synthetic perceptive, emotive and cognitive systems

Cognitive Science & Psychology: Mind, Brain and Behavior

Philosophical and historical roots I (Week 5)

Paul Verschure
csim.upf.edu
specs.upf.edu

Outline

Lecture 1 Introduction - robot future
Lecture 2 The Mind, Brain, behaviour Cycle
Lecture 3 The Knowledge Problem in the Science of Mind and Brain
Lecture 4 The Five Revolutions defining Current Reality
Lecture 5 Conceptual Revolutions in Philosophy of Mind

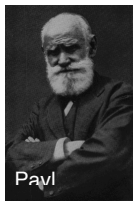
Lecture 6 (1850-1915) Structuralism and Functionalism
Lecture 7 (1915-1950) Behaviorism, Cognitive Behaviorism
Lecture 8 (1950-1960) The Demise of Behaviorism
Lecture 9 (1945-1960) Cybernetics and the Cognitive Revolution
Lecture 10 (1960-Now) Mind as Computation
Lecture 11 (1985-Now) Biology as a Metaphor and Beyond
Lecture 12 (Now-Future) Flux and Synthesis

Realising a science of mind

5 big ideas

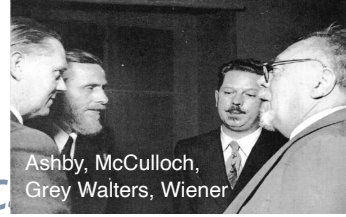
1. Mechanical Universe; Laws of motion
2. Mind in the Physical World; Dualism
3. Mechanics of Life; Evolution
4. Dual Process Mind; ID/EGO/S_EGO
5. Mind as Computation; Turing Machines

Mind/Brain/Behavior Cycle



Behaviorism

Behavior;
the *empty organism*



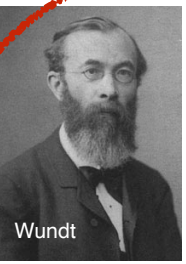
Cybernetic

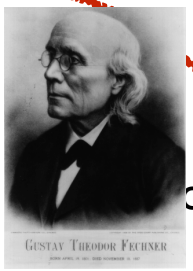
Control;
embodied action

1945

1915

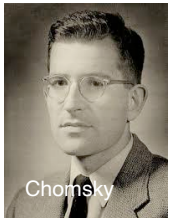
Structuralism





ousness

1880



1950

Cognitivism

Reason;
the *disembodied mind*

1850

1990

Metaphorical Biology;
the *mindless body*

1990

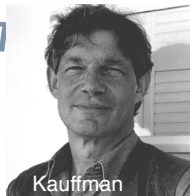
NOW

Connectionism
New AI
Artificia

Brain

Big Data

DL/ML

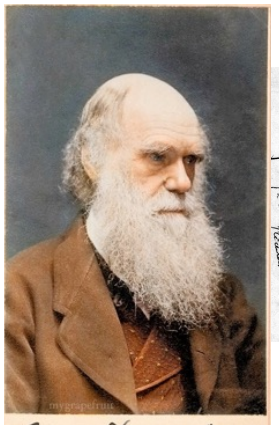


2016, In Press) IEEE Expert; ESF; Conn. Sci.

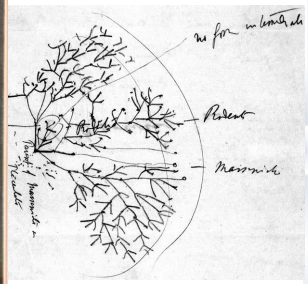
From evolution by selection to the comparative study of learning and adaptation

”The question at once arises how these superior adaptive responses are selected from the multiplicity of responses of which an organism is capable, and then fixated and perpetuated. To those who tried to answer this question, hedonism and the pleasure-pain principle provided the principle of selection, and the laws of association the mechanism of fixation”
(Postman 1947, pp.491)

