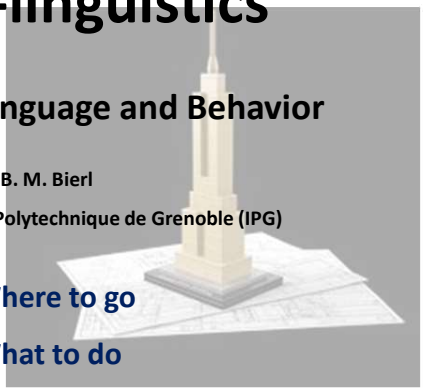
Think big !

Neuro-linguistics

Go west !



Research on Language and Behavior

B. M. Bierl

Docteur de l'Institut Polytechnique de Grenoble (IPG)

1. Where to go
2. What to do
3. What to avoid

Source: Google images

Number of angles on a needle tip*

Theology ⟷ **Philosophy** ⟶ **Philosophy of Nature**

doctor angelicus — subtleness of late scholastic logic, > 1250 AD — Science without God: **'plain' science**

Thomas Aquinas

Holy Scriptures & Greek Philosophers

doctor subtilis — ***doctor invicibilis***

John Duns Scotus

William of Ockham

'scientific' behaviorism
cognitive science
behavioral 'bio-psychology'

Literature — **Transformational Grammar** ⟷ **Language & Literature**
Universal Grammar

*Christian Morgenstern
Euclidian vs. non- Euclidian geometries

May poetry once be generated from machines ?

And holding by the stalk,
I listened and I thought I caught the word –
What was it? Did you call me by my name?
Or did you say –

Robert Frost (**1916**) : The Telephone

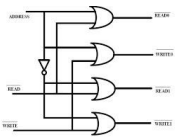
1

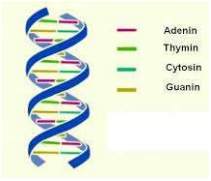
alternative 'Turing' test

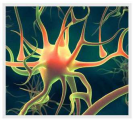
''RAVISHING POETRY BEING NONSENSE''

Layered architecture

```
C COMPUTE POSITIVE ROOT OF A
C QUADRATIC EQUATION
      READ INPUT TAPE 3, 201, A, B, C
  201 FORMAT (3I5)
      IF (A) 300,400,400
  300 STOP 1
  400 R=-B+SQRT(B*B-4*A*C)/(2*A)
      WRITE OUTPUT TAPE 4, 501, R
  501 FORMAT (F5.3)
      STOP
      END
```







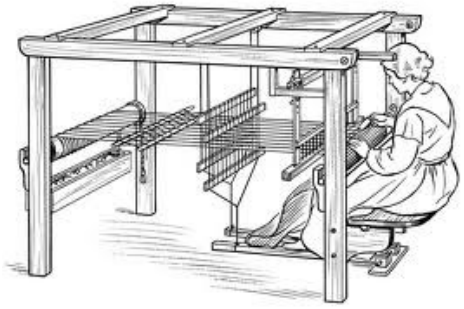
static

(100-)years

(milli-)seconds

Source: Google Images

Sir C. S. Sherrington (1857-1952): **The brain as a magic loom**



Source: Googleimages

2

about the magic loom producing mind

WHO'S SITTING AT THE LOOM ?

Three dialogues from G. Berkeley:

[Philonous] There is nothing such as matter. Everything exists only in the mind.

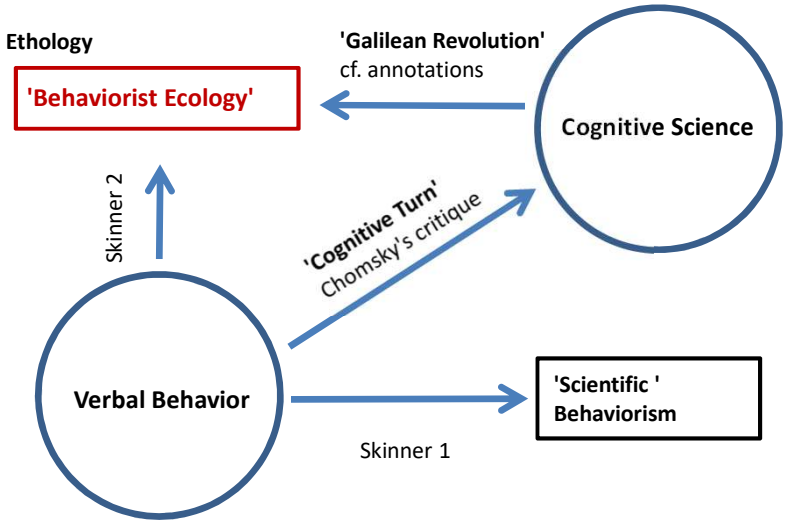
[Hylas] Imaginations and ideas rely on nothing else but inner or outer experience.*

1. How may matter produce ideas?
2. Doesn't the image correspond to the imaged?
3. Isn't the image of an idea also an idea?

<< esse est percipi >>

*based on Locke's Empiricism

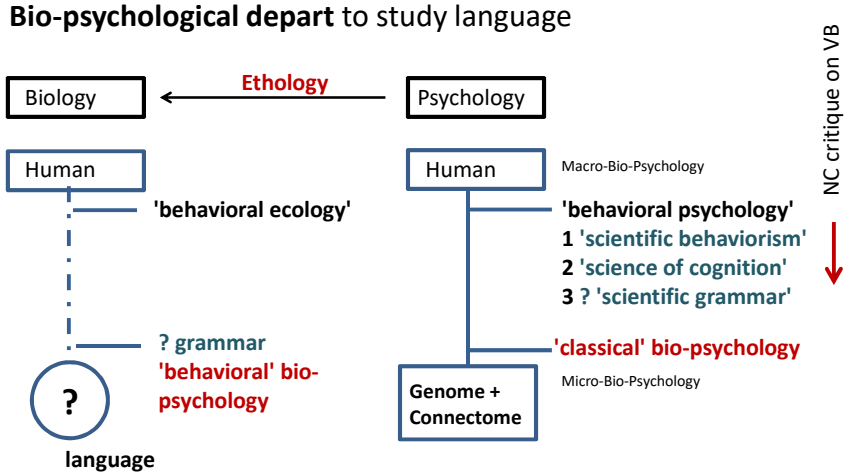
The 'ethologic turn'



''... [taken literally , Skinner] covers almost no aspect of verbal behavior, and [metaphorically], [ ] no improvement [ ].''

