changes in the voltage-potential over axon membrane, carried through by inflow of Na⁺(sodium) and outflow of K⁺(potassium).

The outflow of K⁺ starts first about 0,5 ms after the inflow of Na⁺, when this reaches its maximum. This "phase displacement" resembles the one between electric and magnetic components in an electromagnetic wave and could probably be interpreted as a related formulation of the same structural principle - with K⁻ and Na⁺-ions corresponding to E- and M-factors in an EM-wave.

d) "Motions to / from each other" as poles 1a - 1b:

When Na⁺ flows in through the membrane at an impulse, it means a depolarization over the membrane to 0 as in the dimension model "motions towards each other", pole 1a with origin in inward direction defines a 0'-pole. When K⁺ then flows out, it implies a re-polarization as "motions from each other" (pole 1b) with origin in outward direction defines an anticenter, a 00'-pole.

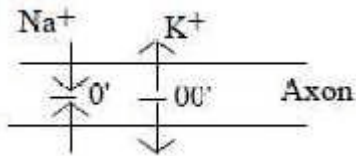


Fig Ns-26-91-1

The signal propagates at straight angle to in- and outflows as in EM-waves. Axons as lines are quantified.

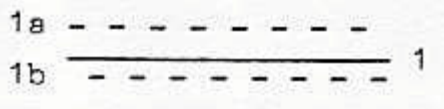


Fig Ns-27

e) How does the nervous signal propagate within the axons?

The answer seems not very clear. The transport of electric currents is not depending on ion wandering in its cytoplasm. One theory is that the "wave" propagates through displacements of charge in a "bridge" of water molecules (Zf p. 202).

It's was said above that an axon is excitable even without cytoplasm. In later sources (Wikipedia) the "electrically conductive" cytoplasm is seen as explanation for the internal spread of a wave from the local action potentials.

Myelin sheaths that inhibit in- and outflows, increase the velocity of propagation (distance per second). They increase length of the steps between nodes, the distance. Hence, it cannot be transport of the ions in cytoplasm that drives the propagation but some more immediate change of charge as through electron displacements.

The action potential is transversal, the propagating "wave" longitudinal. It's processes in different dimensions. We could think about "waves" that in relation to "mass" may be interpreted as a development - or aspect - in the less substantial lower d-degrees $2 \rightarrow > 1 \rightarrow > 0/00$.

In the series of [chemical forces](#) as expressed in bonds we have identified ion bonds in d-degree step 3 - 2, dipole bonds in step 2 - 1 and van der Waals bonds in step 1 - 0/00. The nervous signal appears as an expression for steps between these ion and dipole forces (probably also van der waals moments involved).

The exchange of ions (Na^+ / K^+) with same charge seems driven by a concentration gradient, in terms of density mass/volume, and becomes in some sense a "binding force" as of higher d-degree in relation to quantified "dipole" waves of charge as electric currents. Mass versus charge in the model defined as a relation d-degree 3 to 2 and higher d-degrees postulated as binding force in next lower d-degree.

There is the step from ions as whole atoms to electrons as carrier of the forces, and these simultaneously coupled to a step in [phases](#), corresponding to d-degrees $3 \rightarrow > 2 \rightarrow > 1$: crossing of membrane as mass in relation to the more fluid medium inside membrane.

Another feature is the step from two-way to one-way direction, also an expression for a polarization step: An action potential (the ion exchange) may actually give electric currents in two directions, for instance when ignited at the middle of an axon. The phase displacement between in- and outflows of the ions becomes responsible for - or transformed to - the one-way direction of the current.

Direction (d-degree 4 in the model) of the concentration gradient and the electric current is closely connected, seems to guide all steps.

Experiments show that if the polarity over the cell membrane artificially is reversed to positive inside, negative outside, the nerve impulse takes the opposite direction, backwards in axons.

Expressed in terms of the dimension model it reveals the interdependence between polarizations in different d-degrees and poles that have the same character inherited from 0- or 00-pole.

When it concerns the chemical transport in the same direction within the axons, one has also found a type of peristaltic waves, which seem driven by the myelin sheaths. Cf. ring-shaped muscles around intestines. Such a peristaltic wave with transversal, circular and longitudinal contractions gets the same geometry on the chemical level as the nervous signal on the electric level.

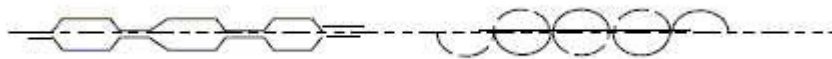


Fig Ns-28-91-3

(Statically they get the form of standing EM-waves, cf. about worms in [Evolution.](#))

f) "Ignition" of the nerve signal - curious details:

According to general descriptions the frequency modulated impulse gets ignited at outlet (*hillock*) of the axon from the cell body.

One could possibly imagine the process as in this figure:

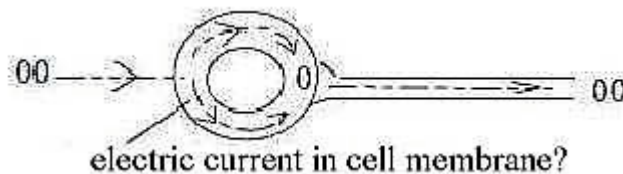


Fig Ns-29-92-1

However, it seems to be a curious fact that the action potential gets ignited from a trigger point further out in the axon (*Nf p. 103*).

It sounds as if there was some sort of an "imaginary" quantum jump in the impulse through another dimension.

In the dimension model 2 poles of a certain d-degree virtually exist as synchronous in next higher (underlying) d-degree, before the step of polarization to the lower d-degree has released 1 d-degree as a new factor of distance or time (motions).

With the cell body as center, ~ a 0-pole, and the axon directed towards anticenter, the 00-pole, some location on this could be defined as a primary anticenter (decided by a distance or quantified by some other factor).

It's then possible to think that the "quantum jump" passes through underlying, next higher d-degree (as d-degree 5 in the figure or d-degree 1 in relation to d-degree 0/00 of motions): the higher d-degree that includes both poles?

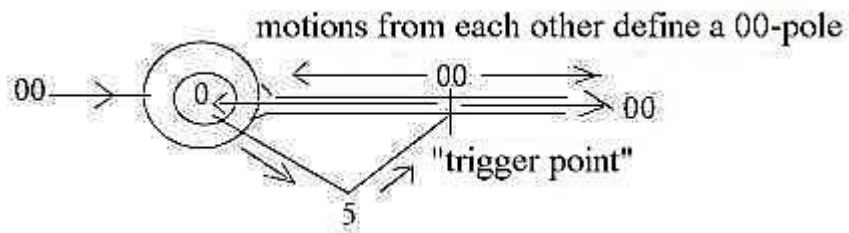


Fig Ns-30-92-2

Compare perhaps [cilia](#) where the motion can start furthest out and not seems driven by the cell body.

Another such curious observation: Out at sensory receptor cells the inward conducting nerve cells seem sometimes to have synapse vesicles towards the receptor cell, as if it sooner were the nerve fiber that affected the receptor cell than the reverse.

This could perhaps be a related phenomenon, which could be described as a "picking up of stimulation" - from the opposite pole via another dimension, an underlying not polarized phase or d-degree?

g) The action potential, levels and ion numbers:

A nerve impulse:

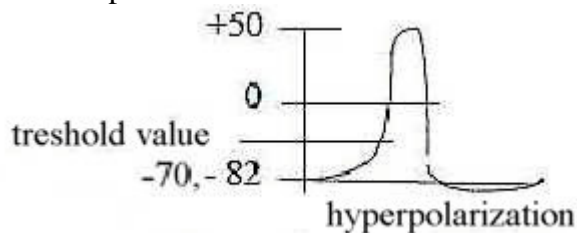


Fig Ns-31-95-1

We can count on 5-6 levels of the potential over the membrane during one action potential:

	Charge inside
impulse maximum - point for change of directions	+
0 - zero charge - passage through the zero line	0
threshold level - "angle change" to "vertical" rise	-
facilitated (graded)	-
normal rest potential - "horizontal" level	-
hyperpolarization - "horizontal" level	-

A sketch on the steps as a whole dimension chain:

- depolarizations interpreted as steps inwards towards higher d-degrees,
- polarizations as steps outwards towards lower d-degrees in the chain:

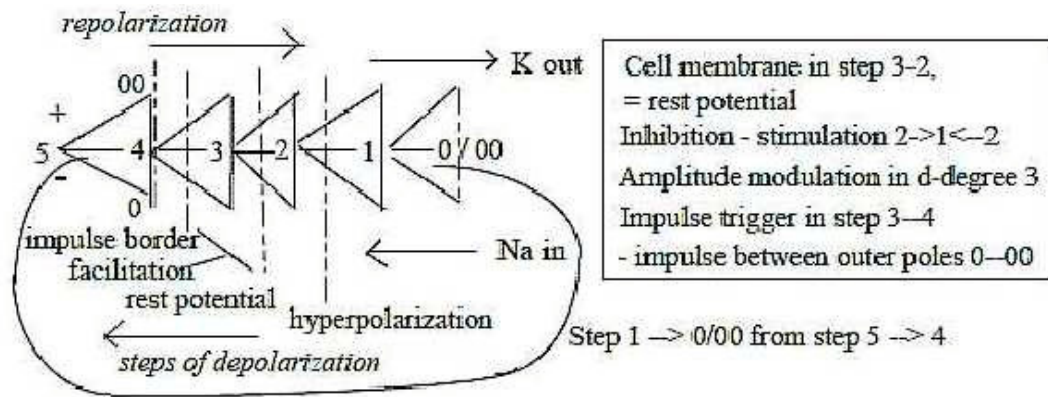


Fig Ns-32

Ion numbers:

Na 11 Z, 3rd shell, as ionized 10 e⁻, 2nd shell

K 19 Z, 4th shell, as ionized 18 e⁻, 3rd shell

Numbers in the 2x²-chain behind the periodic system:

2x ² -chain:		f	d	p	s	→ orbitals
	5	4	3	2	1	0
	50 -	32 -	18	8 -	2 -	0
number of e ⁻ →			K ⁺		Na ⁺	
			10			
			Na ⁺			
		K ⁺ inside the cell		Na ⁺ outside the cell		
		outflow	Na 23 A	inflow		

Cell membrane as in step 3 - 2

Fig Ns-33

Both atoms in the s-orbital of the shells, representing step 1-0/00.

Sum Z of Na + K = 30 = 2 times the sum of an elementary chain 5 → 0:

15 -/+ 4 = Na Z - K Z.

	5	4	3	2	1	= 15
2x:	10 -	8 -	6 -	4 -	2	
	K ⁺		Na ⁺		2e ⁻	

Fig Ns-34-94-2

Concentrations of K⁺ and Na⁺ ions inside - outside the membrane in a certain part of the axon (1 μm x 1 μm x 0,1 μm according to reference *Mfp. 35*:

outside:	108.000 Na ⁺ , 2000 K ⁺ , → + 6 K ⁺ , gives the rest potential
inside:	100.000 K ⁺ , 10.000 Na ⁺ , → + 8 Na ⁺ , gives the action potential

Fig Ns-35- 94-3a

Since the sums happen to give the sum 110 x 10³ of the 2x²-chain above, the figures could be illustrated in this chain:

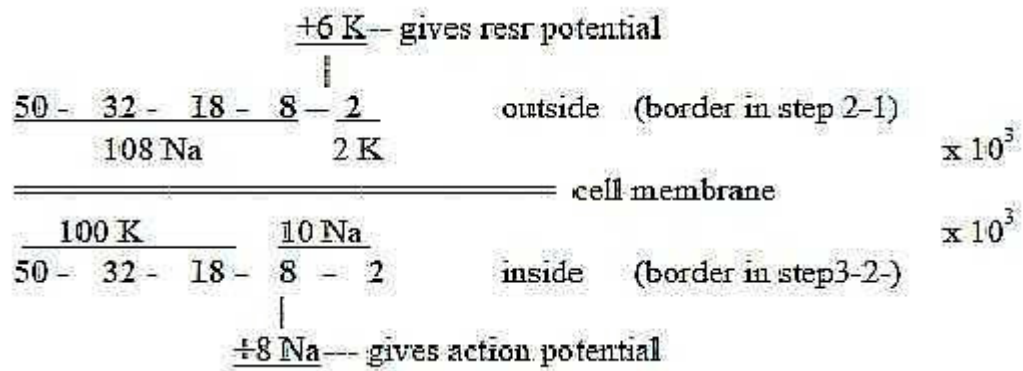


Fig Ns-36-94-3b

Cf. steps 1 - 2 - 3 and number relations between Na- and K-ions that get pumped in and out by the Na-K-pump to restore the rest potential concentrations. In different studies and different cells it has been found that the relation Na / K can be 2:1 or 3:1 or 3:2 (*Nf. p. 43*)

*

Nervous system

- Brain Parts -

1. Ventricles and the CSF-liquid:

In the evolutionary development of the brain the ventricles and their shapes could have been an equally decisive factor as the development of neural mass, this with dimensional views applied to the design. Compare mass - space as poles of d-degree 3 with neural mass versus ventricles.

Evolutionary development of lateral ventricles in forebrain, cross-section, left and right cerebral hemisphere:

A simplified sketch after Kz p. 250-251:

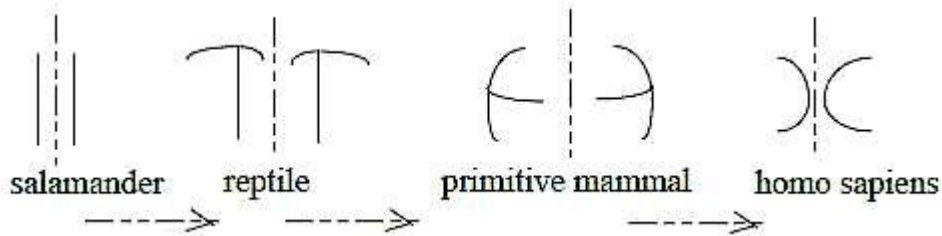


Fig Ns-37-97-1

- Salamander: ventricles along longitudinal axes of the body - as d-degree 4.
- Reptile: a polarization towards perpendicular relation through a step d- degree 4 \rightarrow 3 (radial - circular as geometric poles of d-degree 3).
- Primitive mammal (*Solenodons*, a kind of mouse): whole ventricle turned 90° - as through next step 3 \rightarrow 2.
- Humans: an inversion convex - concave of the half circles - as in a d-degree step 2 - 1.

(It could be said that shape of the hemispheres simultaneously develop towards increasing number of "sides", from "two-sided" in salamanders, "3-sided" in reptiles, "4-sided" in *Solenodons* to approximately semispherical in humans.)

The ventricles 4, 3 and 2 in humans has shapes that roughly illustrates the geometries of corresponding d-degrees in the dimension model - with increasing size:

(Fig. freely after Mf p. 347.)

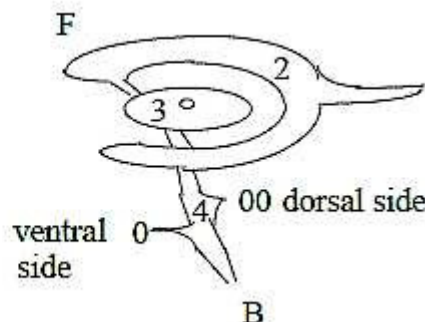


Fig Ns-38- 97-2

- 4th ventricle: along the axes F-B, front-back, a widened canal with a little polarization dorsal - ventral direction as between poles 00 - 0.
- 3rd ventricle: a widened space volume.
- 2nd ventricles, division in two, bows surrounding 3rd ventricle as "shells" around a central room.

Related parts of neural brain:

- Hemispheres of *cerebrum* around the 2nd ventricles.
- *Diencephalon* around the 3rd ventricle.
- *Mesencephalon* around the canal between 4th and 3rd ventricles.
- *Medulla oblongata* with pons on ventral side and *cerebellum* on dorsal side of the 4th ventricle.

The central canal of the spinal cord as a cavity is at start of the embryological development a built-in surrounding, an insubstantial space, which widens and develops into design of the ventricles, of the embryo, i.e. anticenter at the animal pole that gets enclosed when the neural plate invaginates to the neural tube, in positions a pole exchange ac - c, mass - space:

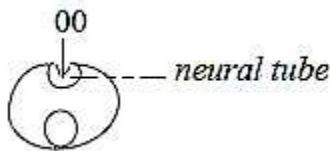


Fig Ns-39-098-1

The spinal canal with CSF becomes the opposite pole to the neural mass around it. As a primary anticenter it could perhaps be suspected that the CSF chemically induces such polarizations as for instance the transverse bands on the spinal cord and divisions in brain bladders (?). Cf. 00-pole as a first polarizing force in the model here.

While the canal with CSF develops stepwise to the central ventricles, it takes a side-way too at 4th ventricle to circulate anticentrically around the whole brain, a polarization c - ac in relation to inner ventricles.

It's notable that this branching occurs in the 4th ventricle and in its ceiling and *dorsally* (the anticenter side deriving from first animal pole) and through 3 small holes (*foramina*). It illustrates how a step from d-degree 4 to a geometry of d-degree 3 can be expressed biologically.

We have in the dimension model that the 00-pole may be regarded as debranched, meeting "the other way around" in a haploid chain, inwards to circular pole 3a:

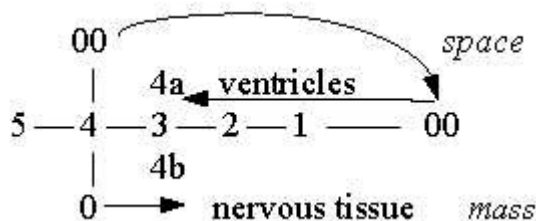


Fig Ns-40-98-2

Another expression for the primary character of inward direction of CSF is that it's produced in inward - backward direction from the ceiling of 3rd ventricle, the floor of 2nd ventricles (hence in step 3 - 2).

It is non-neural tissue epithelium, dorsally in the neural tube in forebrain and diencephalon that has been displaced inwards towards the inner ventricles and has become gland epithelium for the production of CSF (*Kz p. 242*). Hence, in several respects expression for anticenter and inward direction.

In the relation neural tissue - CSF we have naturally also a relation between phases, between organic matter and liquids of the kind that can be described as 3- to 2-dimensional with regard to chemical bonds. (Content of proteins etc. in the liquid here neglected.)

CSF contains more of Na⁺ ions than other extracellular liquid, which could be a sign of its origin from outer surrounding of the embryo?

The relation CSF-canal — surrounding neural mass can be compared with the elevator versus stairs in a building (possibly both chemically and psychologically). Also a relation continuum - quantum jumps.