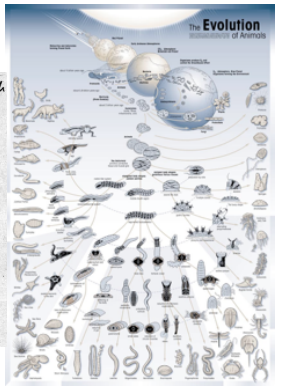
The Darwinian (R)Evolution



Charles Robert Darwin
1809-1882

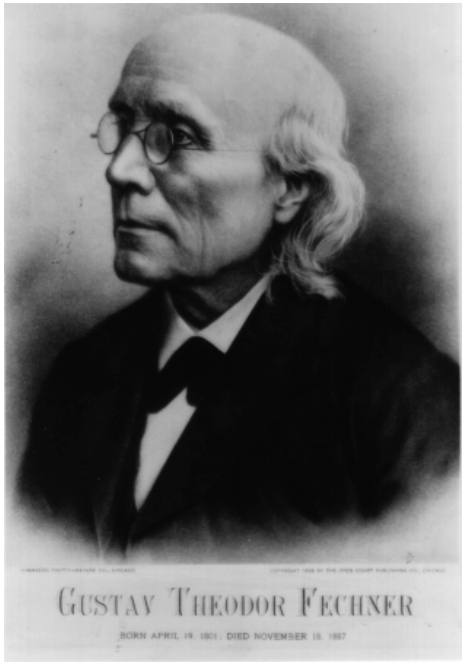


Darwin’s notebook



The experimental study of psychology

Fechner started the first laboratory of psychology in Leipzig



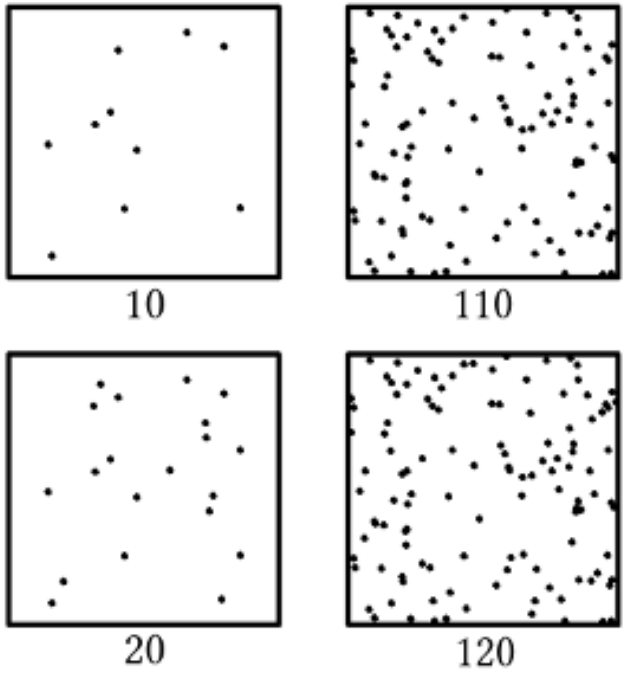
Gustav Theodor Fechner (1801-1887)

Fechner (October 22, 1850) : the connection between the mind and the body can be understood by establishing the relation between mental sensation and properties of the material stimulus

= Psychophysics

The Weber-Fechner law

"Simple differential sensitivity is inversely proportional to the size of the components of the difference; relative differential sensitivity remains the same regardless of size."