Chomsky's problem: behavioral ecological terms being more specific than those from cognitive science[1].

Bio-psychological depart to study language

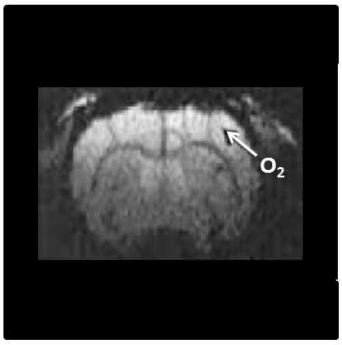


Methodology: preclinical UHF fMRI

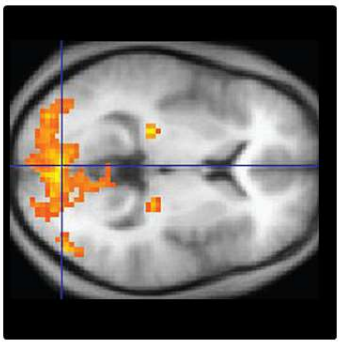
$(\omega - \gamma B) = 0$ Larmor eqn.

fMRI Signal

Rat brain: enhanced proliferation of oxygen leads to signal increase.

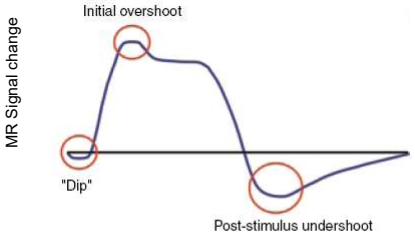


Human brain: yellow areas show increased activity.



BOLD-model: The 'brain (physiological) effect' + the 'vein (anatomical) effect'

Balloon model (Buxton 1998): The venous compartment is treated as a distensible balloon.



A typical BOLD response for a block design stimulus. Transients are an occasional brief initial dip at the beginning, an initial overshoot, and a prolonged post-stimulus undershoot.

$$\frac{dq}{dt} = \frac{1}{\tau_{\mathrm{MTT}}}\left[f(t)\frac{E(t)}{E_0} - \frac{q(t)}{v(t)}f_{\mathrm{out}}(v,t)\right]$$

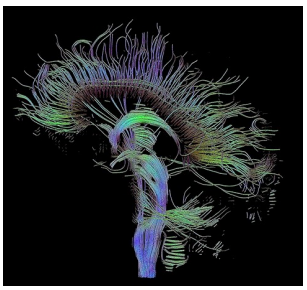
$$\frac{dv}{dt} = \frac{1}{\tau_{\mathrm{MTT}}}\left[f(t) - f_{\mathrm{out}}(v,t)\right]$$

$$E(f) = 1 - (1 - E_0)^{1/f}$$

Source: Edelman et al. (Eds.)

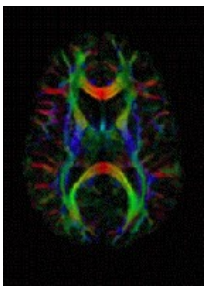
Imaging long-term changes in brain connectivity

$(\partial_t - \Delta)\,\varphi = 0$ A. Einstein
(E. Schrödinger BC\ϕ = 0)

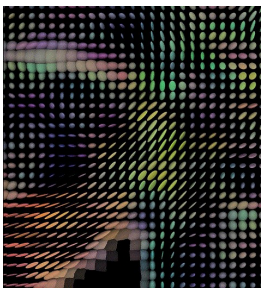


Tractographic reconstruction of neural connections via DTI.

DTI Color Map.



Visualization of DTI data with ellipsoids.



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3

about the different epistemological steps

HOW ARE THE EXPERIMENTS TO BE DESIGNED

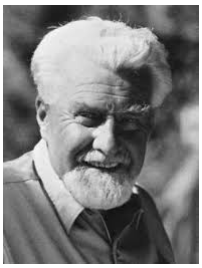
Eene distractie bij het invallen van den prikkel wordt altijd met verlenging van het proces gestraft.

F.C. Donders (1818-1889)

D.O. Hebb (1904-1985)

When an axon of cell A is near enough to excite cell B and (…) takes part in firing it, some growth process (…) takes place in one or both cells such that A's efficiency, (…) [in] firing B, is increased.

Irenäus Eibl-Eibesfeldt (*1928)



Konrad Lorenz (*1903-1989)

Eric Kandel (*1929)

Avram Noam Chomsky and Amy Goodman

From where to where to go

GB ⇒ Minimalist Program ⇒ ?

1981 NC Lectures — 1995 NC MP

Epistemologic turtle

Bertrand Russell (1872-1970)

?

- Mathematics
- Logical reasoning
- Linguistics
- Culture*

* A Compagnon to American Thought. Fox & Kloppenburg

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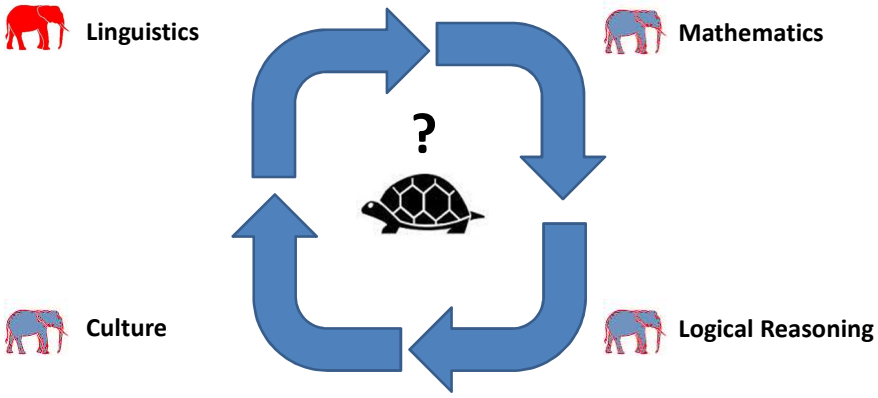
THE HERMENEUTIC CIRCLE



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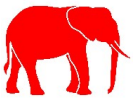
If language is a biologic organ, it can be studied based on behavioral biology.