"Reissners thread" is a mysterious line of glycoproteins with unknown function that goes from secretory cells in diencephalon backwards through the whole CSF-canal. It's believed to serve transport of molecules. It could be regarded as one expression for the main coordinate axis F - B. Perhaps it corresponds to "the other way around" in the figure above! It's only absent in primates, which eventually could have connection with the loss of a (real) tail?

(It seems as if a part of this fiber (RF) could have an impact on outgrowth of axons in e.g. chicken embryos (<http://www.springerlink.com/content/n80v070740616q62/>).

According to information some decades ago it seemed to be internal secretion of substances from the circulating CSF-liquid into the brain that induces sleep, among other molecules GABA (γ -Aminobutyric acid). Together with the neural center for sleep in medulla oblongata, it illustrates the double-direction $00 \rightleftharpoons 0$ inwards-outwards during sleep: the phase for animals as "whole worlds" or entities in themselves, both centers and anticenters.

2. Brain parts:

§It can be noted that the number of bladders on front part of the neural tube that develops to a brain is 5 already on an early evolutionary stage of craniates, 5 with the widening of medulla oblongata: in number corresponding to steps in the dimension model.

After a rearrangement to 3 and new differentiations the bladders become these 5 well known parts of a human brain:

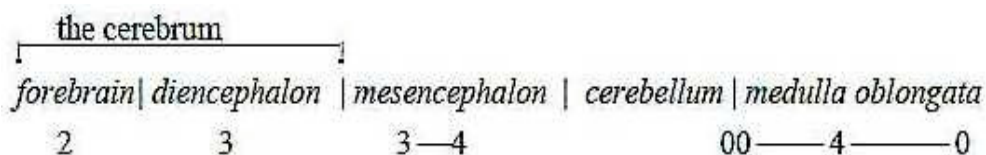


Fig Ns-41-99-1

(Figures are preliminary identification of d-degrees, more closely commented below.)

The long evolution of the nervous system is similar to other organs as the blood system: a development $0 \rightarrow 1 \rightarrow 2 \rightarrow 3$ in dimensions from single neurons to a "linear" tube to wavy forms with curves (concave - convex) to a more and more centralized mass.

From spinal cord to the brain there is a rearrangement of neurons from the "linear" order in columns to an arrangement in separate, more centralized nuclei, also a dimensional development towards d-degree 3 on the neuron level.

The prolongation of the neural tube to the brainstem can be regarded as a center in the centralized mass of the brain - with root in the body.

A general principle is that integrating centers lie deeper down with increasing differentiation outwards the surfaces.

a) Medulla oblongata and Pons:

Some of the functional centers mentioned below are actually located to Pons on the ventral side of medulla (*Wikipedia and earlier sources*).

Medulla oblongata around the 4th ventricle contains the reticular activating system RAS (ascending part ARAS) - with a general, unspecific and divergent spread of pathways upwards to the whole cortex for an arousal level and downwards for muscle tonus for instance. The neurons have extra richly branched axons.

These systems become in the interpretation here an obvious expression for d-degree 4, the level of vector fields.

Centers for *consciousness* as such are located here but also for *sleep*, playing a role in generating dreams. Cf. sleep as pointed to above is a phase of two-way direction, d-degree 4 as only "virtually" polarized.

Another example of the two-way direction is the center for *respiration* that regulates the *breathing*: in agreement with most other polarities inhalation ~ inwards: dorsal part of the center, exhalation ~ outwards the ventral part.

Further, it's notable that the reticular formation contains centers for the *basic directions in postures* of the body and its *balance* around the center of gravity. It gives another example of the 4-dimensional character of this system.

The *extrapyramidal tracts* are chiefly found in the reticular formation of the Pons and Medulla. It's essential to underline that these tracts also have the ability to execute motions governed by the will (*LEL p. 160*). A will that comes from direction in this deep structure.

Furthermore, medulla includes centers for control of blood circulation and elementary digestive functions, thus also for the vegetative system.

Several other sensory and motor centers are mentioned in Pons as for hearing, taste, eye movements and facial expressions.

In the "reticular formation" white and gray substance is not yet separated as in the forebrain but a network of closely integrated neurons and nuclei. Cf. polarizations as d-degree steps outwards the forebrain on this macro-scale on the tissue level.

It's also interesting - and not astonishing - that some relationship between RAS circuits and pathways for physiological pain has been found. Cf. about [pain](#) as one of the oldest and most general senses.

A last notice: The cranial nerve that governs the motor activity of the tongue emanates from a location furthest back in medulla oblongata. Cf. the connection between d-degree 4 in our model and d-degree 0/00 of motions with speech as the last in a dimension chain of [psychological faculties](#).

b) Cerebellum:

It's original and basic function seems to be a sensory integration (pole 4a, inward direction in our model) when it concerns body positions (in 3-dimensional space) and motions, thus in agreement with its dorsal (~ anticenter) position. Cerebellum has also

by several scientists been regarded as at bottom a sensory organ (*Wikipedia*): it receives the lot of inputs from both cerebrum and sensors from muscles in the body and has regulating, inhibiting functions.

The smallest region, the *flocculonodular lobe*, is mentioned as the oldest part in evolutionary terms, participating in balance and spatial orientation. Its primary connections are with the vestibular nuclei, the [organ for equilibrium](#), although it receives visual and other sensory input too. Damage to it causes disturbances of balance and gait. Cf. gait with d-degree step $1 \rightarrow 0/00$ of motions in our model. (0 and 00 the outer poles defining d-degree 4.) It has 4 nuclei in the center that becomes 3 in mammals.

The development of the hemispheres as 3-dimensional volumes occurs later during evolution in mammals.

The design of cerebellum is typically 3-numbered with 3 x 2 peduncles or stalks, 3 layers in its cortex (compared with 6 in cortex of forebrain), 3 coordinate axes in structure of this cortex, and not least its connection with the organ of equilibrium with its 3 arches.

It's also said to have 3 representations of the body - compared with only 2 in the forebrain.

Cortex of cerebellum differs in essential ways from cortex of the forebrain, which has cells arranged in "radial" columns.

The big, integrating purkinje cells make up roughly only one layer. Their dendrites become an outer layer. A big amount of small granule cells inside the purkinje cells distribute input to these dendrites through branching, transversal axons, i.e. axons that become perpendicular, to the main radial input - output structure. It correlates with the postulated circular structure that pole 4a (inward direction) gets in d-degree 3 in the dimension model, the angle step from 180° to 90° of polarity in relation to pole 4b.

The fact that cortex as such in its macro-shape is much deeper furrowed than the wavy cortex of forebrain could depend on the polarizing force from anticenter, 00 and pole 4a being principally stronger in distal cerebellum. More of a vector field character inwards from anticenter is retained?

We may compare the function of cerebellum for body positions, closely connected with gravitation, and the pole 4a representing gravitation on the physical level and in the dimension chain of [forces](#).

There are two nuclei in the brain with a similar cellular design as cerebellum: the dorsal cochlear nucleus in mammals and one that receives input from lateral line organs in fishes (*Wikipedia*). Hearing (and equilibrium) organs of mammals have been regarded as developed from those lateral side lines. These organs are both senses for pressure, connected with gravity, the primarily inward direction of d-degree 4.

In all, as distal, mainly a sensory center, regulating and inhibiting motor activities and as such part of the primary motor \leftrightarrow sensory polarity (see [Ns I, No. 1](#)), cerebellum may be interpreted as an organ from step $4a \leftarrow 3$ inwards in the dimension chain. Its system has also been described in terms of divergence - convergence, i.e. directions V_{div} V_{conv} , which are outer poles of d-degree 3 in our model.

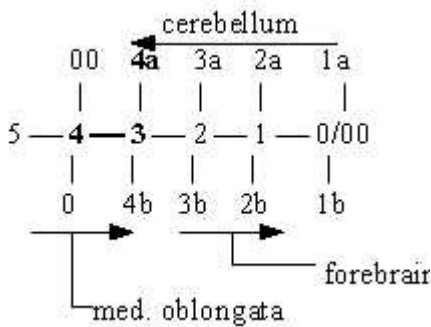


Fig Ns-42

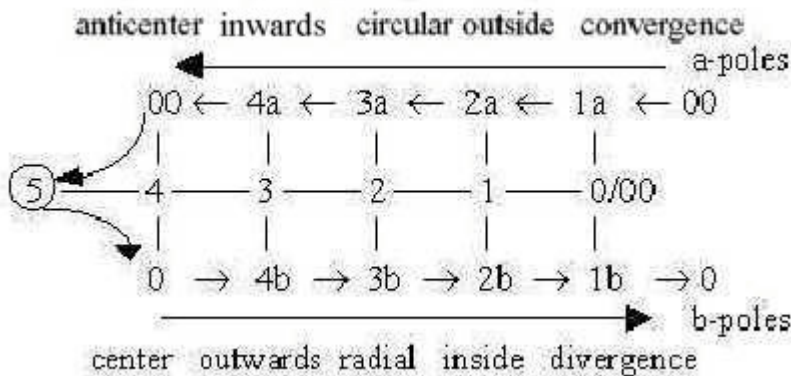


Fig Ns-43

(It may be added that granule cells of cerebellum make up about 3/4 of all neurons in a human brain (*Wikipedia*)! Input a manifold, output unity: also a relation between lower and higher d-degrees.

c) Mesencephalon - the midbrain:

The midbrain is small and positioned at the aqueduct between 4th and 3rd ventricles and is sometimes seen as a part of the brainstem. The reticular network reaches up in midbrain too.

It seems possible to see the relation *midbrain - cerebellum* as neural masses that correspond to the branching of ventricles or CSF-flows in the top of 4th ventricle:

- forward to the aqueduct to 3rd ventricle, corresponding to the central midbrain,
- sideways to the CSF-circulation around whole brain, corresponding to cerebellum with its mostly inhibiting function.

Cerebellum is typically "debranched" and could in our model represent the 00-pole of d-degree 4 as debranched, meeting "the other way around" (figure below) - and hence developed later in evolution.

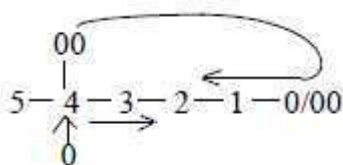


Fig Ns-44-5-1

The general architecture of the human midbrain is shared with the most ancient vertebrates. Earlier, during history of evolution, before the craniates appeared, the mesencephalon seems to have been the front part of the brain, the center for sight, origin for eyes and smell organs. It's still the most front part of the brain in birds.

It's noteworthy that the whole diencephalon and forebrain have developed from the smell brain.

Even in lower craniates the midbrain functions as an integration center for sensory sight and hearing, but later these functions were taken over by centers further towards the front. Such a fact that certain functions move forwards in the brain could illustrate how lower d-degrees originate from polarization of higher ones in our model.

In the midbrain motor and sensory centers become distinctly separated areas and centered nuclei. Arrangement is the usual with motor centers (~ pole 4b, outward direction) ventrally, sensory centers (~ pole 4 a, inward direction) distally around the aqueduct.

(We could note that number 4 here appears also in the name of the sensory centers, the colliculus, called *corpora quadrigemina*: 2 for eye movements, 2 on ventral side of aqueduct for hearing.)

Below, in the ventral part of midbrain, the **red nuclei** with functions for motor coordination appear in illustrations as more or less circular centers, cf. 0-poles. The difference to **substantia nigra** should be noted: it starts below the red nuclei and have the form of more radial, divergent bands. This "substance" is perhaps best known as producer of the essential transmitter dopamine. Lesion in the function is connected with the motor disease Parkinson. Dopamine, however, is also said to play a role in "**motivation**" of species, from humans to animals as insects.

Hence, both in its shape and in function it seems as a prolongation associated with the outward direction of d-degree 4b, with efferent vectors from the RAS system in medulla oblongata: arousal, consciousness, potential action, with "will" in the deeper sense (cf. above about the extrapyramidal tracts in medulla oblongata).

The lateral axis has in midbrain been clearly marked with the doubling of all the mentioned centers and areas, while the reticular activating system also reaches up here. Cf. the identification of coordinate axes in [Embryology](#) with d-degrees 4 - 3 - 2:

4: Distal - Ventral axis: Sensory - Motor directions.

3: Front - Back: midbrain between medulla and diencephalon: halfway separation of sensory centers (sight - hearing) and of motor areas (red nucleus - substantia nigra)?

2: Left - Right: lateral axis, doubling of structures.

Why is the lateral axis, if representing d-degree 2, expressed already here? One aspect could be the loop version of the dimension chain where step 4 → 3 through debranched degrees corresponds to step 2 ← 1. Another that midbrain earlier was the front part of the brain and as such included next steps too.



Fig Ns-45

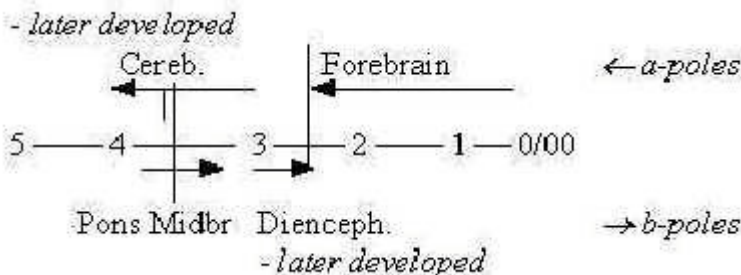


Fig Ns-46

d) Diencephalon:

Geometrically the diencephalon represent the step where transition to 2 hemispheres occur and the step from the "circular" 3rd ventricle as a room to half-bows of 2nd ventricles. (The lateral axis gets further expressed with the temporal lobes of the forebrain.)

Diencephalon seems to make up an inner brain in itself with the poles 3b-3a:

- **Radially**, from the two symmetric thalamus structures as centers, relaying nervous signals motor and sensory signals divergent / convergent to/from the whole cortex of forebrain with neocortex.
- **Circularly** there is the several parts of the limbic system above, around and below the 3rd ventricle: for instance the bows of *Hippocampus* and of *Fornix* as a C-shaped bundle of nerve axons from hippocampus to hypothalamus and the similar shape of *Stria terminalis*. Further cortex of the *cingulate gyrus*, above corpus callosum, the transverse bundle of fibers that connect the two hemispheres.
(To this come secondary, centric bodies as *Amygdala* and the *Mamillary body*.)

The cortex of *cingulate gyrus* as an inner one compared to neocortex of the forebrain is not convoluted, and its gyri are vertical ("*parasagittally*"), while gyri of neocortex are transverse. The vertical type is observed in non-primate species and hence regarded as older in evolution (*Wikipedia*).

Both these differences imply a d-degree step in our interpretations here, from the radial - circular polarity in step 3 - 2, to the wavy form of neocortex, implying a polarization of d-degree 2 in convex - concave. Simultaneously it's an angle step, here vertical to transverse planes.

One essential aspect is that here in diencephalon - as in a middle step - the meeting of the basic nervous and endocrine systems occurs, systems from primary animal and vegetative poles A - V:

- dorsally in epiphysis (*pineal gland*) which earlier in evolution was a median eye, a photoreceptor in lampreys for instance, now in humans is a light-dependant producer of melatonin that have with sleep and seasonal regulation to do,
- ventrally in hypothalamus with hypophysis, which produces neurohormones for the autonomous inner system, regulating e.g. hunger, thirst, body temperature etc., functions of the digestive, vegetative system.

Thus, this polarity reflects primary directions A-V: from outside environment inwards in dorsal pineal gland, from inside the body outwards (forwards) to the ventral gland hypophysis-hypothalamus.

The fundamental coupling in these glands between chemical and electric communication, hormones via blood system versus nerve signals, is a polarity which can be associated with mass and structure (d-degree 3) and covalent bonds on one hand and charge (d-degree 2 in our model) and metal ions on the other.

The smell organ with the olfactory tract connects here, with its enormous chemical differentiation ability.

Regarding the function of diencephalon, different parts of it are involved in memory creation and storing.

It's noteworthy that it especially concerns **memories** for spatial orientation, i.e. the 3-dimensional room, and memories for places, in agreement with our dimensional interpretations here.

Probably sensory information from different areas of neocortex get connected here and generally it's a well known experience that memories need an associative "context" to reappear. Sensations of smell do often awake memories, cf. the olfactory tract here.

Memories as stored "inwards" could have a parallel in the storage of DNA with methylated T-base inwards from RNA on the genetic level.

Further, elementary *emotions* are located to centers here. It's also obvious that essential emotional experiences influence memory storing.

First such emotions are mentioned in terms of "fight or flight" (see [about Lorenz](#)), which can be translated to directions outwards/inwards, the outer poles 4b - 4a of d-degree 3 in our model.

There are also centers for pleasure that activates a repeated reward behavior, which could be described as a kind of "circular" repetition.

Another aspect is that many emotions implies polarizations such as openness - closeness, good - bad, negative - positive and in this sense reflect the property of [charge](#) as a physical quantity, in the dimension model assumed as a quality of d-degree 2.

e) Forebrain with neocortex:

In the forebrain , newer in evolution, the polarity radial - circular geometry appears clearly on the tissue level as a separation between inner, radial white matter of nerve fibers and outer "circular" surface of gray matter, the cell columns.

The surface (d-degree 2) gets wavy, meandering as described above, (poles convex - concave and inside - outside of d-degree 2).

Transverse fibers along the surface of circumference connect its different areas.



Fig Ns-47-99-2

The forebrain as a whole can be regarded as a circumference, a layer around diencephalon as a central mass/space structure. As mentioned above about cerebellum the growth of cortex of cerebrum (*telencephalon*) on the embryonic stage is also circular (*Fc p. 353*) as a process around a center. It has been described as upwards on the ventral side, circular around the front and backwards on the dorsal side, in agreement with first directions of vegetative - animal poles when turned to a back - front axis.

Brain parts in d-degree steps:

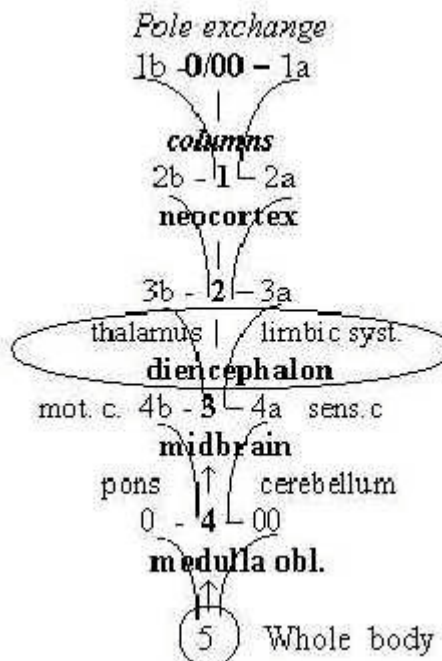


Fig Ns-48

Cortex of forebrain:

The lateral furrow on top divides the primary motor and sensory centers in accordance with the general, functional coordinate axes: ventral side for outward direction becomes the motor area and distal side for inward direction becomes the sensory area with visual area at back of the head.

About numbers of things as numbers in a dimension chain:

5 different types of nerve cells are mentioned in cerebellum, while neocortex has a multitude: a relation few - many as between higher and lower degrees. (According to an old classification there were "about 50" different areas in cortex of cerebrum.)

While cerebellum (like also inner cortex of cingulate gyrus in diencephalon as it seems) contains 3 cell layers, neocortex contains 6 layers, as number of "potentials" in a dimensions chain:

5 - 4 - 3 - 2 - 1 - 0/00
| | | | | |

Fig Ns-49-103-1

Certain of the dimensional aspects above on the nervous system seem possible to find in the 6 layers in cell columns of neocortex; here the layers renamed from outside inwards:

layers: I II III IV V VI
= 00 1 2 3 4 0 *Fig Ns-50-103-2*

After *Nf p. 256*:

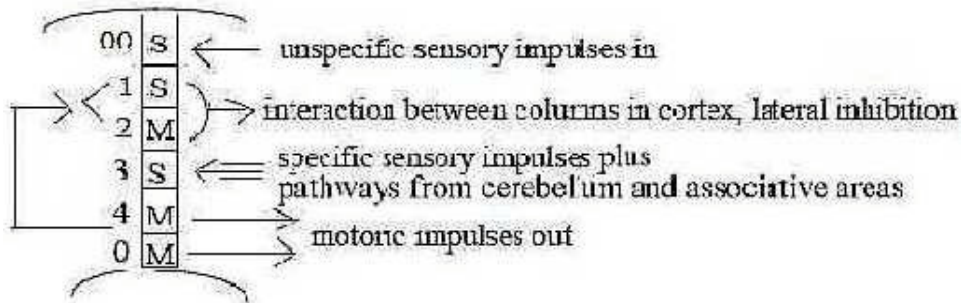


Fig Ns-51-103-3

00: Unspecific sensory impulses in; general anticenter, outermost layer.

0-4: Motor impulses = outward directed impulses out from innermost layers.

3: Sensory impulses in to layer 3 from 3 directions: specific sensory nerve pathways from the body, nerves from the (3-numbered) cerebellum and from pathways along the surface of cortex from associative areas. The cells can be regarded as interneurons and have effects on the pathways from layers 0 and 4 according to the reference.

1-2: In loop version of the dimension model we have that debranched degrees in higher steps outwards may meet the other way around as steps $2 \leftarrow 1 \leftarrow 00$:

In layers 1-2 nerve fibers called collaterals could be apprehended as illustration: branches from outgoing motor axons, layer 0-4, go to layers 1-2.

Then, from layers 1 and 2 perpendicular threads depart along the surface (note the angle step) to other columns in cortex and have the function of lateral inhibition. Cf.

interpretation earlier of stimulation - inhibition as a polarity in step 2-1 in the chain of all polarities within the nervous system.

[The order S - M in layers 3 - 2 may seem to conflict with the view on higher d-degrees as characterized of the 0-pole and outward direction in relation to the lower one but could be a result of a retained polarity from step 4 - 3 in the loop model.

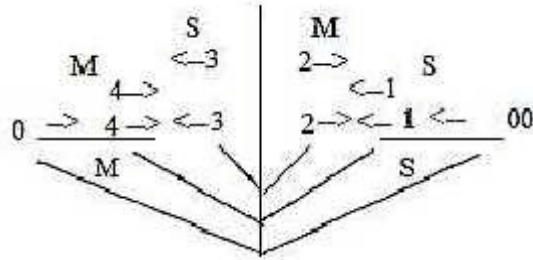


Fig Ns-52- 104-1]

Different types of sensory impulses are located to different columns. Hence, the qualitative differentiation is radial, while the divisions in locations are *circular*, i.e. which domains in the skin the signals come from.

(According to a figure in reference *Nf p. 236* one could ask if there eventually is a more fundamental division too between a group of sensory impulses from the skin senses and one from the inner milieu of the body, from joints, tendons and muscles etc.?)

Conceptually the qualitative differentiation between different senses should represent different d-degree steps in the dimension model (cf. following files about senses).

If such identifications are possible, how are the different qualities projected and arranged on the surface of different columns within a certain domain? (No data in the used references.) Consistently arranged in some way - perhaps in circles derived from different depths of levels as in the funnel figure here?

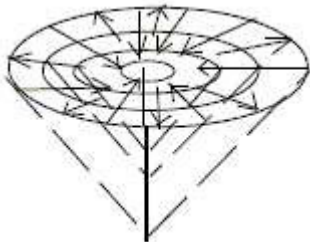


Fig Ns-53-104-2

In *motor* cortex a certain area of columns represents *direction of movements* in a joint, regulated by a group of muscles, which get represented both vertically and horizontally (*Nf p. 253*). (Perhaps in the same way as in the funnel figure above?)

A principal outline of association areas as peripheral around more primary motor and sensory ones should with application of the funnel figure imply that the deeper the integration center, the wider the area for integration, the more complex the sensory impulses and reactions. In direction upwards in the figure, along the vertical axis, there would be more and more limited, elementary perceptions. Cf. "tunnel vision". (?)

In *bundles of nerves* the nerve fibers go increasingly peripherally, the further from the front end of the body they come from. This arrangement agrees with the fundamental identifications here of the front - back coordinate axis, derived from first A-V-axis animal-vegetative poles, 00 — 0.

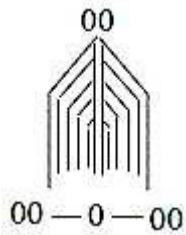


Fig Ns-54-104-3



Fig Ns-55-104-4

Compare the patterns of growth in bird embryos around the primitive streak and amoeboid movements through currents in the cytoplasm, right figure above.

Psychological "faculties":

We may associate the main parts of the brain with the psychological "faculties":

- **will** in the deeper sense of aim and direction with the brainstem;
- **emotions** with diencephalon and the limbic system;
- **conceptions** of the world as 3-2-dimensional structures and "plane" pictures with the forebrain including parts of diencephalon and inner "cortex of cingulate gyrus";
- **thoughts** as linear connections between concepts with neocortex;
- **speech** as thoughts transcribed into motions in last (and every) step:

Faculties - D-degrees - Brain parts:

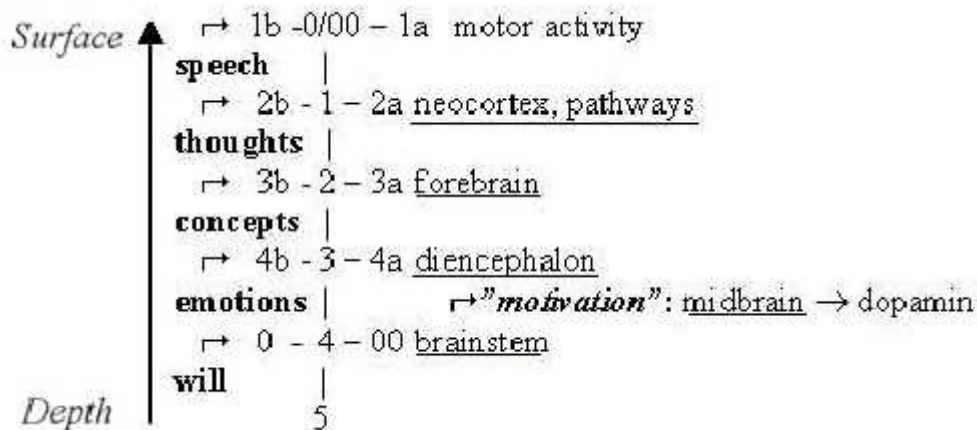


Fig-Ns-56*

Note: step 1-0/00, some kind of communication and motor activity in each step.

Potential "speech", "thoughts" and "concepts" should exist already in higher d-degrees and more elementary animals without a forebrain according to the loop version of the dimension model.

*See further a book in Psychology, "The I and the Ego" (not translated into English), connecting to these faculties and the [general model](#). A description of the book in English [here](#).

"GENERAL SENSES"

PAIN - TEMPERATURE - PRESSURE - TOUCH – VIBRATION

1. Pain:

- Sense of pain is phylogenetically an old sense.
- Nerve fibers for pain exist in all kinds of membranes and tubes (*Mf*), hence what may be regarded as the tissue level underlying level of organs. (Embryos in their first stages consist mostly of membranes and tubes before a nervous system is developed.)

Pain is a general sense with little specificity, primarily a chemical sense at destruction of cells but may be activated by temperature and pressure as well.

The function of pain is to preserve the organism as an integrated whole; raggedness and breaks gives pain. It's a witness of the integrating force of an organism, hence at bottom of all differentiations within its body. In terms of the dimension model the sense of pain can be regarded as an expression for the primary binding force from 0-pole at polarization of 5th dimension degree (shortened *d-degree*).

On the chemical level destruction of a cell membrane leads to outflow of K⁺-ions. There is a strong connection between quantity of K⁺ in the intercellular tissue fluid outside the cell and the intensity of pain (*LEL p. 170*); thus it's a chemical expression for a destroyed membrane. It's mainly the level of K⁺ inside a cell that decides its rest potential.

At propagation of all nerve signals there is an outflow of K⁺, however in very small quantities, followed by an inflow of Na⁺. It would be possible here to see a connection between nerve signals as such and the sense of pain, where the counter directed, opposite inflow of Na⁺ is lacking. Pain becomes a one-way direction force outwards. (Cf. mental pain when the "I" doesn't meet confirmation from others.)

Another similar example that connects pain with direction and position of otherwise usual substances in the nervous system is Acetylcholine, a very old transmitter in the history of evolution. It's found in a multitude of synapses - inside nerve fibers and with a very short life time outside in the synapses. Applied on the skin in a high dose it gives pain. As in the case for K⁺ the condition is an unusually high concentration and localization outside cells, i.e. outside the regulation in nerves and synapses.

[There are obviously exceptions from the rule that innervation for pain sensations exists in all membranes and tubes. Evidently it's possible to cut and burn in bowels without pain for the patient, while stretching lengthwise gives pain. Could it have an embryological and geometrical explanation? Pain from stress that can hurt their original geometry? Intestines have their origin from archenteron and primary vegetative 0-pole of the embryo, implying the character of outward direction (divergence) in d-degree 4 (0 → when unnaturally reinforced giving pain? While outer skin derives from the animal 00-pole, with circular geometry in d-degree 3, when broken giving pain?] Other features that point out pain as a fundamental sense of high d-degree in our model:

- Pain is a sense with only free nerve ends, more or less branched. The other general senses have free nerve ends too but have also developed encapsulated ends of specific types.

It indicates a way from a primordial, more elementary radial structure towards differentiations, in geometrical terms of our model from vectors in d-degree 4 to the polarity circular - radial in d-degree 3.

- Part of the nerve ends react to several kinds of stimuli, both to chemical ones, temperature and pressure, are "polymodal". Others react only to specified stimuli as high temperature or strong pressure (*Nf*), which indicates a step to differentiation, halfway to the following senses - as a result of "polarizations".
- The nerve ends don't adapt, which seems natural with respect to their function to preserve the organism. In relation to adapting senses it's like a mathematical function relative its derivative.
- Pain has the steepest log-curve of all the senses. (All senses are logarithmic in the relation between intensity of the stimulus and perceived intensity.) Log-curves of the senses ordered after steepness:
Pain - Heat - Pressure - Cold - Vibration - Hearing - Light (*Nf*).

Pathways of the pain-conducting nerves are special:

- Most curious - if shown to be a fact - is that the nerve fibers for pain seem to enter also ventrally (*Nf p. 461*) into vertebra (while all other sensory nerves enter only dorsally). It looks like a reminiscence of the underlying two-way direction of d-degree 4 in our model?
- Pathways for the general pain - and temperature - pass in a special lateral tract in the spinal cord, nearer the ventral horns, the *paleospinal* tract, phylogenetically older than the dorsal tract in which nerves for other senses pass as for lower pressure, touch, vibration and motions in joints etc.
The nerves for pain are also more disordered.
- It should be underlined too that this paleospinal tract - via the limbic system and thalamus - spreads out the signals widely to the whole brain - as a radially directed vector field.

C-A-delta fibers:

That the sense of pain include also a half step towards senses "of lower degrees" is evident from the two kinds of nerve fibers for pain: C and A, corresponding to a step from a more general (diffuse) pain to a distinct:

- C-nerves, unmyelinated, propagate the "slow pain". They pass as mentioned in the paleospinal tract and have the general, divergent distribution.
- A-delta nerves for "fast pain" are myelinated and pass through the *neospinal* tract to special areas in primary sensory cortex with its map of the body.

C-threads only branches, A-threads form plexa, more complicated structures (*Nf p. 466*).

C-threads lie also deeper in the skin than the A-threads.

Pain - Temperature:

A step of polarization seems obvious between pain and temperature. The sense of temperature too has C- and A-types of nerves but here polarized to complementary receptors, with C-threads for warmth and A-threads for cold (*TA p. 73*). Cf. that strong warmth gives pain and that this sense had the next steepest log-curve:

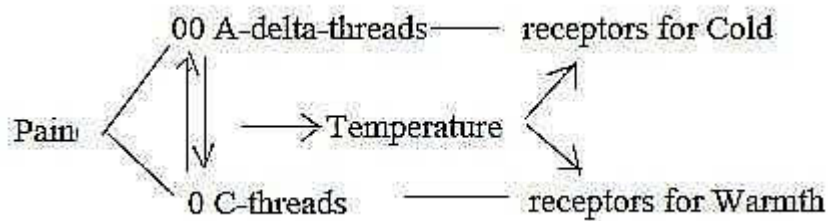


Fig Gs-1-127-1

This implies also a d-degree step as from a function to its derivative:

- Pain receptors are **tonic**, not-adapting, always with a certain activity.
- Thermal receptors are "**phase** receptors", fast adapting, reacting to changes, the "derivative" type (*Aph*).

Types of pain and muscle tonus:

- Superficial, shrill, burning, shooting, localized pain raises blood pressure and muscle tonus, effects like those of the sympathetic nervous system.
- Diffuse, dull pain from deeper tissues lowers muscle tonus and blood pressure: effects like those of the parasympathetic system (*LEL*).

Hence, it seems as the two reactions can be described in terms of opposite directions:

- Pain from anticenter: $00 \rightarrow 0$: Sympathetic nervous system as center-pole activated: $\rightarrow 0$.

- Pain from center: $0 \rightarrow$: Parasympathetic nervous system as anticenter-pole activated: $\leftarrow 00$.

The inhibiting system is of the "antiparallel" type as for the other skin senses, with signals coming from higher centers, mostly centers in the brain stem near the aqueduct between 4th and 3rd ventricles (*LEL p.171*).

Lateral inhibition doesn't exist, but activation of other skin senses as touch may have some inhibiting effect.

2. Temperature:

Shapes of receptors and functions:

As mentioned above the sense of temperature has free nerve ends as those for pain but also, according to older sources (*Zf*) specialized, encapsulated end organs. This latter apprehension may have been revised but mentions *round* capsules (*Kruuse's*) around branched nerve fibers for cold and more *oval* or banana-shaped capsules for warmth - around a more horizontally branched nerve fiber (*Zf p. 268*).

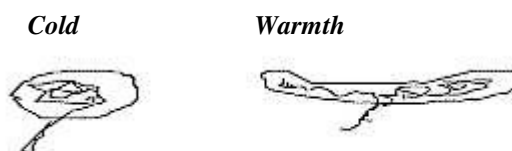


Fig Gs-2-128-1

Such a geometrical polarization in shapes resembles those between sacs in the sense of equilibrium and the windows in cochlea, the organ for hearing. It may be apprehended as expression for an angle step outwards in d-degrees, as from 360° towards 180° .

Cf. temperature as degree of spread in molecular velocity: colder = decreasing spread, warmer = increasing spread. Vertical axis = number of particles, a principal sketch:

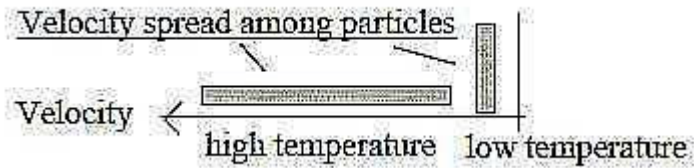


Fig Gs-3-122-1

Higher warmth implies more of motions, of kinetic energy, the direction towards increasing entropy. With this aspect cold comes to represent the 0-pole, warmth a relative 00-pole, ~ lower d-degrees.

As mentioned about pain the receptors for temperature are of the derivative type, reacting to changes - and even to the the velocity of these changes (Zf).

It should be observed here that they react to the **direction** of these changes: cold receptors on decreasing temperature (~ convergence), receptors for warmth on increasing temperature (~ divergence).

Cf. contraction of blood vessels as reaction to cold, dilation of the vessels as reaction to warmth. It confirms the view on the polarity in figure Gs-1 above.

- A-threads, myelinated: convergence from a 00-pole towards cold.
- C-threads: divergence from a 0-pole towards warmth.

Myelination is also a later development.

(It has been shown however that C-threads also can relay cold but then as it seems at much lower temperatures than the A-threads (Nf p. 443). Could it be a reminiscence of an older system with only unmyelinated C-threads and their general spread in the brain?)

Receptors for cold lie deeper in dermis (or subcutaneous layer (Zf p. 268) than the receptors for warmth.

Another information (Nf) may be interesting with the dimension chain in mind: The sensitivity measured as threshold stimulus of receptors are 4 times higher for warmth than for cold (0,001° relative to 0,004°), a relation 4/1 that can illustrate increasing differentiation towards lower d-degrees.

Temperature intervals:

Receptors for cold answer in a temperature interval roughly 15° to 35° C, receptors for warmth roughly between 20° to 45° where they finish answering (Nf p. 442). Hence an overlapping interval 20° - 35°. The latter receptors have maxima around 38° to 43°.

However, cold receptors get activated above 45° together with specialized pain receptors, which shortly can give what is called "paradoxical cold" sensations from heat objects. In the central nervous system there are also nerve cells that get impulses from both cold and pain neurons that get identified as heat (Mf p. 313 f).

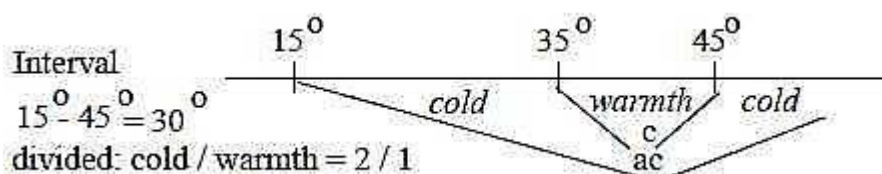


Fig Gs-4-129-1

One interpretation could be that the activation of cold receptors occurs through pain as underlying level as shown with dashed arrows in the figure below - in agreement with the dimension model and with interpretation of pain as the general sense polarized in the following ones.