Linguistics



? = Behavioral 'bio-psychology'

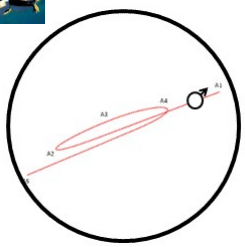
Verbal stimuli/ verbal operands			Acting as …
com	'mand': (com'mand')		'stim' trigger ('stim'ulus)
	echoic	behavior	'verbal' 4: ('verbal' style)
	textual	behavior	'verbal' 5
	intraverbal	behavior	'verbal' 6
con	'tact': (con'tact')		'stim' exposition
	audience		'stim' feedback

B.F. Skinner (1904-1990)

Example 1: Rocket control

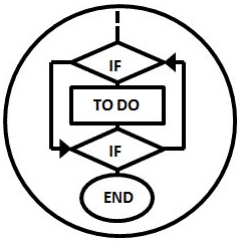
[1] behavioristic control:

Example of 'empirical' conduct. Not all internal parameters can be controlled.



[2] mentalistic control:

Example of a 'model' evoking some inner 'mental state' where conduct is based on, but barely 'task-oriented'.



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Example 2: Speaker being his own audience

[1] Speaker:

Broca's brain area of language production

Pierre P. Broca
(1824-1880)

[2] Audience:

Wernicke's brain area of language comprehension

Carl Wernicke
(1848-1905)

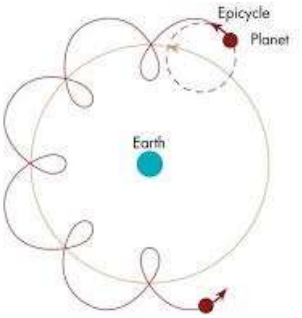
4

about weak reductionism

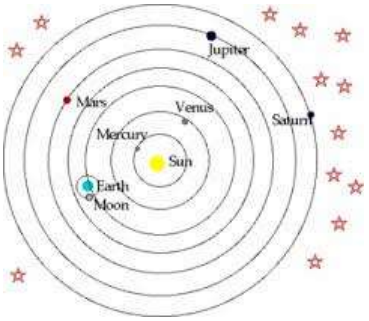
LITERAL VERSUS METHAPHORICAL REDUCTIONISM

Weak reductionism: Loss of unnecessary complexity

Ptolemais



Copernicus



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5

about critique on Chomsky's critique

CRITIQUE DOES NOT GRASP SKINNER'S WORK

From **Behaviorism** to **Cognitive Science**

	Skinner Setting	Enhanced Skinner Setting	Cognitive Setting
External parameters	bell food award timing … dog's training …	**'Verbal Behavior'** **'Universal Grammar'**	**'Cognitive Science'** **'Universal Grammar'**
Internal parameters	individual dog dog's breed … dog's training …	**'Verbal Behavior'** **'Universal Grammar'**	**'Cognitive Science'** **'Universal Grammar'**

I M R A D – document structure: Introduction, M&M, Results, and **Discussion**

Standard animal models for projects 1-6, 8 (6+1)

Nominalism	Empiricism	Cognitive Science
		
Words **Names**	**Perception** **Phrases**	**Memory** **Attention** **Behavior**

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Experimental Design Keywords

Perception	Structure	Function
Obstruction	Paradigm	Reinforcement
Occurrence	Stimulus	Response
Prediction	Language	Control

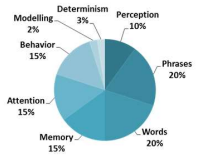
Underlined are the Skinnerian-specific controlling variables.

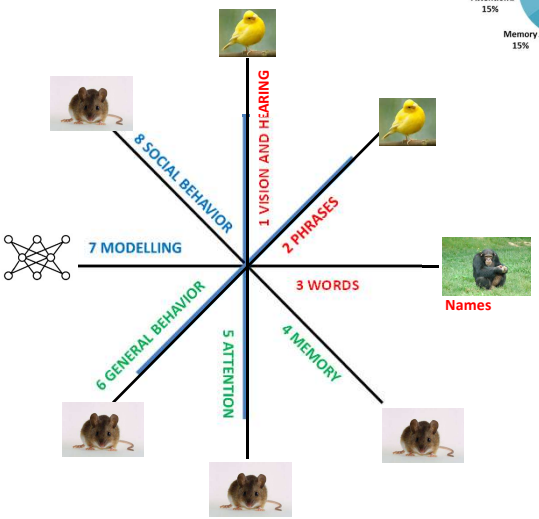
6

about the eight ways to study cognitive science

SKINNER'S 'GENERALIZATION' OF PLAIN BEHAVIORISM

Eight ways to study the cognitive turn



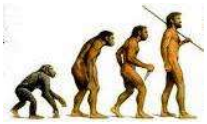


Project		Target region	Category	Method of Investigation	Object of interest
Perception		Cortex	Color, Shape	ICA	Brain regions
Phrases		Projection neurons	Melodies	ICA	Brain Regions
Words		Cortex	Words	Interaction with caregiver	Brain regions
Memory		Hippocampus	Orientation	Hippocampus size	Hippocampus
Attention		Cortex	Color, Shape	Brain activation	Brain regions
General Behavior		Frontal lobe	Orientation	Brain activation	Brain regions
Modeling		Architecture	Simulation	Neuronal Networks	Projects 1-6, 8
Social Behavior		Cortex	Orientation	Description	Determinism