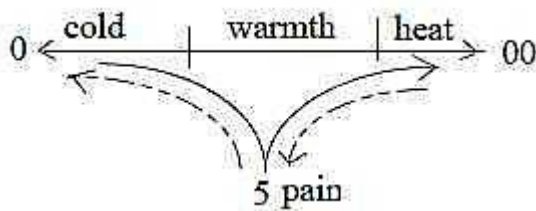


Fig Gs-5-129-2

Or with a related view: The presumed "pole exchange" in a d-degree step $1 \rightarrow 0/00$ (represented in each step of a dimension chain) should imply that heat as divergence defines a secondary $00'$ -pole, redefining cold on the thermal scale: cold as direction inwards the 0-pole. (5th d-degree equivalent with $0/00$, d-degree of motions.)

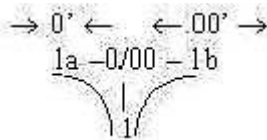


Fig Gs-6

Receptors as a keyboard for temperatures:

The receptor threads registering temperature are differentiated with their maximal burst frequencies at different degrees of temperature (*Nf p. 442*), reminding of hair cells in response to sound waves. How this differentiation is organized in cochlea is well understood, but how among receptors for temperature? (No information in used references.) Perhaps through a map of positions within different domains in the skin or inner membranes - with a corresponding one in the brain?

3. Pressure, Touch, Vibration - mechanical senses:

The senses for pressure, touch and vibration are mechanical and appear as a further differentiation from the sense of pain. Cf. the differentiation of pain above as a) polymodal, b) for warmth, c) for pressure, and the order of steepness in log-curves: pain \rightarrow warmth \rightarrow pressure.

- Nerve fibers for pressure are mostly thicker, myelinated threads in opposition to the thin threads for pain and temperature (*Mf*).
- The pathways for most of these mechanical senses go in another, more distal *neospinal* tract in the spinal cord than the more lateral, ventral tract for pain and temperature, the *paleospinal tract*, which also is the one for hard pressure (*Aph*).

Ends of nerve fibers:

Free nerve ends exist as for instance around roots of the hairs, which are encircled by nerve ends. Mostly however, the nerve ends for mechanical senses are encapsulated in capsules of connective tissue and further differentiated in specialized structures in at least 4 known types.

We can identify 2 polarization steps:

- in slow and fast adapting ones (tonic and phasic types), each of which polarized
- in those with small and those with bigger receptive fields.

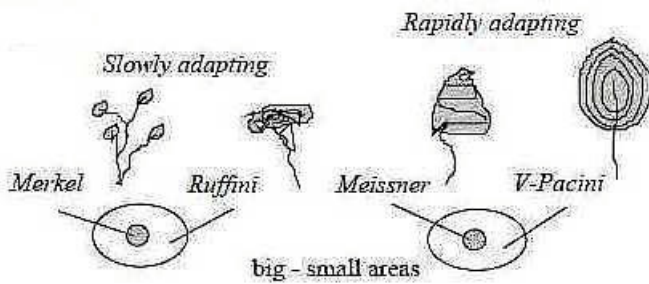


Fig. freely after Fc, Nf, BB)

Fig Gs-7-130

Further, there is the differentiation in function between fine touch and pressure (only a difference of degree) and deep pressure.

The fast adapting end organs are simultaneously sensitive to vibration and differentiated between low and high frequencies (f.) of vibration.

1. Slow adapting, simpler kind of embedding:

a) **Merkel's discs** : Receptive fields small (~ center pole)

- Structure: Dendrites disc-shaped, closely ("vertically") attached to special big cells in epithelium.
- Sensitive to fine touch and pressure.

b) **Ruffini's corpuscles**: Receptive fields bigger, vaguely demarcated (~ anticenter pole).

- Structure: Nerve ends spread in a bundle of "horizontal" collagen fibers.
- Sensitive to pressure and distortion, tension of skin. Note this angle step.

2. Fast adapting, more complex kind of embedding:

a) **Meissner's corpuscles**: Receptive fields small (~ center pole).

- Structure: doubly embedded, branched and coiled dendrites with ends surrounded by modified Schwann cells and this whole enclosed in a capsule.
- Sensitive to fine touch and low frequency vibration.

b) **V. Pacini's corpuscles**: Receptive fields big (~ anticenter pole), vaguely demarcated.

- Structure: one single dendrite thread within several layers of concentric collagen fibers (lamellae), rather flat.
- Sensitive to deep pressure and high frequency vibration (~ "overtones").

It's noteworthy that the structures differ more clearly than their functions seem to do.

If we should try to apply the dimension chain on these separate structures, certain features at least are possible to identify as such:

- The relation between "radially" spread discs of Merkel's type versus the horizontally arranged of Ruffini's type as poles from step 4 →> 3.
- The big rounded, doubly embedded Meissner's type versus the more flat concentric Pacini's type as a feature relation 3 to 2 (and 2 to 1 with regard to the structure of dendrites within the corpuscles).

It has been proved that it is the embedding in corpuscles of the nerve ends that makes them fast adapting.

The fast adapting types, sensitive for vibration, could perhaps also be described as derivations from the slow adapting in two steps (?):

- 4 -|- 3: Merkel's: radially branched nerve ends: fine touch and pressure.
 ↓→ Meissner's: branched, coiled nerve ends: fine touch and low f. vibration.
 3 -|- 2 - 1 Ruffini's: horizontally nerve end(s) in bundles: pressure and tension.
 ↓→ Pacini's: one single, vertical nerve end: deep pressure and high f. vibration.

Positions in layers of skin:

Pain: - Merkel's — Ruffini's + Meissner's - Pacini's: →> *more embedded*:

If we may regard the senses from pain to the mechanical senses touch and pressure as differentiations analogous to steps towards lower d-degrees, from free nerve ends to big end receptors and from non-adapting to fast adapting, the direction in *positions* becomes roughly from outer layer of the skin to inner, underlying layers. Epidermis originates from the animal 00-pole, deeper layer from endoderm of the vegetative 0-pole and mesoderm embryologically.

The localization of receptors in opposition to the suggested d-degree of their character could perhaps be understood in terms of lacking answers:

- Pain as outward directed, not answered by adequate response from outside, outer skin.
- Deep pressure as inward directed, not answered by balancing pressure from inside.

4. About receptors in joints, an addition:

Besides other sensory receptors within the body as e.g. baroreceptors in blood vessels and proprioceptors in muscles and joints etc. there are receptors similar to Pacini's and Ruffini's in joints (*Nf p. 440*). Those which adapt slowly give information about direction of motion, velocity and position.

- They react to motion in the joint within a certain angle interval, a differentiation of receptors as along angle steps in a dimension chain: change of Direction, ~ d-degree 4.
- Frequency of receptive response is linearly proportional to the velocity of the motion. Velocity has in this dimension model been suggested as the physical quantity of a dimension step, type 1→>0/00 (the very quantum jump between d-degrees).
- Discharge of the receptive response drops to a level that corresponds to the position of the joint, hence a spatial qualifier as out of angled directions; position, d-degree 3.

The same receptor mediates information of all three properties: direction, velocity and position:

D-degrees in the dimension chain:
 4 ————— 3
 Direction Velocity Position

5. All senses: dimensional aspects on their mutual relations?

Usually in human biology there is talk about 5 to 6 senses (at least the hitherto identified):

Equilibrium - Taste - Smell - Sight - Hearing plus
 Kinetic sense from inner muscles and joints.

To these comes the skin senses for pain - temperature - touch/pressure - vibration, plus all inner receptors for blood pressure, chemical milieu etc.

An interpretation of all these senses in their mutual relation with aspects from a dimension chain becomes probably most natural with a division in kinds of stimuli they respond to, and how these stimuli are related to fundamental physical qualities (or "quantities"). (About how these physical qualities are suggested to be stepwise defined in the dimension chain, see [here](#).)

Sense of equilibrium is connected with gravitation and outward acceleration, chemical senses with mass and matter in next steps (and charge), sight with electromagnetic waves related to charge etc.:

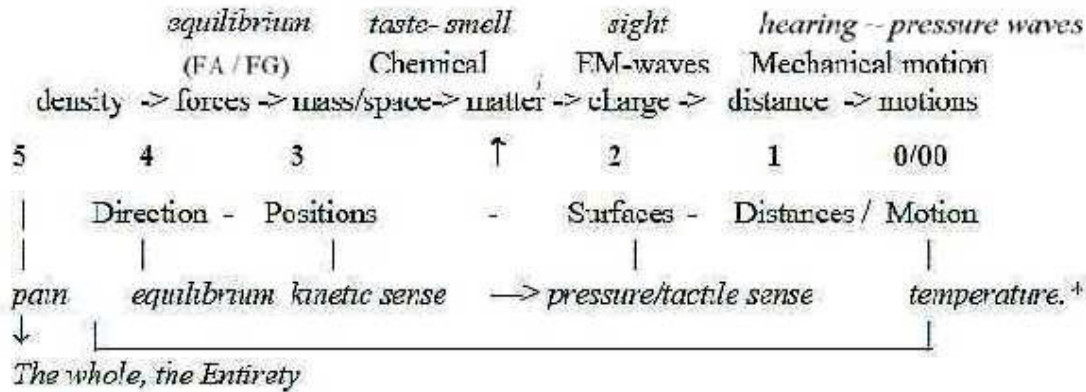
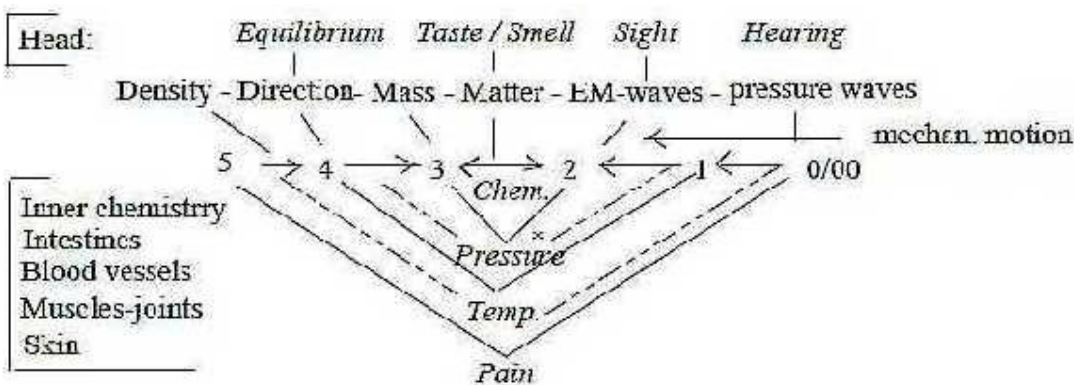


Fig Gs-8-132-1

* D-degree step 1 →> 0/00 debranched from step 5 →> 4: Temperature as warmth is related to density among particles, partly a matter of their motional energy and velocity (a quality distance/time), partly a matter of imbalances in radiation (EM-waves).

Step 1 →> 0/00 debranched from step 4 →> 3: motions of the body registered by the sense of equilibrium and receptors of the kinetic senses.

With the loop version of the dimension model the senses regarded in such a chain becomes also roughly an illustration of steps from inner senses to outer "near senses" as taste and smell to outer "distant senses" as sight and hearing:



* Pressure = Force / m² = force (~ direction) through surface unit.
Pressure = Mass / t² x m = mass through time squared x distance.

Fig Gs-9-132-2

Thus, pressure may be translated into a relation force (4) and distance (1), or to mass (3) and the quantities distance plus time.

Directions and sense of **Equilibrium** are expressed in motions of the body and closely related to Sight.

Mass →> Matter as Chemical senses: body motions governed by Smell and Sight in seeking for food.

TASTE AND SMELL

1. Taste and smell compared:

Both taste and smell (olfaction) are chemical senses in opposition to the other three special senses. Between themselves however, they show features of a 0-00 polarization. A simple observation is the locations in one versus two openings respectively, taste ventrally, smell more distally; left and right nerve bulbs in the nostrils operate also separately.

Taste receptors on tongue is an unpaired* sense, while smell becomes a paired sense already in sharks.

*(Yet, there exist species that have taste senses on the legs!)

Taste concerns directly the nutrition system, originating from the vegetative 0-pole, and is a "near sense", while smell concerns the environment, is a "long-distance sense" (which also gets involved in communication as a language): a polarity of the type center - circumference.

Smell receptors are nerve cells with own axons. It is the only sense with receptors that are neurons with direct connections with cortex in the brain. Whole cerebrum has been interpreted as developed from the olfactory cortex. Thus, smell has the closest relation to the neural system, the 00-pole of the embryo.

The sense of taste differentiates only among up to 6 (?) different tastes, the sense of smell of some animals up to 10-20 millions: a polarity between unity and multitude.

There is also a difference between levels of complexity in registered chemicals: small atomic ions and atomic groups decides tastes, more complex molecules are registered by the sense of smell.

Transduction of stimuli occurs for the simplest tastes salty and sour through chemically gated ion channels, for the little more complex other tastes through G-proteins and secondary messenger, cAMP-gated channels, as does the transduction in the olfactory sense. A partial polarity.

The direction of microvilli of taste receptors is vertical to upper surface of tongue. The corresponding dendrites of smell neurons are "horizontally" spread at right angle to the cells along the surface of the mucous membrane: a geometrical angle step and polarity of d-degree 3 in our model that derives from the 0-00-polarity.

Finally, opposite directions in/out in breathing (cf. directions from 00- and 0-poles) is connected with smell versus taste: It is during exhalation that the smell sense contributes to the "flavor" - in contrast to that of proper smell which occurs during the inhalation phase (*Wikipedia*).

2. Taste (gustation):

Number 3 appears both in types of papillae and in number of nerves (*Nfp. 421*) from tongue via bipolar cells to spinal cord. Of the 3 papillae types 2 have taste buds, 1 only a function of friction.

- *Fungiform* type of papillae has about 5 taste buds.
- *Circumvallate* type is bigger and has up to about 100 buds (*Aph*).

The bigger circumvallate type is mostly gathered in a v-form on back of the tongue, while it seems as if the fungiform type of papillae are more lengthwise arranged. If so, they represent a certain angle step inwards.

(Each bud in a pore consists of receptor cells with specialized epithelium and is a collection of ca. 40 cells shaped as thick leaves as in an onion.)

Already these features - and the innervation by 3 different cranial nerves - show the general principle of polarizations:

- Front 2/3 of tongue is innervated by branches of the facial nerve VII,
- back 1/3 part of tongue by the glossopharyngeal nerve IX and by branches from the vagus nerve X,
- taste buds furthest back in pharynx and epiglottis by this vagus nerve X.

Hence, there are steps in depth between branches of these cranial nerves, which also serve other parts in similar steps from surface to depth in the body:

VII the face, IX the head and neck, X the inner visceral organs. Something to remember when it comes to the different tastes:

The "5" tastes - or 5 + 1:

Simplifying incomplete data, the 5 hitherto identified tastes (besides water) could be arranged in three groups of increasing complexity: from simple atomic ions to small (end)-groups of OH (as in carbohydrates) and NHx in nitrogen substances to these both groups appearing in amino acids and small peptides:

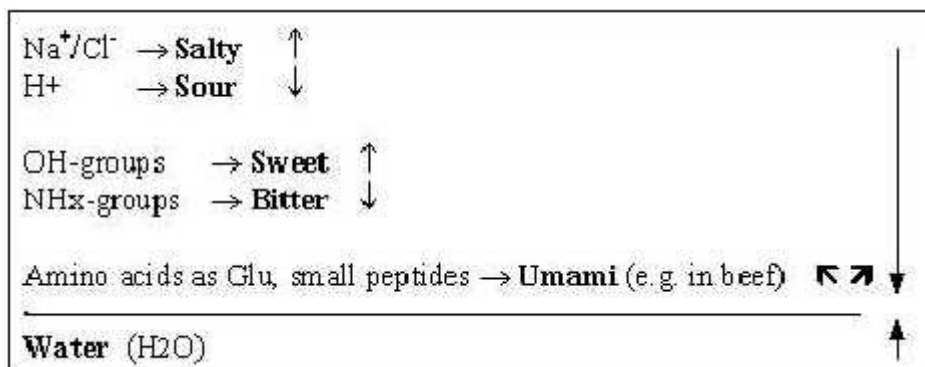


Fig TS-1

About the arrows below.

- Sweet and bitter, it's said, show a certain feature of complementarity reminding of complementary colors: many sweet substances are followed by a bitter taste, especially if the stimulus moves from apex of tongue inwards its base (*Nfp*. 423).

- Umami is (especially?) identified at the bigger circumvallate papillae in v-form back on the tongue (*Wikipedia*, *Aph*).

It looks somewhat like polarization steps from umami to the N-O-polarity in bitter-sweet to the simple ions and salty character of a first environment. So too with regard to valences of the atoms:

- in umami C-N-O = valences 4-3-2, in bitter - sweet N-O = 3-2,
- in sour H^+ 1,
- in NaCl 0 (+/-1); also a way from living cells as centers in an environment as anticenter.

- Water, a taste detected in humans and some other animals, seems to be registered especially by taste buds in pharynx, furthest back. (Water →> umami as a first fundamental polarization ?) Thus, it should be innervated by the vagus nerve which mainly goes to inner, visceral organs: an eventual connection with thirst? Could thirst and hunger be connected in a common center in hypothalamus?

About localization, old maps are shown to be false. All the 4 best known tastes are detected by all taste buds. There is however certain indications that sensitivity for salty and sweet tastes are higher on front part of the tongue, sensitivity for sour and bitter higher further back (*Aph p. 553*). It could hypothetically imply a factor of direction (d-degree 4) appearing here, a polarization outward / inwards within the groups as shown with the vertical arrows in the figure above. (Cf. about complementary sensations sweet-bitter above (*Nf*)).

Sensitivity for the "inward directed" tastes is much higher than the other: for sour taste it's 1000 times stronger than for sweet and salty, for bitter taste still 100 times stronger (*Aph*). Hence, there would be values 1 - 3 - 5 on the log-scale between these tastes.

Innervation in the sense of taste seems very simple compared with sense of smell: the sensory bipolar cells mediate the signals directly from receptor cells to spinal cord and medulla oblongata. There are no other cell layers out at the organ.

However, there is a polarization between very thin and thicker nerve endings at the membranes of receptor cells. Further, one nerve branches to many receptor cells and each of these receives ends from many nerve branches: a system of divergence and convergence. (Unsaid if this arrangement gives blended tastes and has a function of discrimination or something else.)

It's said that the taste buds include 4 different types of cells. Stem cells are mentioned, curiously also innervated, as the matured receptors. (It's unknown if they take part in sensations.)

There is no adaptation in receptors, only in higher centers.