7

about modeling Skinner's function

MODELING SKINNER'S FUNCTION AND COGNITIVE SCIENCE



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bell

food

Enhanced Skinner

Skinner

Project : 'Skinner Box' and 'Enhanced Skinner Box' Design

Tom 2 & Li
September 2015

Stimulus Response provided Response requested Reward

Experimental Design

Greek: αγάπη agape 'love'; όρνις ornis 'bird': Eight species are native to the African continent

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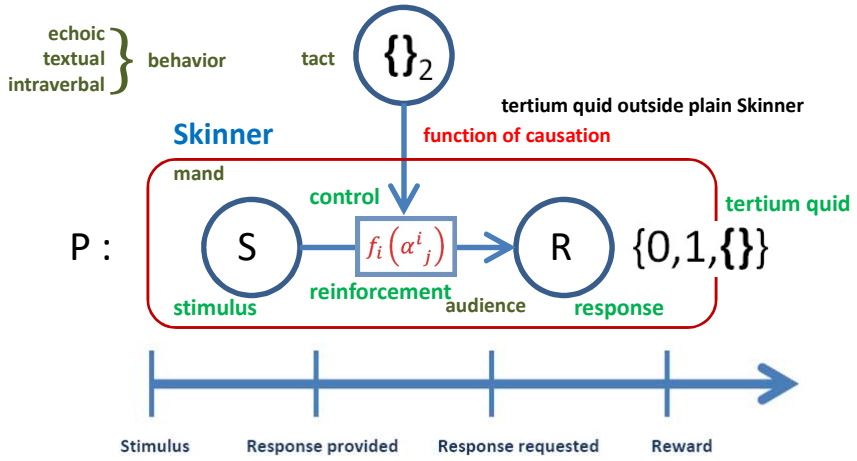
Enhanced Skinner: Functional multi-parametric multi-causation modeling.



Binary experimental design versus 'tertium quid' design:

binary logic	**{ 0, 1}**
tertium quid logic	**{ 0, 1, {}}**

fluid logic	**{} =]0, 1[**	
quantum logic	**{} = {0.2, 0.4, 0.6, 0.8}**	(example)
tracer logic	**{} = {{}1, {}2, {}3, …}**	

8

about the generalization of paradigms

MULTI CAUSATION BASED ON STIMULUS AND RESPONSE – THE STUDY OF BEHAVIORAL ECOLOGY

Tom 2 & Li, Brussels-Jette, September 2015

Much more than only …

… lovely birds

… angry birds

Empiricism

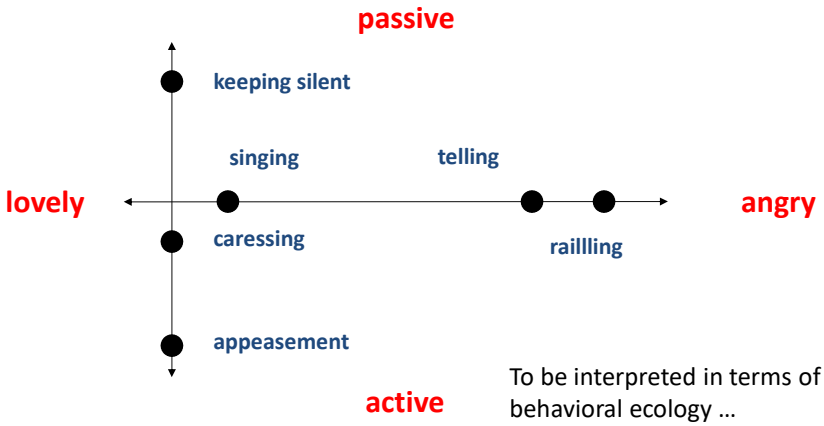
Home, family-oriented behavior study of everyday situation as for instance

Tom 2 & Li
September 2015

[0.0] Appeasement
[0.2] Caressing
[0.4] Keeping silent together
[0.6] Railing
[0.8] Singing together
[1.0] Telling s.o.

Experimental Design: mand, tact, audience, echoic, textual, intra-verbal operands that define the Experimental Design.

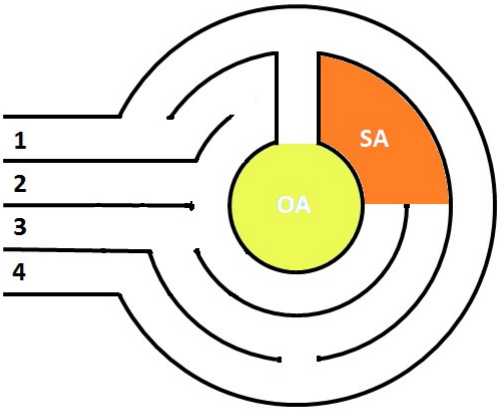
A 2D response to the Experimental Design could be:



To be interpreted in terms of behavioral ecology …

Cognition

Equal Area Labyrinth

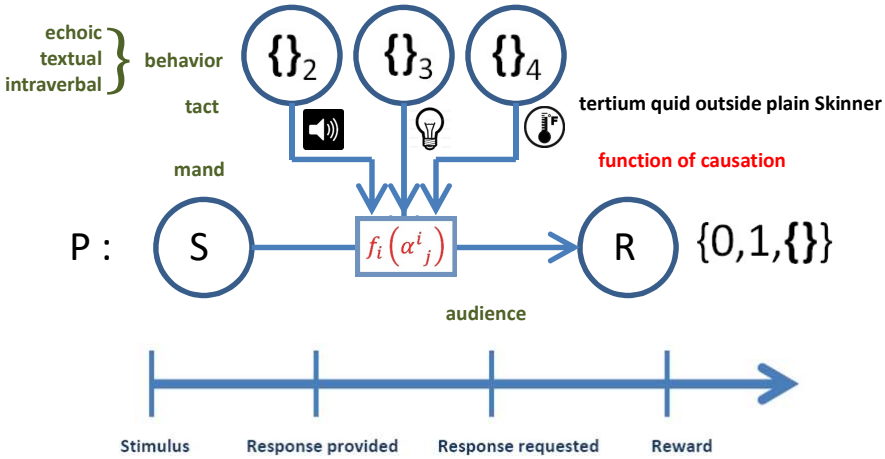


9

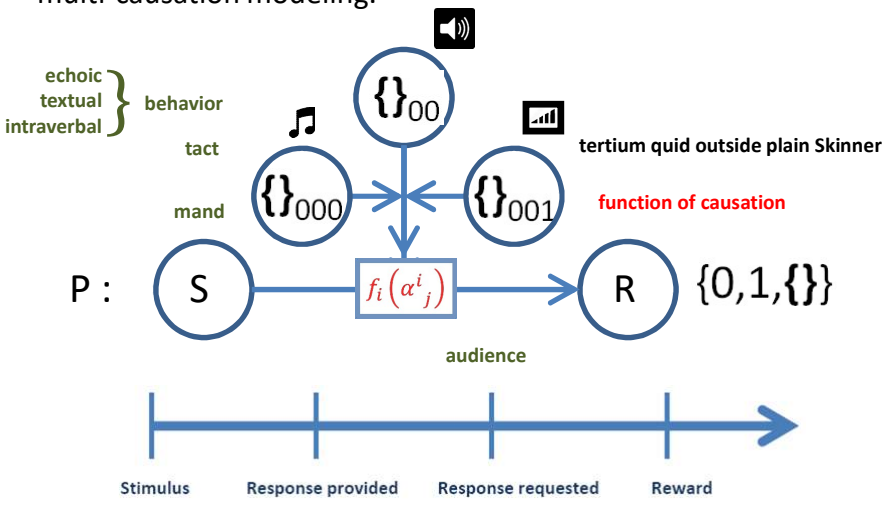
about the untangling of paradigms

SKINNER'S SETTING AND THE TERTIUM QUID

Enhanced Skinner: Functional multi-parametric multi-causation modeling.



Enhanced Skinner: Functional multi-parametric multi-causation modeling.



Example of how to design experimentally the 'tertium quid':

decision	distract from task	no distraction from task
Expected possible result – case '1' '**positive**'	Yes/No	Yes
Expected possible result – case '2' '**negative**'	Yes/No	No
Expected possible result – case '3' '**tertium** quid'	Yes/No	Yes/No

The 'task'-variable here would be some additional 'Skinnerian' control variable, realized for instance by **loud sound** or **bright light** on/ off (the 'tact') distracting the animals' decision during the task.

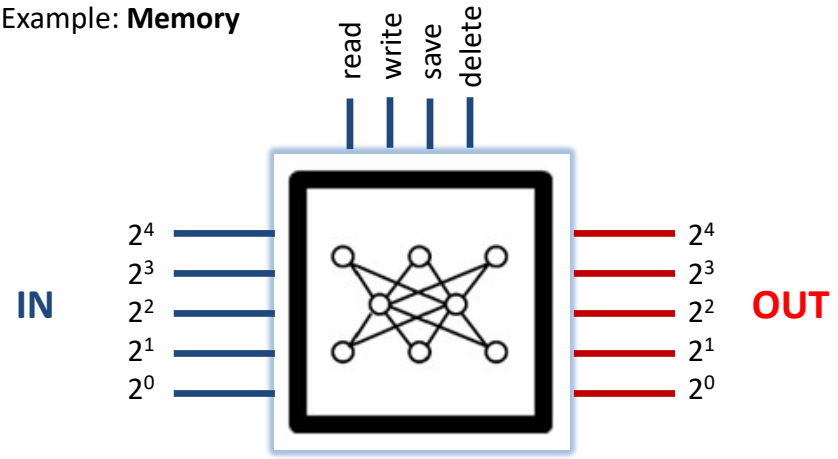
10

about the Kohonen network

MODELING CAUSATION BASED ON THE KOHONEN NETWORK

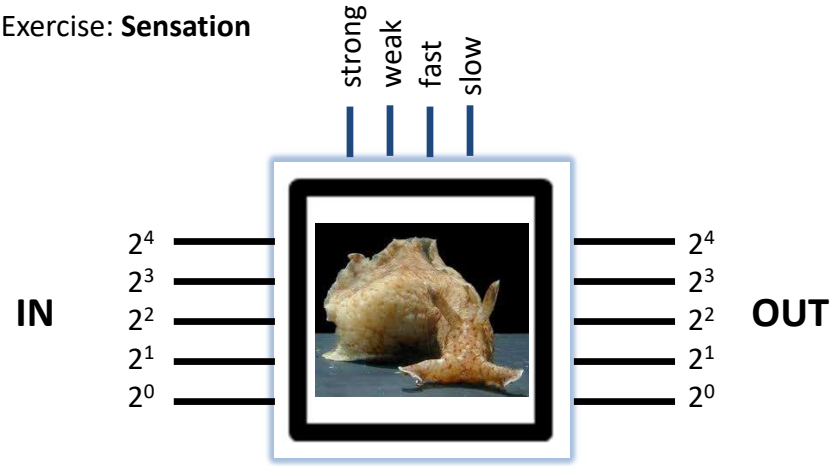
Houses built on stilts
Unteruhldingen, Lake of Constance

Example: **Memory**



Task: **Determine the minimal Kohonen network**

Exercise: **Sensation**



Task: **Exploit the sensation of Aplysia Californica**

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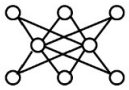
Where does complexity in the neural network come from?

Binary circuit		Neuronal circuit	
1000	Gates	1000	Neurons
2^{1000}	Gate states	1	Neuron states
2*1000	Links	1000 !	Links
1	Link states	1000	Link states

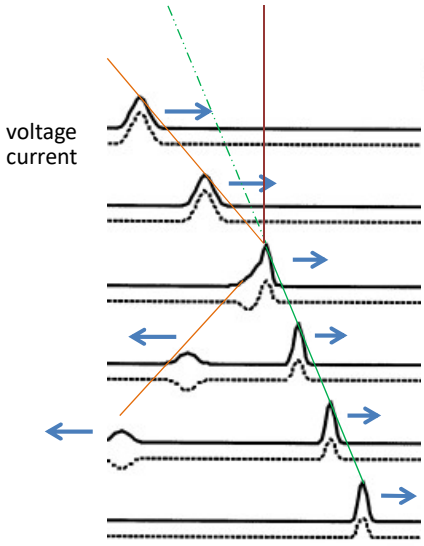


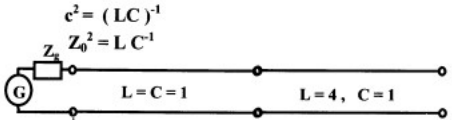
Complexity comes from 1000 ! >> 2^{1000}

1000*999*998*…*3*2*1 >> 2*2*2*…*2*2*2

The Transmission-Line Matrix Method:

Modeling the Axon Fibers





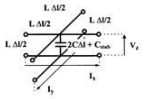
time

Googleimages

The Transmission-Line Matrix Method:

Mathematical Background

$$Y_{ram} = j\omega C Y_{st}\,\Delta\ell/2 = j\,\omega C_{st} \qquad \varepsilon_r = 1 + \frac{Y_{st}}{4}$$
$$\varepsilon_r\varepsilon_0 = 2\,C\,\Delta\ell + C_{st}$$



© Johns 1971

Eine Impulsion von Port 1-4 "sieht" $Y_{tot} = 3 + Y_{st}$

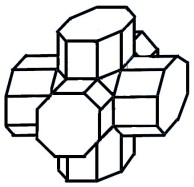
$$\Gamma_0 = \frac{2+Y_{st}}{2-Y_{st}} = -\frac{1}{2\,\varepsilon_r} - \frac{\chi_e}{\varepsilon_r}, \quad T_0 = 1+\Gamma_0 = \frac{1}{2\,\varepsilon_r}$$

Eine Impulsion von der Stichleitung "sieht" $Y_{tot} = 4$

$$\Gamma_5 = \frac{Y_{st}-4}{Y_{st}+4} = -\frac{1}{\varepsilon_r} + \frac{\chi_e}{\varepsilon_r}, \quad T_5 = 1+\Gamma_5 = \frac{2\chi_e}{\varepsilon_r}$$

Johns et Beuerle Proc. IEE Trans. 118, 9 (1971) 1203

$$\underline{\mathbf{S}} = \begin{bmatrix} \Gamma_0 & T_0 & T_0 & T_0 & T_5 \\ T_0 & \Gamma_0 & T_0 & T_0 & T_5 \\ T_0 & T_0 & \Gamma_0 & T_0 & T_5 \\ T_0 & T_0 & T_0 & \Gamma_0 & T_5 \\ T_0 & T_0 & T_0 & T_0 & \Gamma_5 \end{bmatrix}$$



Riemann node

© bierl 2016

$$\left[\partial_x \underline{\mathbf{A}}_E + \partial_t\right]\mathbf{u} = 0 \qquad \mathbf{u} = \left[E_z/2 \quad H_x \quad H_y\right]^T$$
$$\left[\partial_y \underline{\mathbf{A}}_F + \partial_t\right]\mathbf{u} = 0$$

$$\underline{\mathbf{A}}_E = \begin{bmatrix} 0 & 0 & -1/\varepsilon \\ 0 & 0 & 0 \\ -2/\mu & 0 & 0 \end{bmatrix} \qquad \underline{\mathbf{A}}_F = \begin{bmatrix} 0 & -1/\varepsilon & 0 \\ 2/\mu & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

Table 1: *The TLM method in 1D, 2D and in 3D.*

In 1D as follows

$\Delta\ell = \kappa_{1D}\, c_0\, \Delta t$

$$E_x^{(1)} = \left[\frac{1}{\sqrt{\varepsilon\mu}} - \frac{\chi}{\sqrt{\varepsilon\mu}}\right] E_x^{(0)} + \frac{2\chi}{\sqrt{\varepsilon\mu}}\hat{E}_x$$

and in 2D

$\Delta\ell = \sqrt{2}\kappa_{2D}\, c_0\, \Delta t$

$$E_x^{(1)} = \left[\frac{1-\chi_e}{\varepsilon}\right] E_x^{(0)} + \frac{2\chi_e}{\varepsilon}\hat{E}_x$$

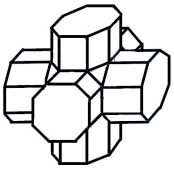
and in 3D

$\Delta\ell = 2\kappa_{3D}\, c_0\, \Delta t$

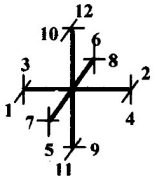
$$E_x^{(1)} = \left[\frac{1-\chi_e}{\varepsilon}\right] E_x^{(0)} + \frac{2\chi_e}{\varepsilon}\hat{E}_x, \ldots$$
$$H_x^{(1)} = \left[\frac{1-\chi_m}{\mu}\right] H_x^{(0)} + \frac{2\chi_m}{\mu}\hat{H}_x, \ldots$$

Neuro-linguistics related to Chomsky's critique

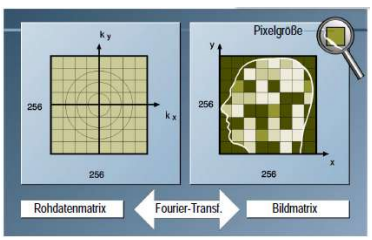
Riemann node



John's node



[4] **Memory**	Numerical Data Storage
[5] **Attention**	Signal Amplification/ Weakening
[6] **Behavior**	Fourier Transform



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11

about the example framework

FLUID, QUANTUM, AND TRACER LOGIC ENHANCED NETWORK MODELING

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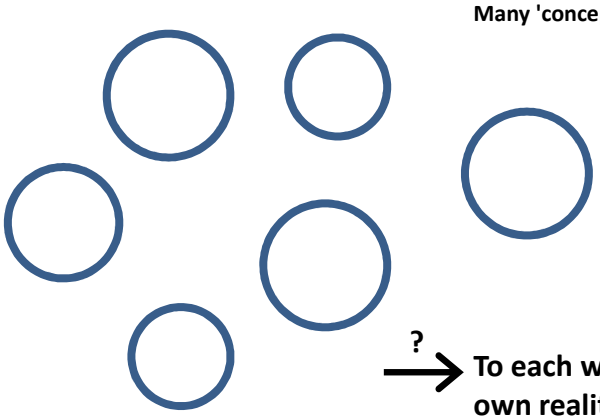
Unteruhldingen, Lake of Constance