Total number of taste buds is said to be about 10.000 in newborn human babies and medium about 3000 in adults.

3. Smell - olfaction:

Humans are able to distinguish between ca. 2000 - 4000 odours (animals like dogs as well-known an awful lot more). (Old data. Humans can unconsciously distinguish an immense lot more odours than earlier believed, according to newest discoveries.)

There has been studies identifying at least 50 primary smells; if so an interesting number, one 10-power more than the number of tastes.

The fact that the olfactory receptors are the only ones with own axons to the brain, and that the olfactory brain is seen as origin for the whole cerebral cortex seems to indicate that this sense made up the very front of the neural tube in earlier brains; closest to the surrounding anticenter as polarizing force in our model. (Cf. that insects have the same organs on antennae.) This could be a reason for the multitude of differentiations and genes coding for proteins in the olfactory system?

Structure (reference here *Wikipedia.*):

From the parts of mucous membrane that are covered with sensory neurons, the axons penetrate the bone into a *bulb* just inside.

In these bulbs an outer layer of axons from many neurons gather intertwined in what is called glomeruli, as it seems a unique kind of convergence, not associated with synapses on dendrites of cells, yet gathered in small round bladders.

If so, perhaps an early form of centered network during evolution, an intermediate form between the simpler nerve branching at taste receptors and later bipolar cells replacing them?

Then mitral cells in a deeper layer of the bulb gathers stimuli from many glomeruli (like ganglion cells in vision) - and from mitral cells the axons gather to the olfactory tract, entering the brain.

Besides the mitral cells there are two other types in the bulbs, *periglomerular* cells and *granular* cells for lateral inhibition. Cf. two corresponding layers in vision.)

It makes 4 type of cells out at the organ (the stem cells not included), to compare with 5 in vision.

Like taste receptors these chemical receptors are renewable - perhaps depending on the higher dimension degree (shortened *d-degree*) of chemical senses compared with those for EM-waves and mechanical stimuli according to our interpretations (end of file **General senses**).

Adaptation occurs as in the taste organ at synapses in higher centers, not at receptive neurons.

The convergence is of the same degree as between bipolar cells and rods in **vision**: a factor of ca. 1000: 25000 axons synapsing on ca. 25 mitral cells. (Once again factor 5!?)

In the figure below an effort to interpret the information. Here the number of different distinct features of molecules is reduced to 5, a-b-c-d-e. They are naturally many more - and probably of both structural (geometrical), chemical and electric kinds (?).

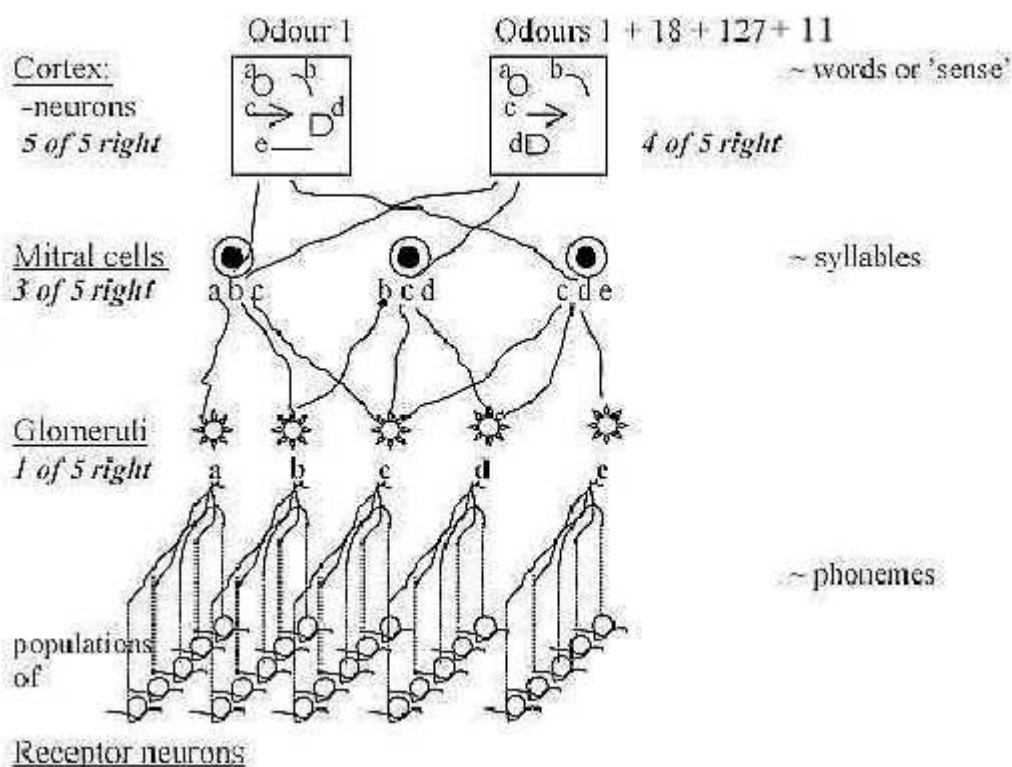


Fig TS-2

Similarities with levels in language are marked in the figure. (The cortical neurons may remind of gathered Egyptian hieroglyphics within frames as "speech bubbles" referring to Pharaohs.) Odors as pheromones and others have also the function of a language between individuals of a specie and are actively produced by scent-glands.

The structural analysis of an odor seems to go stepwise from brain to receptor neurons. (Synthesis the other, afferent way.)

1. Each receptor recognizes only a particular molecular feature or class of odor molecules. There are receptor populations with distinct sensitivities.

A glomerulus gathers nerves from these populations that detect similar features in a molecule.

2. Different glomeruli register different features of one and the same molecule.

3. Each mitral cell gathers signals from many glomeruli.

In the bulb many neurons (must refer to the mitral cells) are responsive to many different odors.

In cortex of the brain however, half neurons respond only to one odor, the rest to only a few. Scientists have different theories and imagine a kind of "spatial" or "chemotopic map" in cortex for each odor.

(So far *Wikipedia, Olfaction*.)

If there are no intermediate cells for convergence, it should mean that the afferent axons from mitral cells diverge to different neurons in cortex and that a neuron in cortex only responds to the right combination of signals from mitral cells as supposed in the figure above.

Smell - memory - feelings:

That smell sensations have connections with long-term memory as well as with elementary feelings is well-known.

Olfactory tract from smell organs distribute signals to 5 different areas in the brain. 3 pathways go to cortex, the limbic system around the 3rd ventricle and to hypothalamus with its neurosecretion. Hippocampus and Amygdala, associated with the limbic system, are locations for long-term memory and elementary feelings. One example is fright and fishes that flee from the smell of dead fish.

It has been found that there are single neurons in cortex that answer distinctly on e. g. photos of a certain known person and on nobody else, as if the whole memory of that person with all its features was stored in one cell.

A conclusion seems to be that Memory as such is organized in a similar, intricate way as Olfaction, gathering structural pieces from a lot of senses. (Analysis of grammar in language in a similar way?)

Similarities between the sense of smell (chemical) and of vision (electromagnetic) are noted in Wikipedia. It concerns the way of analysis in distinct features, the system of lateral inhibition out at the organ and especially the unique fact that ion channels in receptor cells are directly opened by cAMP and cGMP respectively, without mediating enzyme (protein kinase A). It's suggested that there eventually have been an evolutionary development from one of the senses to the other.

The fact about opening of ion channels is perhaps an example of protein enzymes as a later phase during evolution with more and more of intermediators? (Cf. human societies.). The same could be the case in the difference between these senses: glomeruli in olfaction versus bipolar cells developed in vision?

*

SIGHT

Most data here concerns the human eye.

1. Geometry of analysis:

A geometrical analysis of received pictures is performed by the eye. It appears to be much of the same kind as the elementary geometrical definitions of the complementary poles in our [dimension model](#).

Scientists have been able to distinguish 5 different types of ganglion cells, sensible for different geometrical features (*Nfp. 373*), in number also the same as degrees in the model.

There are for instance cells sensible for direction of linear structures, others sensible for round forms, others for curves, convex or concave, others for straight lines in different angles, others for motions of geometrical elements in certain directions.



Fig S-1-113-2

Cf. in the model proposed geometries of polarized dimension degrees (shortened here d-degrees) d-degrees:

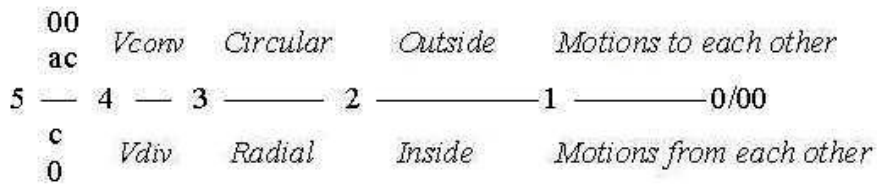


Fig S-2

Direction (4): Vdiv - Vconv, Volumes (3): radial - circular structure, Surfaces (2): concave - convex, inside - outside. Distances (1): motions to - from each other (0/00).

2. Number of cell layers:

There are 5 layers of cells in the retina (compare number 5 in the many other cases of arrangements in the human body):

3 cells in 'vertical' direction, from receptors of photons, the cones and rods, via bipolar cells to ganglion cells, leading the signals to the optic nerve and visual cortex in the brain.

2 intermediate transverse layers of cells, at right angle to the other ones, the layer of *horizontal* cells and the layer of *amacrine* cells.

It's a number relation as in step 3-2 in the dimension chain, where the polarization 3 → 2 was defined in elementary geometry: radial versus circular, outer poles of d-degree 2 in the model, that of surfaces.

An outline of the layers without any precision:

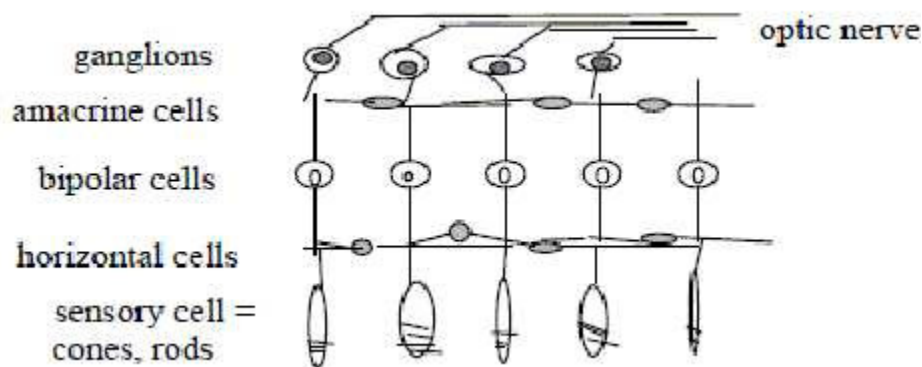


Fig S-3-111-1

Here the cells in 'vertical' lines are the integrating ones. Cf. the relation between d-degrees 3 and 2 as corresponding to a 0-00-relation: the 0-pole as integrating, the 00-pole as differentiating. Bipolar cells gather signals from many receptors, ganglion cells from many bipolar ones.

Cells in the transverse, 'horizontal' layers have a similar function of lateral inhibition or stimulation as corresponding cells in the general nervous system: facilitate or inhibit the sensitivity of propagated light signals: it's the polarization we have suggested as d-degree step 2-1 in the chain of [polarities in the nervous system](#).

5 → 4 → 3
 \ 1 \ 2 → debranched d-degrees
 meeting the other way around

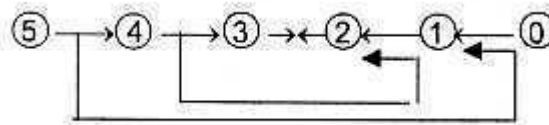


Fig S-4

3. Center - anticenter polarity in d-degree 2:

Structure of the eye is on a macro-scale 3-2-dimensional with the globe (3) and the retina (2): pictures principally 2-dimensional. We could note that the eye-globe really can rotate, the "external motion" assumed in d-degree 3 in our model (!). A rotation through its 6 muscles (m.), a number that happens to be sum of the poles 3a + 3b out of polarized d-degree 3.

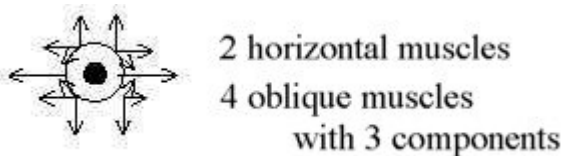


Fig S-5 (after Mf p. 335)

(Cf. muscles in the dimension [chain of organs](#) identified in d-degree step 3 - 2 and angle steps $180^\circ \rightarrow 90^\circ \rightarrow 45^\circ$.)

A general, structural feature on a more detailed level regard surfaces (d-degree 2) and the polarity between a central area and an anticentric one; not explicitly included before in the model among the polarizations of d-degree 2 (concave / convex, inside / inside...).



Fig S-6-111-2

The same polarity appeared among types of corpuscles for general senses in the skin but only as smaller and bigger fields for reaction. In the eyes this opposition becomes much more obviously a polarity. (Embryologically the differentiation of cells around animal pole in the blastula is of the same kind.)

- The **pupil** of the eyeball is of course a first example of this center - anticenter (c - ac) structure. The center as just an opening, a hole (!) could be regarded as one kind if inversion, cf. the cell interpreted as inversion of an atom.

Area of this center, the pupil, is governed by radial and circular muscles, the geometric poles 3b and 3a out of d-degree 3 and outer poles of d-degree 2 in the dimension chain.

These muscles are in their turn governed by the sympathetic and parasympathetic nervous system respectively for outward and inward directions, The fact that the pupil not only functions as an aperture but also chronically "oscillates" a little in size (*Nf p. 353*) could perhaps be traced back to the vibrational moment assumed in d-degree 4 of Direction, origin of these muscles?

- Next example is the **organization of cones and rods** in the retina, with cones in the central region and fovea, a central shallow depression, and rods in the anticentric area. While cones have more own pathways, signals from up to 1000 of rods (*Aph*) may converge to one ganglion cell: it shows the typical convergence = direction inwards from an anticenter. The whole system for analyses of signals seems built on processing steps of convergence / divergence (*Mf p. 363*), the forces from 00- and 0-poles.

1/3 of the fibers in the optic nerve comes from the fovea, 2/3 from the surrounding area (also a noteworthy division) as numbers of steps from d-degree 3 (?).

About P and M in the figure, see below.

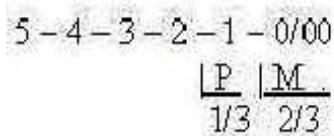


Fig S-7- 112-1

In cortex however, it appears that these threads occupy equal parts of the primary visual cortex (*Mf p. 310*), a division 1/1 which could support the view on a c-ac-polarization of the same d-degree.

We could note the number 3 too in the different kinds of cones creating all colors.

White light is all wavelengths gathered together: the eye shows the generalized peripherally in the sensitivity of rods, the separated wavelength, the colors, centrally, which reflects the polarity unity - manifold between 0- and 00-poles.

- The **"P-M-system"** is a third example of the c-ac polarity in d-degree 2. The reception areas of the ganglion cells are usually circular with a center field and surrounding anticenter field:

Ganglions for cones are called P-cells: they have small reception areas, mostly in the center.

Ganglion cells for rods, called M-cells, have larger reception fields, mostly peripherally.

That this division corresponds to a polarization becomes evident too from the fact that they have synapses in different cell layers in the visual cortex and get projected to different secondary areas (*TA p. 106*).

These types show simultaneously a relation of higher d-degree to lower ones in two respects, as such a relation always is of the kind 0 to 00:

The P-cells react especially on colors, a property connected with surfaces (\sim d-degree 2) and wavelengths (\sim d-degree 1 as distance), the M-cells especially on motions, the last degree 0/00 in the dimension chain; cf. the figure above.

Further, M-cells adapt fast in opposition to the P-cells. Such fast adapting cells can be regarded as "derivative cells", illustrating changes in the same way as the derivative of a mathematical function illustrates changes of directions in a curve and implies a decrease in d-degree.

4. On-off-center cells:

The polarization of the derivative M-cells show the complementary feature of poles in our model very clearly.

The receptor fields of the ganglion cell becomes through different connections in the net polarized in two kinds, on- and off-center cells:

One type gets active when light hits the center, and inhibited when it hits the circumference of its receptive field.

The other type is the inverse: gets active when light hits the surrounding area, inhibited when it hits the center of its receptive field.

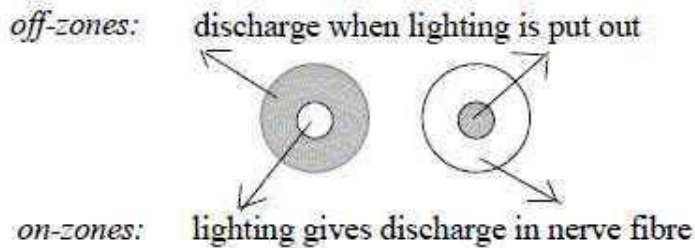


Fig S-8-112-3 after Nf p. 370

We may compare with polarization of a derivative in an inclination upwards of a curve and an inclination downwards, with polarization of signs plus/minus as in the physical property of charges.

According to a principal sketch (Nf) inhibiting pathways go to centers in the one kind, to the anticenter in the other kind.

The arrangement could be interpreted in terms of the final step $1 \rightarrow 0/00$ with "pole exchange" in the dimension model: Pole 1b, "motions from each other" out of divergence and 0-pole, define an anticenter, a new 00-pole, and "motions to each other", out of convergence and 00-pole, define a new center: With 00-pole representing inhibition, 0-pole excitation we get following scheme:

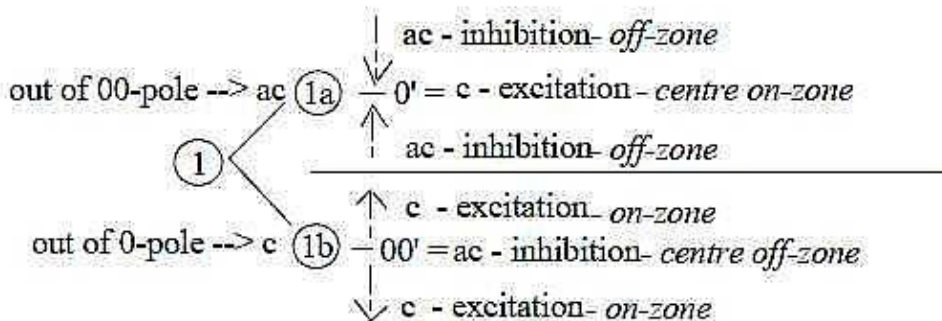


Fig S-9-113-1

The approximate number of cells reacting in different ways seems to include 3 steps of divisions in percentage:: 100 →> 50-50, 50 →> 30-20, 20→>(10-10 ?, no figures given):

- 50 % of them react both when light is turned on and when it's turned off, on-off-cells,
- 30 % react when light is turned off, off-center cells,
- 20 % react when light is turned on and during lighting, on-center cells.

These 20 % are further divided in such that only react initially, and those that also react during continuous lighting.



In other terms, the opposite eye seems to represent a center or the vertical axis, the eye from the same side the horizontal one. It corresponds to first polarization in d-degree step 4 \rightarrow 3 in our model. The differentiation becomes horizontal for directions as along a circle..

Distance in the depth columns seems defined through equal, horizontal distribution of signals from both eyes (a bit vague expressed in the reference). Differentiation hence vertical. (It should also represent a step from vector to scalar.) An own interpretation of the reference below:

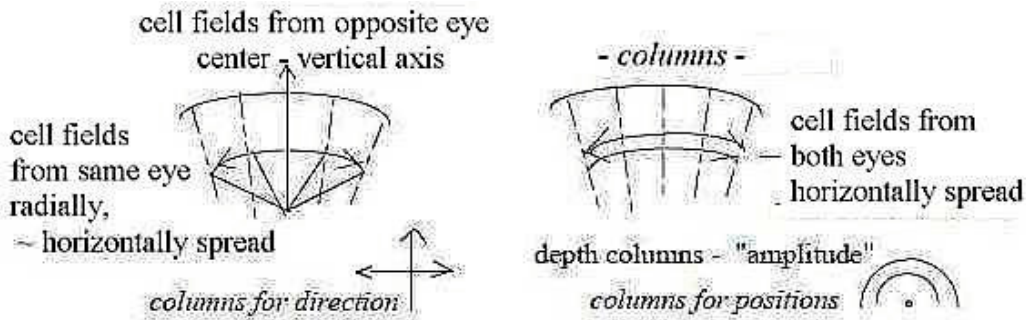


Fig S-12-114-1

Texts in this figure concerns actually cells in one single column. It's said in more general words that the vertical organization in a column concerns details and orientation, the topographic picture of retina the "place"; cf. in this sense directions (d-degree 4) - of lines and other details too - versus 3-dimensional space.

7. Layers in columns of cortex;

The deeper the research towards a detailed level, the more a stringent geometrical organization within biology is revealed. There is for instance also a strict order of fibers in the optic nerve. At first station where fibers cross over from one eye to the other side (*lateral geniculate nucleus*) the cells are arranged in 6 layers. Fibers from the opposite side go to layer 6 and 4 + 1, fibers from the same side to layers 5 and 3 + 2. (Nf p. 375).

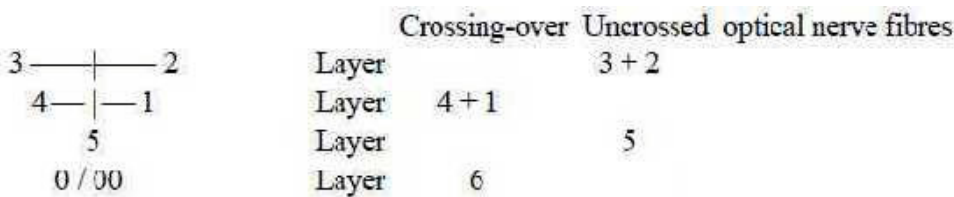


Fig S-13-114-2

Cf. 3 polarizations of 5 in a dimension chain, 0/00 (~ "6th" d-degree) as one of them.

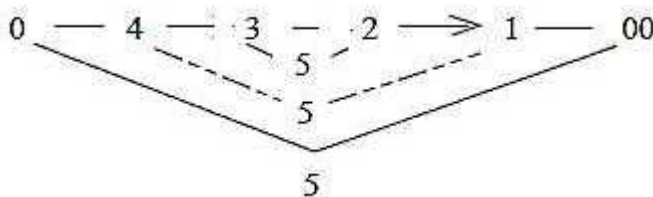


Fig S-14-7-3

8. About number of cells in the human retina:

Human beings have about 125 million rods and about 6 million cones. (Also about 6 million bipolar cells) and about 1 million ganglion cells and fibers in the optic nerve (*Aph*). An interpretation of the very numbers:

Levels as in a dimension chain = 6.
 5 radii on each level.
 Gives 125 crossing points.
 + 6 along the central axis = 131

Suppose each level represents a 10-power.

We get the number 125×10^6 rods
 and 6×10^6 cones.

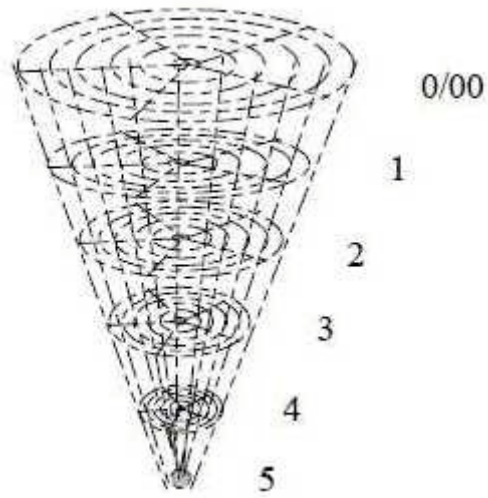


Fig S-15-114-3

*

EQUILIBRIUM

1. The sense of equilibrium builds on the gravitational force (F_G) as the sense of sight on the electromagnetic one (F_{EM}). Early forms of chordates as tunicates had one receptor cell for electromagnetic waves and one "statocyst" as "gravitational organ" (K_z). In the history of evolution these organs could be regarded as the "first" specialized senses for external orientation. (The forces obviously still more decisive for plants!)

Already in *cyclostomes* this organ for equilibrium has developed to sacs with 1-2 ducts, and sharks have the two sacs *saccula* and *utricle* plus the 3 semicircular canals in three directions as all later species and human beings.

The organs for equilibrium originates obviously from the lateral line system of fishes, depressed canals along the sides with sensory hair cells.

Hence, this is a further example of how the environment (the 00-pole in our model) is successively built-in into an organism as a center versus the surroundings, a 0-pole: one general principle view in the dimension model.

A specialization of that lateral line system becomes the receptors for electric fields among species of fishes, which implies a step between **forces** $F_G/F_A \rightarrow F_{EM}$.

2. The organ of equilibrium becomes divided in 5 structural parts, differentiated in functions.

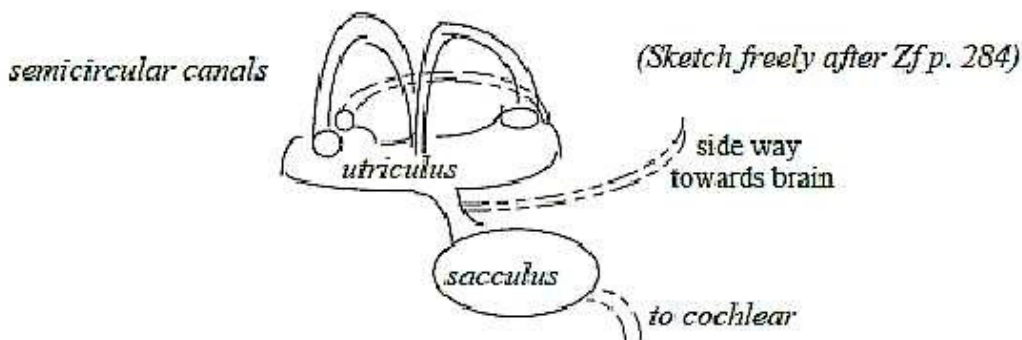


Fig Eq-1-115

Receptors are hair cells that react mechanically on the movements of the fluid endolymph in sacs and the 3 ducts at changes of body and head positions. They are embedded in *christae* (called *macula* in the sacs), one in each duct, one in utricle, one divided in saccula, hence 5 to 6.

There is a first polarization between sacs and ducts: while the sacs register static forces, the ducts register changes in velocity and directions of rotation, also a relation of the kind between a function and its derivative.

The christae in the sacs react on motions along gravitational axis up-down and on linear acceleration. Compare our **interpretation** of outward acceleration (F_A) as complementary pole to gravitation (F_G) as inward acceleration. The hair cells in the ducts (the semicircular canals) react on different kinds of rotation of the head.

This polarization agrees with our interpretation of **external motions** in dimension degree (shortened here *d-degree*) step 4 \rightarrow 3 of structure: a 1-dimensional motion developed to a 2-dimensional one (rotation) in d-degree 3. Simultaneously this opposition implies a step from the whole body to the part, the head.

(Hence, hair cells in the sacs register linear acceleration, those in the ducts angular acceleration. This could also be illustrated with a figure of a dimension chain as angle steps, a polarity of 180° in d-degree 4, 90° in d-degree 3 as a transition to rotation.)

A functional differentiation between maculae in the two sacs should reasonably exist but isn't noted in the references here. It's only said (*Mf p. 318*) that the function of saccula is less known but eventually reacts on both linear acceleration and falling - possibly then both F_A and F_G in our terms? It's left as an interesting question.

3. There is however in external form and in arrangement of the ciliated receptors (hair cells) in the sacs features of partial polarizations.

In forms the sacs differ as "round" and "elliptic". An ellipse may be described as a circle, the center of which has been polarized into two focuses. (Cf. about the sense of hearing, the "round" and "oval windows" in cochlea.) The longer coordinate axis of the oval utricle sac becomes also to a certain degree tangential to the round saccula sac. The oval sac seems in this sense as an expression of the very transitional step 4 → 3, to rotation. Followed by the breaking up of "volumes" into three perpendicular 2-dimensional planes, designed as "halved circles" of tube-shaped canals as one expression for d-degree step 3 → 2. (2 vertical ducts, 1 horizontal.)

Cf. 3-dimensional **motion** as "translation in 3 dimensions".

4. The arrangement of the receptors in the sacs differ too according to a figure in a reference (*Zfp. 284*): in the "round" saccula they are positioned both vertically and horizontally with a separate bundle of nerves from each, in the oval utricle only horizontally, showing on a step towards one-way direction.

The higher d-degree of maculae in the sacs may also be seen in the mineral grains of calcium carbonate (the *statoconia*) that lie on cilia of the hair cells and through pressure and motions affect them. This in opposition to only fluid streams that affect hair cells in the ducts. It's a d-degree step in **phase** too of influencing matter.

Further in details: in sacs the relation between the influencing crystals and cilia is vertical, in the ducts the influence of fluid streams on cilia is horizontal.

5. The "hairs" of the individual cells are cilia polarized in two kinds: one big, single *kinocilium* on each hair cell, always at one end, and up to 100 smaller *stereocilia* in parallel rows. Essential for reaction of the receptor cell is if the stereocilia are bent towards the single kinocilium or from it.

Here we have both the polarity unity - manifold of the poles 0 and 00 in our model and simultaneously the directions outwards - inwards, translated to a linear projection.

In ducts the polarity of directions appears between vertical and horizontal ducts through opposite arrangements of the cilia: in vertical ducts the kinocilium is placed outwards from utricle, in the horizontal duct inwards utricle. Since a reaction giving a nerve signal is always the result of stereocilia bending in direction towards the kinocilium, it gives that vertical ducts in this sense represent outward direction, the horizontal one inward direction.

Another feature: in the sacs the hair cells give hardly any signals at ordinary position of the head. In the ducts they have a basic frequency which varies at different motions of the head. It seems as an expression for the increasing motional moments towards lower d-degrees of structure in our model.

6. Signals from hair cells in the 3 ducts correspond to rotation of head in 3 planes, in at least northwest countries signs for "Yes", intermediate "Njae" and "No":

- Vertical plane = Front - Back | Dorsal-Ventral axes: posterior duct, rotation for Yes.
- Vertical plane = Front-Back | Left-Right axes: superior duct: tilting of head for "Njae",
- Horizontal plane = Dorsal - Ventral | Left - Right axes: horizontal duct: rotation for No.

It may be noted that the half or decisive 'No' in these cases include the Left-Right axis, suggested to represent d-degree 2 according to number of polarization steps in embryos' development (**Embryology, No. 8**): a 'No' also connected with "inhibition", **polarization step 2-1** in the nervous system.

7. The bundles of nerves become 6 with two from saccula, one from utricle and one from each duct (Zfp. 284). They join two and two, which implies 3 polarizations from the aspect of a main tract.

The bundle from horizontal cells in saccula joins with the posterior vertical duct: this plane is defined by the primary two coordinate axes of an embryo, which we have interpreted as representing d-degree 4 and 3, the A-V- and F-B-axes. Some geometry guides surely this bundling. Could the horizontal saccula cells represent linear acceleration outwards, the vertical ones gravitation? Or the horizontal one both of these forces, the vertical as secondary one of them? Only guesses.

We can observe in the figure below that the 3 bundles are paired vertical (V) with horizontal (H) in ducts or relations of macula and ducts. Saccula as of higher d-degree has both types, a kind of double-direction.

Posterior duct V-1, superior duct V-2, horizontal duct H:

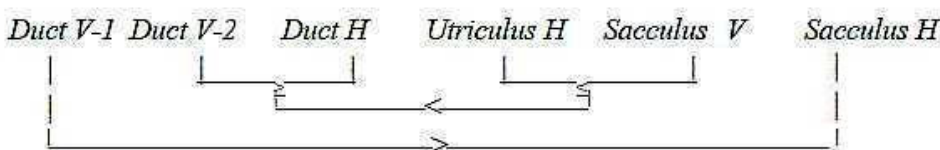


Fig Eq-2-116-2

HEARING

1. Relation between organs for equilibrium and hearing:



Fig H-1-117-1

We have assumed that gravitational waves, if they exist, are of the longitudinal, linear type: $\rightarrow \leftarrow \rightarrow \leftarrow \rightarrow \leftarrow$ So are sound waves, conveyed through variations in pressure on the tympanic membrane in cochlea. Pressure is a quantity F/m^2 , the force F here an inward directed one as is gravitation. Thus, it's rather natural that the sense of hearing is developed in close relation to the sense of equilibrium, even though it sometimes has been called a 'mystery'. (Cf. 'pressure' as increasing 'Density', proposed as only term for first physical quantity defined in step 5 - 4 in the model here, before gravitation gets defined in next step.)

The organ of **equilibrium** concerns own position and movements of the individual, in this sense referring to outward activity from the organism as center, a 0-pole. Hearing is primarily an organ for input, impressions from outside the environment, from the 00-pole. Hence, the two organs may be interpreted as representing a polarization in directions outwards \rightarrow inwards \leftarrow , which may be one factor behind the differences in developed structures.

Hearing is also "time displaced", later developed during evolution. A small canal from saccula in the organ of equilibrium develops to a tube which grows during evolution, becomes a bent tube in reptiles and then the convoluted spiral in cochlea of mammals (figure above).

In the dimension model the outward direction for dimension degree (d-degree) of structure: $5 \rightarrow 4 \rightarrow 3 \rightarrow 2 \rightarrow 1 \rightarrow 0/00$ gives the opposite chain from 0/00 stepwise inwards to 5 in d-degrees of motions. The development of the organ for hearing from first a "linear" tube to rotating spiral could be apprehended as a substantiation of the pattern of motions of increasing d-degrees. (In opposition to the structures in organ of equilibrium, from sacs as volumes to half circle bows with functional steps towards increased d-degree of motional reaction from linear to rotational movements.)

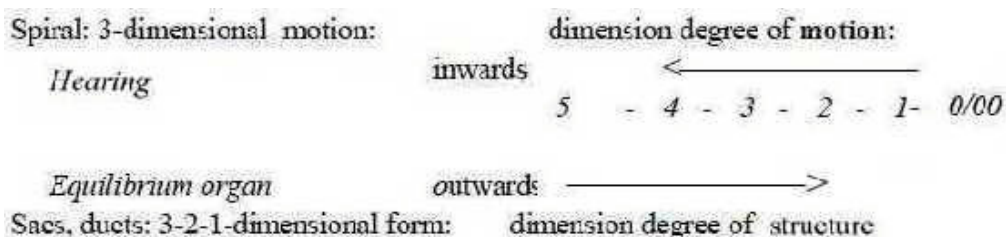


Fig H-2-117-2

2. Number 3 in structure appears in cochlea too:

- Spiral turns - like shell of a mollusk - are nearly 3. In cross-section it gives number 5 in-out as 1-2-3-2-1.
- The auditory ossicles in middle ear are 3 in mammals (Reptiles have only 1 but already among ray-finned fishes one finds 3 small bones on each side of the 4 first vertebra that convey pressure changes from swim bladder to the labyrinth (Kz).
- The inner of cochlea tube becomes divided in 3 canals.

3. Cochlea and organ of equilibrium as one dimension chain:

In the spiraled tube of cochlea the anticentric canals with perilymph are those in which the pressure waves from outside are transmitted in - out. The middle, central canal with basilar membrane contains enclosed endolymph, the same as in the sacs of equilibrium organ.

Cochlea and organ of equilibrium are joined through the mentioned very small canal for endolymph from saccula to the middle canal of cochlea.

If we identify parts of the equilibrium organ as expressions of d-degree steps, saccula with step 5 \rightarrow 4, then the small connecting canal could be identified with the debranched degree in that step: hearing as derivative of static pressure formed by that debranched degree in opposite direction?

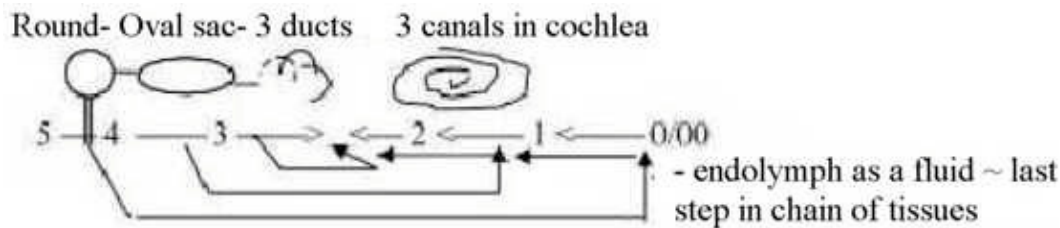


Fig H-3

Cochlea as from debranched d-degrees.

Figure above broken to positioning of right part straight above the left:

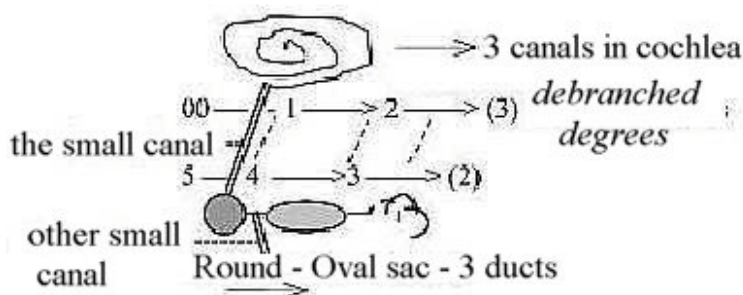


Fig H-4

Two other small canals connect endolymph and perilymph respectively to the brain:

- One departing from between saccula and utricle (as in step 4 \rightarrow 3, marked in the figure above) for *endolymph*, going to the *dura*, a layer near the space for CSF around it. (Cf. CSF departing as a side branch from 4th ventricle to circulation around the brain.)
- One, containing *perilymph*, departing from cochlea (? , divergent information in

sources), going parallel with the preceding one to the subarachnoid space between membranes of the brain, in closer contact with the CSF liquid.