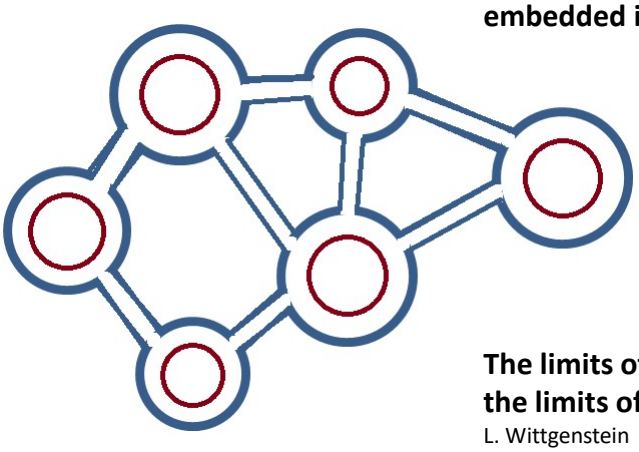
Getting evidence on what is 'real' :

Many 'worlds'
Many 'concepts of reality'



? → **To each world its own reality**

Getting evidence on what is 'real' :



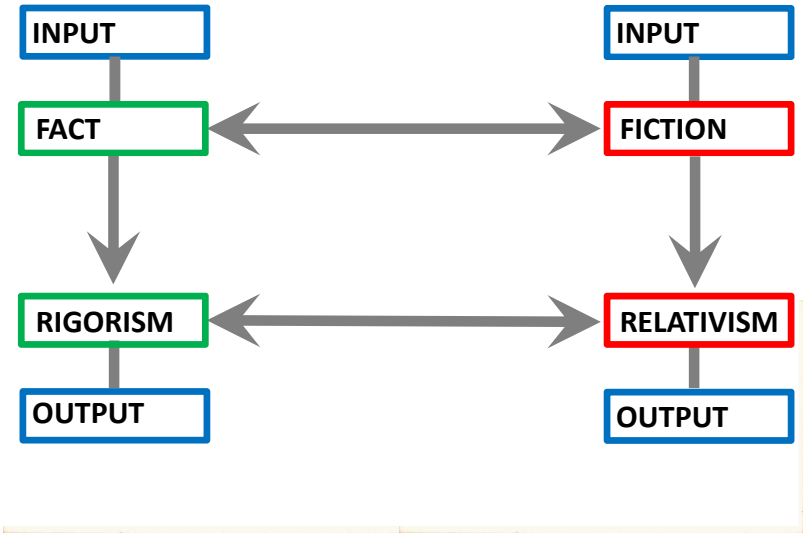
Many 'worlds' embedded in language

Atomium, Brussels

The limits of the language are the limits of my world.

L. Wittgenstein

Logical reasoning of 1st order



Mathematics for Linguistic Problems:

Theory of Sets:	**Axiomatic Foundation**	'Descriptive Foundation'
Description:	**Mathematical Model Theory** [1]	'Descriptive Quantor Logic'
Calculus:	**Fluid-Logic**[2]**, Quantum-Logic, Tracer-Logic**	'Descriptive Field Logic'
Concept:	Symbolic Instruction Code	'plain' description

[1] **R.M. Smullyan :** First Order Logic, Dover books

[2] **Logique floue**, [Alias : Fuzzy-Logic]

12

excursus about modeling

MODELING AND EPISTEMOLOGY

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Unteruhldingen, Lake of Constance

B. Müller-Bierl, F. Schick

Excursus: Dipole modeling

$\Delta\,\Phi = -\,\vec{p}\,\vec{\nabla}\,\delta(\vec{r})$ **Poisson eqn.** for potential Φ

$\vec{\nabla}\,\Phi = \vec{E}$ Electric field from the potential

---

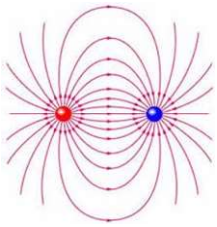
$\Phi = \frac{1}{4\pi\varepsilon_0}\,\frac{\vec{p}\cos\theta}{r^2}$ Electric dipole

Spherical coordinates

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\,\frac{1}{r^3}(2\cos\quad \vec{e}_r + \sin\theta\,\vec{e}_\theta)$$

Cartesian coordinates

$$\vec{E} = -\frac{p}{r^5}\left(r^2 - 3x^2, -3xy, -3xz\right)$$

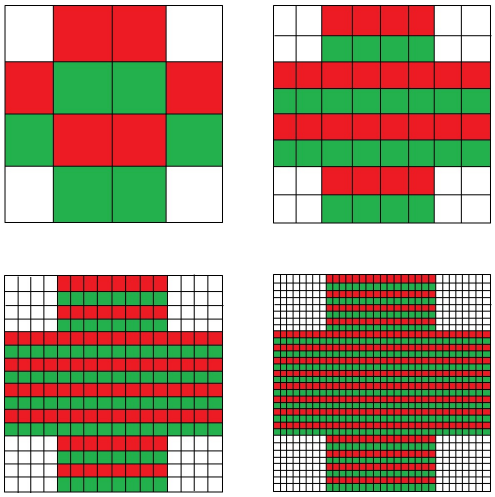


Functional analytic linearity of the Poisson equation operator:

1. The dipole potential is a solution to the Poisson equation
   [proof by definition] $\Delta\,\Phi = \rho$
2. Adding another dipole potential rests still being a solution
   [proof by operator superposition:] $\Delta\,(\lambda_1\Phi_1 + \lambda_2\Phi_2) = \lambda_1\Delta\Phi_1 + \lambda_2\Delta\Phi_2$
3. Superposition of arbitrary many (infinitely small) dipole potentials is also a solution [proof by induction for any finite size]

$$\Phi = \lim_{n\to\infty}\left(\sum_{i=1}^{n}\Phi_i\right)$$

$$\Phi = \lim_{n\to\infty}\left(\sum_{i=1}^{n}\Phi_i\right)$$



Static Electromagnetic Paradoxon

Electrostatic dipole

Electric charges = Poles

Magnetostatic dipole

$\mathbf{div\ B} = 0$

Single magnetic charges do not exist

Pairs of magnetic charges do exist

End of excursus

Material and Experimental Design

Discussion of Results

Empiricism	Realism
Rationalism	Nominalism

Stanford Encyclopedia of Philosophy

Material and Experimental Design

Discussion of Results

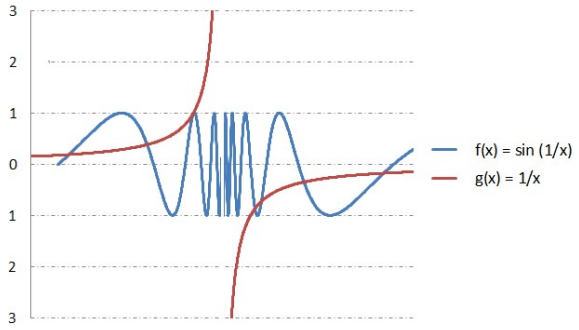
platonistic realism	conceptualism
formalism	intuitionism

Dale Jacquette
Philosophy of Mathematics

Definition of 'continuity' using symbols from 1st order logic :

$f\colon \mathbb{R} \to \mathbb{R}$ continuous in $\zeta \in \mathbb{R}$

$\forall\ \varepsilon > 0\ \exists\ \delta > 0 :\ x \in \mathbb{R},\ |x - \zeta| < \delta :\ |f(x) - f(\zeta)| < \varepsilon$



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about language from the Iron Age on

RHETORIC AND DIALECTIC

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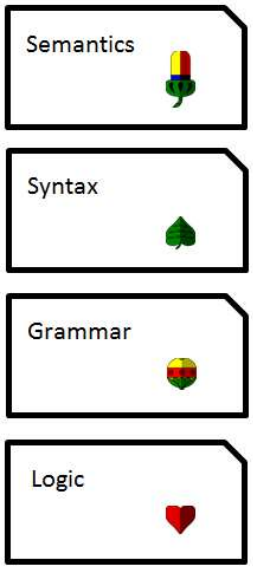

Language

Back to rhetoric

Philosophy of language

Back to dialectic

Modus ponendo ponens statisticus

IF **A** THEN OFTEN **B**
A

_____
OFTEN **B**

Modus tollendo tollens statisticus

IF **A** THEN OFTEN **B**
NOT **B**

_____
OFTEN NOT **A**

[Universal Grammar] 'is not a grammar, but a system of conditions on the range of possible grammars for possible human languages' (R&R, p. 189).

Skinner

Skinnerian multi causal multi-causation function ad-hoc:

$$f_i\left(\alpha^i_{\overline{j}}\right)$$

Chomsky

Various formal grammar approaches as the one of Chomsky:

[1]*traditional*
[3]*standard*
[2]*transformational*
[4]*particular*
Grammar
[8]*generative*
[5]*universal*
[6]*core*
[7]*comparative*

© Minimalism on studying those 8 key aspects.

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about strong reductionism

REPRESENTATIVE VERSUS POTENTIALLY REPRESENTATIVE REDUCTIONISM

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Example of strong reductionism in research: Getting the most leading idea as in : *To study memory, study one single neuron*[1] …

[1] *cited after Eric Kandel's biography:* ***On search for memory***
But: ***What about the connectome ?***

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about Trojan horses

NUMBER OF ANGELS ON A NEEDLE TIP

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No 'results in theology' – no horses to other faculties

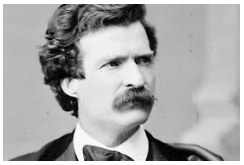
Source: Google Images

More on scientific views that might be discussed within manuscripts:

Point of view	The anarchist's view
Mentalist's view	Matter doesn't matter
Mechanist's view	Mind doesn't mind
View on meaning	Essence is yet essential

Adapted from Nelson Goodman

Explanation of terms of failure in scientific administration:



Mark Twain (1835-1910)

Personnel failure:

1. The extensively **discussing** of ideas instead of simply realizing them.
2. The finding of **obstacles** instead of **solutions**.
3. The discussing of **immature results** with colleagues instead of writing them down and passing them through to colleagues by **presentation**.

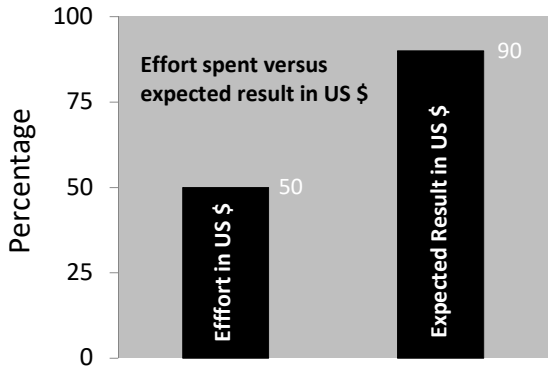
Group failure:

1. By creating **inner group conflicts.**

Common terminology for multiple related disciplines

…
[Human being] This is actually the most complex organism in the kingdom of living beings.
[Human Brain Project] This is a European research project on brain research.
[Human Connectome Project] This is a US American research project on brain research.
[Human Culture] This distinguishes human being from the rest of the kingdom of living beings.
[Human Language] This can be most simple discerned into words, phrases, and grammar.
[Human perception] This is understood as the interface of the human brain to the exterior world.
[Human senses] Those are providing humans with the bodily perception of vision, hearing, tactile stimulus, taste, and olfaction.
[Immanent] This means in this context to adopt a 'positivistic viewpoint' and is the opposite of transcendent.
[Impetus] This is a kind of living (or life) energy.
…

Fifty-Ninety Rule



Languages of documentation

Source: Google Images