The three canals seem to illustrate ramification (polarization) of degrees and join the two organs as to one dimension chain.

If the ducts of equilibrium organ only contains perilymph (according to *Nfp. 396*) or, which seems more probable, in similarity with sacs and cochlea includes endolymph too as later illustrations show, is left here as an open question.

It seems possible also to describe the opposition between the two organs in terms of centric - antcentric lymph:

- It's motions of the centric endolymph that directly activate the hair cells in organ of equilibrium.
- It's pressure waves in the antcentric perilymph that Via a membrane effect the endolymph and hair cells in cochlea.

4. Oval - round window and upper - lower canals:

Pressure waves from tympanic membrane are conducted to the *oval* window into perilymph, upper canal. Through a small hole in apex of the cochlea the pressure can turn to outward direction in perilymph in lower canal and to the *round* window.

Here is once again the polarity between round and oval forms, as a step of polarization one to two focal points, connected with the polarity outward - inward direction (and ultimately with 0-00-poles):

- ac - oval window →> inward direction - upper canal.
- c - round window ←← outward direction - lower canal.

"Upper" versus "lower" as between distal versus ventral sides in the whole nervous system. This latter polarity is defined through the features of the middle canal:

- basilar membrane with hair cells on the wall to lower canal,
- the flap of a membrane (tectorial membrane) that lies over the hairs and affect these from the wall to upper canal.

5. Cochlea as illustration of forces:

a. It's the difference between the pressure forces *inwards* on the oval window and *outward* on the round window that decides the effect on the receptor cells in the middle canal (*AM*), hence a kind of derivative.

Suppose that we associate the force in pressure (F/m^2) inwards on the oval window as derived from gravitation (**F_G**) and the opposite direction of pressure outwards on the round window as derived from the outward acceleration **force (F_A)**. The change of directions inwards - outwards in the small hole at apex of cochlea have the character of a "pole exchange", presumed occurring in last d-degree 0/00, equivalent with 5' in the dimension mode. (Cf. what happens in the "bottom" of black holes!)

From apex an d-degree 0/00 of motions the growing spiral of cochlea illustrates the substantiated 4-dimensional motion assumed in the model of a linear 1-dimensional structure.

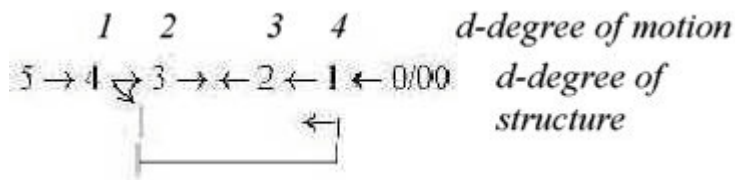


Fig H-5

b. Association to magnetic fields - and d-degree of motions:

The whole cochlea along the length axis gives in cross-section the picture of anticentric motion of canals and pressure waves around the central axis with its nerve fibers from the hair cells.

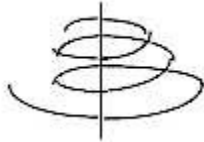


Fig H-6-118-1

It reminds also of the magnetic field around an electric cable. In files about **forces** and **electromagnetic waves** the magnetic factor is suggested as "the son of" gravitation in the following d-degree step 3 - 2. (FG as one of the two forces in d-degree 4 and step 4 → 3.)

Then, a magnetic field around the electric nerve fibers could be partly responsible for the structure of cochlea?

However, the graded radii of circles demonstrate simultaneously what we in file about **motions** have suggested as a 4-dimensional motion in d-degree 1 as "pumping".

6. Two gradients:

The form of the bony cochlea, from the outer broad base towards its inner apex corresponds to inward direction from anticenter to center, 00 → 0. The basilar membrane with hair cells in its middle canal has the opposite structure: most narrow at the broad entrance of cochlea, widening toward its inner, narrow apex as direction 0 → 00. It gives the principle structure of two opposite gradients in each other:

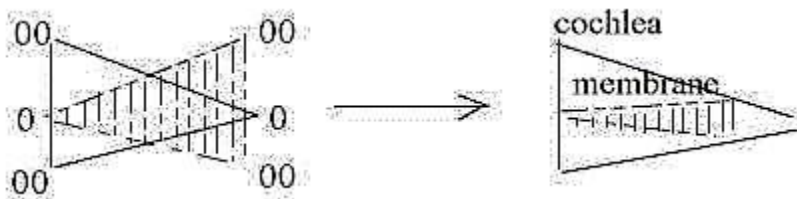


Fig H-7-117-3

Breadth of the basilar membrane furthest out in relation to furthest in is $1/5 (Nf)$ - which perhaps could be seen as expression for relations in a dimension chain?

The construction feels odd* with regard to space but reveals and underlines the clear, complementary polarity of type center — anticenter, receptor structure versus the surrounding bony cochlea..

* (Is explained by the smaller size of central axis nearer apex.)

The figure of gradients could be compared with directions in the **production** of lymph, fluids in opposition to structures a phase relation of the type 00 to 0:

- The endolymph is produced and secreted by specialized cells in the middle canal of cochlea (*Aph p. 578*): hence in direction inwards with the dimensional interpretation above, from organ of hearing to that of equilibrium.

- Perilymph has the similar content as CSF and it would be logical to presume that it derives from the other end, outwards, perhaps from CSF in the brain? (No information available.)

It should imply opposite directions of currents in accordance with the c-ac polarity but as motions of fluids reversed in directions in relation to structures of the organs.

A similar reversal appears in relative **charge** compared with the inner of a cell and its extracellular environment: Central endolymph is positive (+80 mV) in relation to the anticentric perilymph. It doesn't depend on the ion balance; endolymph as central contains much K⁺ as the inner of cells, perilymph much Na⁺ as the fluid outside cells, but here it's the perilymph that contains most proteins, responsible for most negative charge within cells.

Both these reversals could be regarded as results of the opposite directions in the structure according to the suggested interpretation - and most likely as phenomena on different levels.

From the picture of two gradients it follows that basilar membrane with divergence inwards has its origin at anticenter of the body. Generally, receptor cells represent the inward direction in the main polarization of the nervous system in the sensory - motor pathways, thus could be said to have their starting point as 0-pole furthest out at the surface. (They derive obviously also like the organ of equilibrium from the lateral line system of fishes.) In this sense the anticenter becomes built-in into center, the central, endolymph canal in cochlea.

The bony cochlea becomes the inverse, produced from inside out from temporal skull bone. Diverging outwards it encloses the basilar membrane and inner canals.

Such a feature of design, where tissue material from inside becomes anticentric to invaginating material from outside, recurs in several cases in **embryology** (*No. 10 c*).

The basilar membrane has its highest density as stiffness at its "0-pole", nearest the entrance, making it a gradient of density. Cf. "density" regarded as first physical property defined in d-degree step 5 → 4 in our model.

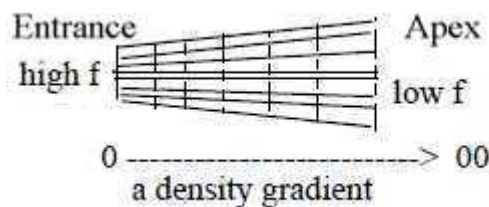


Fig H-8-121-2

Highest frequencies are registered nearest the entrance, the "0-pole" of membrane as gradient.. It's partly depending on the higher density of membrane here. Cf. EM-waves where higher, more energetic frequencies originate from center of an atom. Long wavelengths, lower frequencies reach their maxima further in towards apex where membrane are broader.

In musical terms we get the deepest "fundamental tones" at apex of the cochlea, the center of other gradient, its "overtones" further out in cochlea; in this apprehension in opposite direction from deeper levels to superposed. What's fundamental and depth must obviously here be seen as decided by the waves in perilymph, not the membrane in itself.

In agreement with this latter aspect, signals from apex (lower tones) are registered by centers in the brain at the *ventral* side, signals of higher frequencies from the entrance at *distal* side, sides corresponding to 0- versus ∞-poles in the embryo (*Nf p. 409*).

7. Arrangement of hair cells:

The arrangement of hair cells on the basilar membrane seems to reflect the construction of the whole cochlea: 3 outer rows of hair cells, with cilia in V- or W-form turned inwards the central axis, as mirroring the 3 spiraled canals, and one inner, linear row of cells with linearly arranged cilia along the central axis with ganglions and nerve fibers. In cross-section of the cochlea it appears as one version of the radial / circular poles 3b-3a in the dimension model.

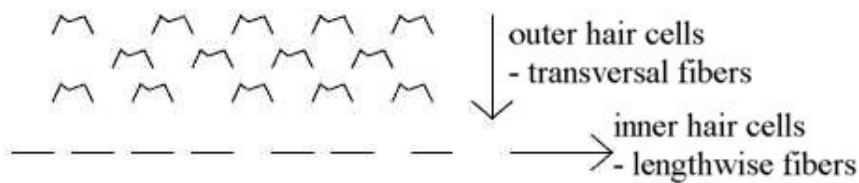


Fig H-9-119-1

Cilia, the "hairs", of the outer cells are also arranged in 3 rows on each cell, in 2 rows on inner row of cells. Number of cilia on each of the outer 3 rows is about 100, on inner row about the half, a relation $\sim 2/1$ (*Nf p. 398*).

Outer hair cells are more sensitive to motions inwards the central axis, the inner ones more sensitive to lengthwise motions along the axis (*Nf p. 399*): another expression for the same geometry.

There are also nerve fibers of two kinds, transversal ones from outer to inner cells and to the central axis, and lengthwise spiraling ones.

The polarity center - anticenter is expressed in many ways.

- It seems as if the outer hair cells "activate" the inner ones (*AM*), if so just as well as it is the pressure waves in antientric canals that activate all hair cells. It should be logical with the sensory nervous system as inward direction and anticenter pole as the polarizing force in our model.

- A further example is the polarity converging - diverging signals in the coupling of nerve fibers: signals from about 10 outer hair cells converge to one nerve fiber (convergence from anticenter), and the signal from each inner hair cell is spread to about 20 afferent nerve fibers (*Nf p. 402*), i.e. diverge. (Divergence from a center pole.)

These relations should imply that outer rows of cells summarize impulses over a broader part of the basilar membrane and that it chiefly is the inner ("linear") row of cells that discriminate between frequencies in sounds.

It looks like the polarity in every nerve cell is transformed to this whole multicellular system: amplitude modulation (summarizing) of incoming signals and frequency modulation of outgoing signals: principally perpendicular entities.

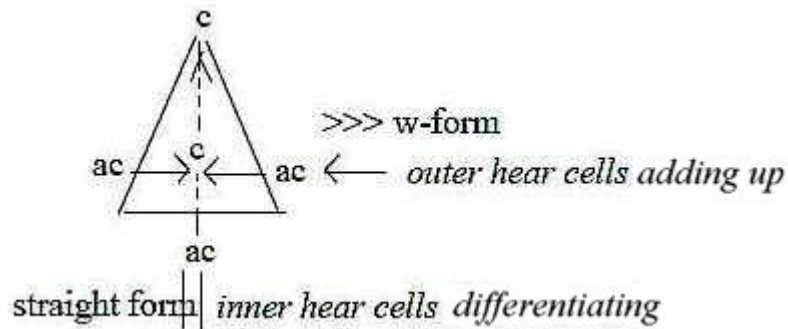


Fig H-10-119-2

8. Wave forms:

Frequency and amplitude as complementary energy forms become translated in different ways in the pressure waves and basilar membrane:

Higher amplitudes increase the bandwidth (~ lengthwise) of frequencies, however most for high frequencies (*Nf p. 408*). Low amplitudes give more narrow maxima. It could illustrate the principally perpendicular relation between these forms of energy as between circular and radial poles out of d-degree 3, originating from anticenter and center respectively in our model.

An illustration of the principle:

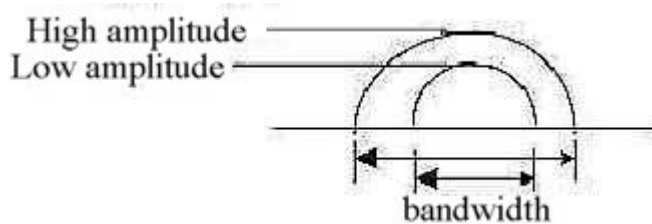


Fig H-11-121-4

The increase in bandwidth at high amplitude of sounds and the inverse at low sounds could be compared with the relation between high and low temperature, another form of energy that seems analogous:

High temperature (to compare with high amplitudes of sound) corresponds to great spread of particle velocities, low temperature to more equal velocities of the particles. Principally it gives heat and cold as properties at straight angle to one another:

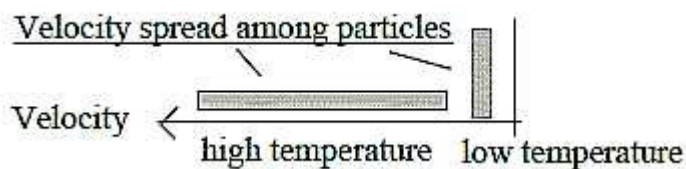


Fig H-12-122-1:

As mentioned above, density (~ stiffness) as a factor behind the frequency distribution on the basilar membrane is in the dimension model proposed as first "physical quality" defined in d-degree step 5 - 4. Temperature as motion of quanta is as "physical quantity" defined in last step 1 - 0/00. A correspondence seems natural with the loop version of the model in mind.

About frequencies (f), there is the other polarity between high and low f :

- Long sound waves (low f) have long rise times, i.e. reach their maxima further in, nearer apex, but have steep, short fall times.

- For short waves (high f) it is the reverse: short rise times, longer fall times. (High f at the entrance = "0-pole" of basilar membrane.)

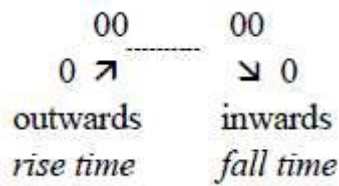


Fig H-13-122-2

Rise and fall times correspond in this way with the main direction of basilar membrane in the illustration of gradients above.

9. Inhibition.

Inhibition of the lateral type between receptor cells isn't found in the cochlea. There are instead efferent nerve pathways from higher nuclear centers in the brain whose axons have synapses with the hair cells. (It seems to imply that hearing is an active, discriminating process!) This "antiparallel" inhibition from higher centers could in terms of the dimension model show hearing as a sense of higher d-degree than for instance sight with lateral inhibiting cell layers - or just on hearing as a later sense in the history of evolution, geometrically less developed?

Inhibiting nerve fibers from higher centers go to the outer rows of hair cells (*TA p. 88*), whose activation of inner row of cells consequently should be hampered. If so, an example of indirect inhibition in two steps, inwards in a level chain:

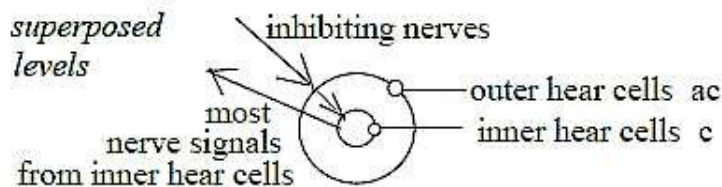


Fig H-14-120-2

In the sensory system as inward directed, the outward directed activity from inside, (fundamentally associated with the motor system), thus becomes inhibiting. In its function also serving contrast:

Activation through these efferent pathways on tones just above or under a certain tone can have inhibitory effect on the frequency of this tone (*AM-Hf*), in this sense an indirect "lateral" inhibition between receptors.

Certain cells in cochlear nuclei are inhibited by tones with frequencies on both sides of its own frequency, other cells only by frequencies on one side, above or under its own (*Nf p. 410*), a differentiation corresponding to further polarizations and increasing "one-way-direction". (Cf. similar polarizations among on-off-cells of ganglia in retina.)

(Hearing impairments often occur $\frac{1}{2}$ - 1 octave above the frequency of the injurious sound but can also spread to lower frequency areas (*AM-Mb*). Thus, it becomes a natural question if such injuries depend on too strong (killing) inhibiting activity from inner, higher centers (?).

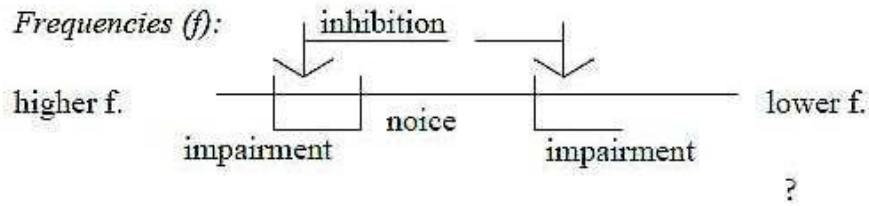


Fig H-15-121-1)

Another observation is that signal answers from hair cells depend on velocity of changes in stimulating tone frequencies. Fast changes give higher, narrower spikes, more distinct discrimination of frequencies (*Nf p. 412*) in cells of higher centers (nucleus cochlearis). It shows on their property as derivatives, developed in many senses, one feature that reveals d-degree steps - as in mathematics. (Velocity tentatively presumed in the model here as the physical entity for the very d-degree steps, distance/time.)

10. Number of hair cells and nerve fibers:

Data vary but one reference says hair cells in a human ear are ca. 15000, nerve fibers from cochlea 25000 - 30.000 (*Nf p. 398, 400*), thus up to twice the number of cells. (Ca. 12000 in outer rows, 3000 in inner row, a relation 4 to 1 - or 4 to 3 in individual rows of cells.) The number of cells happen to be $\sim 10^3$ times the sum of a dimension chain, number of nerve fibers sum of the poles in this chain:

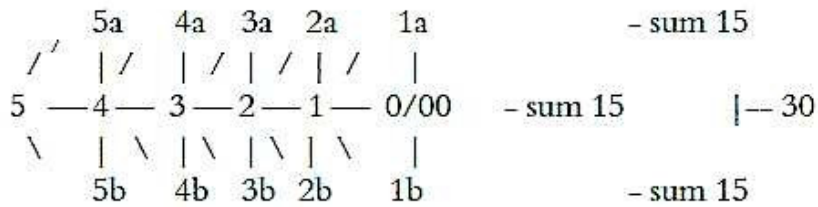


Fig H-16-120-1

BRAIN AND ITS MENTAL FUNCTIONS

- some annotations -

Sleep / Wakefulness - Consciousness - Memory - Left / right hemispheres.

1. Sleep - Wakefulness:

Sleep - wakefulness are expressions for living individuals' double roles:

During sleep an individual has the role as a relative whole in itself. Awake it has a role as a part of the entire whole.

Awake, as part of the whole, she represents center - the 0-pole (half of Universe) - in relation to the surrounding world as anticenter - the 00-pole (the other half) - and is consequently fundamentally outward directed. While sleep is characterized by internal double-direction outwards $\langle====\rangle$ inwards. With this aspect it becomes natural that sleep also includes internal activity.

The outward directed component during sleep is evident from the fact the sleep is actively governed from deep centers in the brain stem, mainly from pons (*Mf*).

Simultaneously, sleep is the result of active inhibition from higher levels, hence characterized by inward direction. The epiphysis dorsally (~ 00-pole) produces sleep hormones as melatonin and different types of sleep phases can be triggered from areas on higher levels in diencephalon and cerebral cortex (*Nf*).

From the CSF fluid, which surrounds the brain in ventricles and around cortex, substances that trigger sleep are secreted inwards the brain, for instance γ -hydroxybuturate (*Nfp*. 337).

These cavities for CSF fluid are originally the primary surrounding of an embryo = anticenter, which get built-in through the invagination of the neural tube. The internal secretion too becomes an expression for the component of inward direction in sleep.

The role of an individual as a relative whole entity in itself and two-way directed leads to internal polarizations - (as a 5-dimensional unit in the dimension model here implies polarizations to a dimension chain).

The main polarization appears as the one between orthodox (non-REM, NREM) sleep and paradoxical REM sleep, (REM for rapid eye movements), during which most dreaming occurs.

Number of periodic changes between the two kinds of sleep is said to be about 4 - 6, which could have connection with number of steps in a dimension chain.

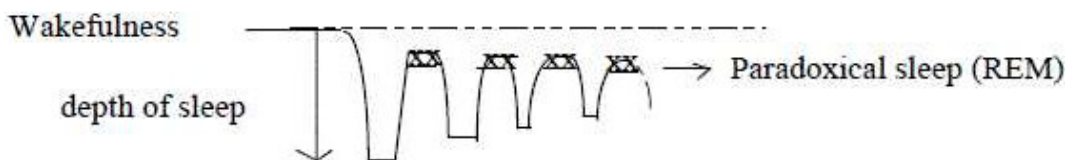


Fig BM-1-133-1

This connection seems supported by later research according to Wikipedia, "Sleep" and a figure (319px-Sleep_Hypnogram_svg-Wikipedia.jpg) from this source:

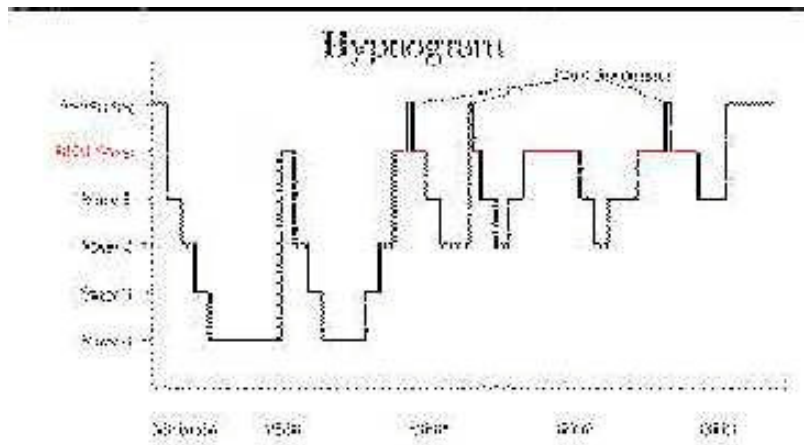


Fig BM-2-319px

Note the stepwise decreasing depth of NREM sleep towards more superficial levels as towards lower dimension degrees (d-degrees), besides the steps between REM and NREM sleep.

Adult humans sleep about 1/3 of the 24 hours: cf. the sleeping individual as a whole (d-degree 5 ~ 0/00) in itself !

(However, elephants sleep only ~ 3 hours.)

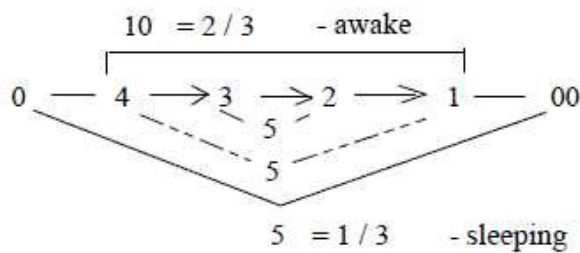


Fig BM-3-134-2

According to older data (*Mf 1979*) about 4/5 of sleep time is of the orthodox NREM type, 1/5 of the REM-type in average.* For newborn babies the quotient can be 50/50.

*(Hardly agreeing with the figure from Wikipedia above?)

Several features make it possible to interpret the two types of sleep as expressions for inward versus outward direction as shown with the arrows in the figure below;

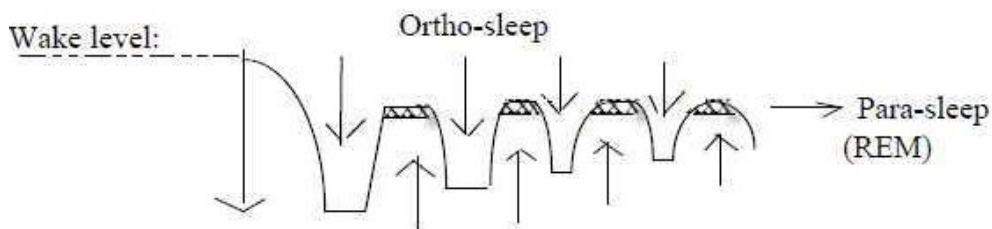


Fig BM-4-134-3

- Stimulation in thalamus gives orthodox sleep, stimulation of a center in pons, a deeper level, triggers paradoxical sleep (*Nf p. 333*). One could imagine that it should be the opposite, deeper center in the brain giving a deeper sleep, but with arrows for directions it seems to make sense. Cf. the **reticular system ARAS** in the brainstem.

thalamus ↓ ortho-sleep - inward direction → parasympathetic nervous system
 pons ↑ para-sleep - outward direction → sympathetic nervous reactions

Fig BM-5-134-4

- Orthodox sleep is characterized by a domination of activity in the parasympathetic nervous system: a decrease of blood pressure, increasing activity in intestines etc., thus by the inward direction of the autonomous nervous system (ANS). While paradoxical sleep is characterized by increasing activity in the sympathetic nervous system, the outward direction of ANS, increasing blood pressure and pulse frequency etc. (*LEL*).

- The activity in visual cortex increases during REM sleep with its rapid eye movements, as expression for the direction outwards, upwards the dorsal lobe of cortex, with answers as the visual pictures of dreams.

- It may appear a bit curious that muscle tonus are blocked or effectively lowered during paradoxical sleep, in spite of general muscle activation being a function of the sympathetic nervous system.

Yet, real muscle activity concerns outer environment, and also sensory impressions from outside are suppressed.* It obviously underlines that the polarization between ortho- and para-sleep concerns the autonomous system, the inner milieu, the individual as "autonomous" in the sense of a whole in itself. (A "nuclear power plant" during reparation.)

- That persons are more difficult to awake during paradoxical REM sleep than during orthodox NREM sleep may seem just 'paradoxical' but shows on the simultaneous suppression of sensory signals from outer world during sleep.

During REM phases a person can be said to exist under and inside the curve in the figure above as under a barrier, during orthodox sleep outside it and without obstacles to the surface of wakefulness. (Besides that the person is already fully occupied in its inner dreams. Dreams as mental reparations?)

What would the curve as a barrier, defined by the opposite directions, then represent? Perhaps something like the potential barrier around an atomic nucleus?

- That different hormones give (or are involved in?) the two types of sleep is a further indication on their polarity.

- Old individuals can lose the paradoxical REM sleep (*LEL*). A possible explanation is that aging often implies that the force from inside (arrows upwards in the figure) grows weaker. The identity becomes more dependent on what is given from outside, the created, surrounding milieu as of memories in backward direction of time. It agrees with the findings that small children sleep more REM-sleep than adults.

EEG waves:

Scientists differentiate simplified between 5 general types of EEG waves from conscious integrating patterns to deeper NREM sleep:

Gamma waves, ~ 30 - 100 Hz — conscious, integrating patterns,

Beta waves, ~ 12 - 30 Hz — normal, concentrated wakefulness,

Alpha waves, ~ 8 - 12 Hz — relaxed wakefulness with closed eyes,

Theta waves, 4 - 7 Hz — drowsiness, transient stages I and II in sleep, more in children

Slow wave sleep, Delta waves, (1) — 4 Hz.

(Numbers from http://en.wikipedia.org/wiki/Electroencephalography#Wave_patterns)

Delta waves have generally the highest amplitudes. The steps correspond very roughly as it seems to a transition from higher amplitudes to higher frequencies. An increase of the amplitude is seen as a decrease in frequency (*Mf*).

The pattern is thus in compliance with the general system for nerve signals: the opposition between amplitude modulation in inward direction to the cells, frequency modulation in outward direction. Inwards towards deeper NREM sleep (as arrows in the figure above) and outwards as towards wakefulness.

2. Wakefulness - Consciousness:

The (A)RAS system in the brain stem (in upper part of the reticular system) activates all parts of cerebral cortex, and the unspecific projections from thalamus leads to general wakefulness. Hence, wakefulness can be described as radial divergence from deep inner centers.

It may be remembered in this context what has been mentioned about "**will**", psychologically often apprehended as a governing force from "above", from higher centers. Will-governed motions however cannot be triggered by electric stimulation in cortex. Activity in deeper centers is involved.

However, *wakefulness* is not the same as consciousness. A person can be awake even without a cerebral cortex (*Nf*)! Consciousness demands in the first place undamaged deeper centers but also these in interaction with a cortex. "Probably" participation of both ARAS and thalamus as well as of cerebral cortex (*Mf*).

If the basis for what usually has been meant with "*consciousness*" is the meeting or interaction of the opposite poles 0 and 00 (as ARAS and anticentric cortex) and directions outwards → ← inwards, consciousness could perhaps be described as a "rebound in cortex", of "reflection", as light bounces from a mirror.

Compare in the development of an embryo when the top of invaginated archenteron from vegetative pole reaches the animal pole and this induces the invagination of a neural tube.

Elementary emotions as pain and its opposite: anguish (as a fear for a threatening pain, cf. anguish to fall) have naturally influence on consciousness.

Physiologically pain turns off alpha waves, gives beta waves corresponding to attention, characterized by outward direction..

Anguish seems to block neural connections and integration and mentally imply repression, and inhibition, hence constrict consciousness. (Anguish seems to give a big disorder in normal EEG-patterns, no closer information available in here used sources.)

If pain can be described as a lack of adequate answer from outside, anguish becomes the expression for an unanswered inward direction as the lack of supporting ground in the fear to fall. (Referring here to a book in Swedish: "*The I and the Ego. Psycho-geometry*".)

Both these emotions concerns self-preservation, the individual as a whole in itself, but pain its outward direction, anguish its inward direction in terms of the dimension model.

Cortex sends impulses downwards to the reticular formation in the brain stem and can thus exert an influence on its own activity. (It has probably an impact on which psychological sense a certain stimulation has (*LEL p. 199*). Cf. blocking of incoming signals in stages of potential anguish.

For a person in the role of part in the entirety, only a 0-pole, a state of wakefulness, the real anticenter isn't the cortex as during sleep but the surrounding world. Consciousness can be assumed to grow through responses from this outer world - as answers on the person's own activity from "0-pole" - and thus be a question of a gradual development.

The word con-sciousness (from Latin) means with - know(ledge). The answer from outside gives the word with = con.

Consciousness in the psychological sense surely grows through increasing interaction and connections between neurons in the brain, but the brain develops through double-direction and presupposes an active, localized center.

It's shown that the activity in the brain during drowsiness on the way to sleep doesn't disappear but gets disintegrated, more randomly spread, while wakefulness or physiological "consciousness" gives integrated patterns. This in agreement with the dimension model where the force from 0-pole is defined as the integrating one, the force from 00-pole as the disintegrating one.

Besides the physiological and psychological purport of the word consciousness, it cannot be excluded that there is a knowledge without the prefix with = con, as an "inner eye", capable of getting all the inner knowledge from depths of the own body structures, atoms and history. Even during "wakefulness" without a cortex, although without its transformations into identifying symbols and signs.

"Awareness" is another sense of "consciousness" and could be described as a special part of knowledge, integrated in the total activity of a conscious brain.

3. Memory:

Centers for creation of long-term memories are situated in areas around the 3rd ventricle, hippocampus and amygdaloid body that are parts of the limbic system. It's areas that also are connected with centers for elementary emotions.

Memories belong to passed times, the time direction inwards, as the limbic system is inwards from cortex. Storage of these long-term memories occurs however in cortex.

Human experiences indicate that a free access to one's memories demand a position "inside" the memories, a not blocked center.

It's surely a rather common experience that one fails a forgotten name or other such special details when trying to reach the memory as from outside - inwards, from a detailed verbal and sensory level, while the memory pops up later during a relaxed, less concentrated level; psychologically from an underlying level that awakes a bigger association area. It implies that the memories exist in outward direction from the I in the same sense that storeroom shelves surround a storeroom manager. Compare repression of bad memories.

Hence, these mechanisms seem to indicate that involvement of deeper centers in the brain is necessary for memory as well as for consciousness.

Principally, it may be presumed as a fundamental principle that *wider* areas of cortex, including association areas, are integrated from deeper levels in the brain than from more superficial ones, illustrated by the gradient funnel below:

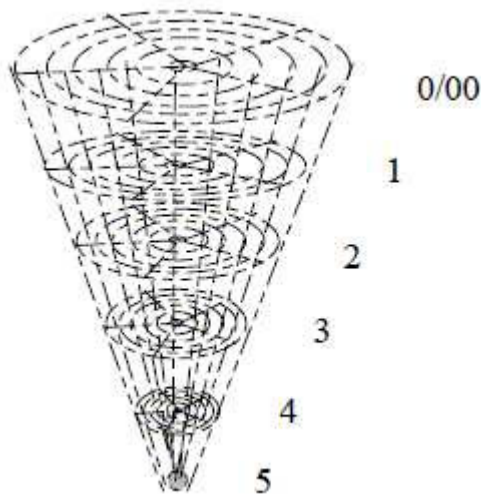


Fig BM-6-114-3

4. Right - Left hemispheres of the brain:

3rd coordinate axes of the body, the right-left one, may probably be regarded as bilateral symmetric at first stages of the embryonic development, but several asymmetric features develop later along this axis too: in the transverse aortic arch and which side, the right (in birds) and the left in humans (*Kz*) that become the big aorta. Further the asymmetric positions of heart, liver and spleen for instance.

The differentiations between the cerebral hemispheres become an expression of this polarization - with character of complementarity, both in size and in functions.

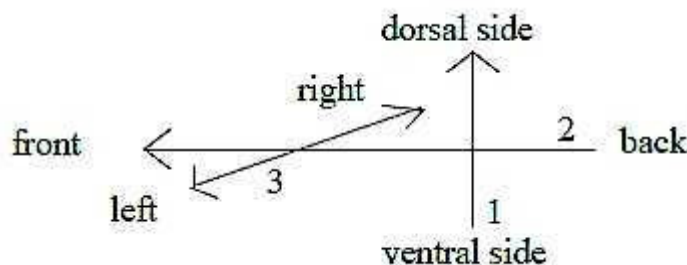


Fig BM-7-137-1

- Spatial apprehension, understanding of 3-dimensional relations - and of emotional content in conversations - are among the functions that have been attributed to the right hemisphere.

- Reading, writing, speech and "mathematical calculation" are functions (and centers) most often localized to the left hemisphere.

A more appropriate and general description has been said to be that right hemisphere (usually) is responsible for comprehensive apprehension, the left hemisphere for analytic functions.

Translated to a dimension chain:

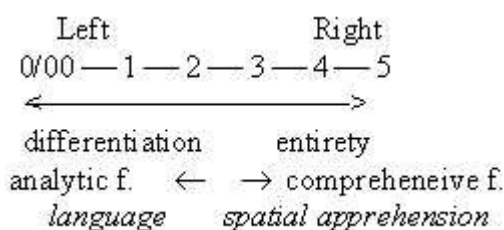


Fig BM-8-137-2

We may note that reading, writing and speech (and some types of mathematics and so called "logic") demand an ability to linear, 1-dimensional functions, which demands ability for transitions from higher d-degrees, as from 3- to 2-dimensional pictures for instance.

The fundamental double-direction is revealed in many common transpositions of letters.

It has been said that right hemisphere only can count to 20, that's 5 x 4, first steps in a dimension chain.

Impact of left and right halves of the brain on the function of the other half?

According to the dimension model the differentiation should also be a question of directions as marked in the figure above. Which influence could the centers in right hemisphere and a force as direction "outwards" from these towards the left hemisphere have on the development of speech and other "linear" abilities. (Analysis as equivalent with dissolution of factors.) And vice versa; a force from left centers "inwards" on the right hemisphere? (A synthesizing factor.) Can they be regarded as two gradients in each other:

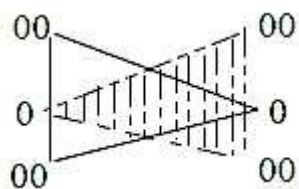


Fig BM-9-117-3

It's left as an open question here if such an interpretation agrees with other findings, for instance from persons with only one hemisphere or where a person has got the connection between the hemispheres cut off. Such a connection for the mutual interplay between directions must in those cases have existed earlier in development of the brain or occur through deeper, underlying levels in diencephalon or brain stem.

The interpretation of right hemisphere as "the inner pole", the left one as "the outer" pole in a relation of the type 0 — 00 does agree with a theory that left hemisphere hampers emotions that arouse from right hemisphere. In the same way as elementary emotions have centers on inner levels as in the limbic system, and cortex to a big extent represent inhibiting impulses, it sounds natural that emotions should originate in direction from the "inner" right hemisphere and psychological, inhibiting impulses from the "outer" left hemisphere in its secondary role as anticenter.

Left-handed people make up about 9 % of all in our days and are said to have grown in number. It could assumably depend on less authoritarian societies, less suppression, more liberation of emotions - in opposition to the old, in language established opinion that right hand is "recht" (German), "right" as opposite to wrong (in western cultures at least).

Cf. too in the world of etiquette the position of a man at left side of a woman and the old conception (or demand) that man is the representative of reason and logic, the woman of feelings.

END