Weber's law

just-noticeable difference (JND) dS

$$dS = K * S$$

constant reference stimulus

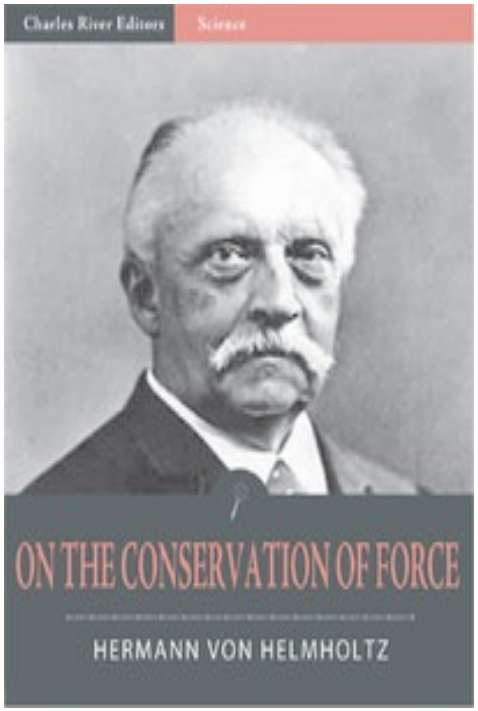
Fechner's law:
Subjective sensation is proportional to the logarithm of stimulus intensity

$$p = k \ln \frac{S}{S_0}$$

1860 *Elemente der Psychophysik*

Hermann von Helmholtz

- Physiologist and physicist
- Student of Johannes Muller
  Teacher of Wilhelm Wundt
- Rejection of **Naturephilosophie**: Kantian view that time, space and causation are not products of sense experiences but mental attributes by which we perceive the world
- **All knowledge comes through senses**
- All science could and should be reduced to the laws of **classical mechanics**
- Principle of conservation of energy (1847): **"On the conservation of force"**

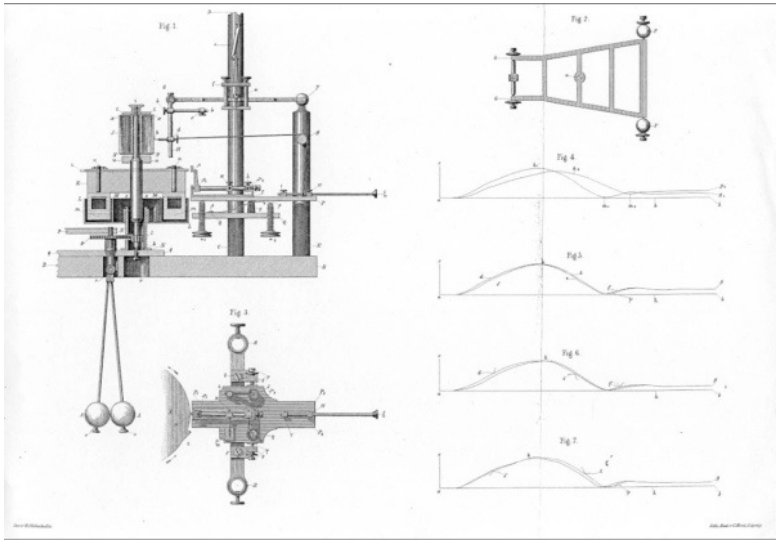


(Germany, b. 1821 - d.1894)

Nerve's conduction rate and Reaction Time

In 1852 he measured the speed of a frog's nerve impulse

Impulse velocity within the nervous system was calculated at 26 mt/s (much slower than previously believed)



Reaction Time experiments of unexpected events with humans

Touched the shoulder or the wrist of subjects and noted the difference in reaction times

Pioneer of theory of measurement

→ experimental psychology

S

"Sign theory" (1848-1868):

- Sensations symbolize their stimuli but are not direct copies of those stimuli
- We construct that correspondence by means of learned, "unconscious inferences"
- The more we know about the physiology of perception the more accurate our inferences about our experiences will be.

“Objects are always imagined as being present in the field of vision as would have to be there in order to produce the same impression on the nervous mechanism”

Hermann Ludwig Ferdinand von Helmholtz

The stage model of Donders

Time = mental complexity

Subtraction method

Discrete Stage Model

F.C. Donders 1818-1889

"The idea occurred to me to interpose into the process of physiological time some new components of mental action. If I investigated how much this would lengthen the physiological time, this would, I judged, reveal the time required for the interposed term" (Donders, 1868).

Example Donders task

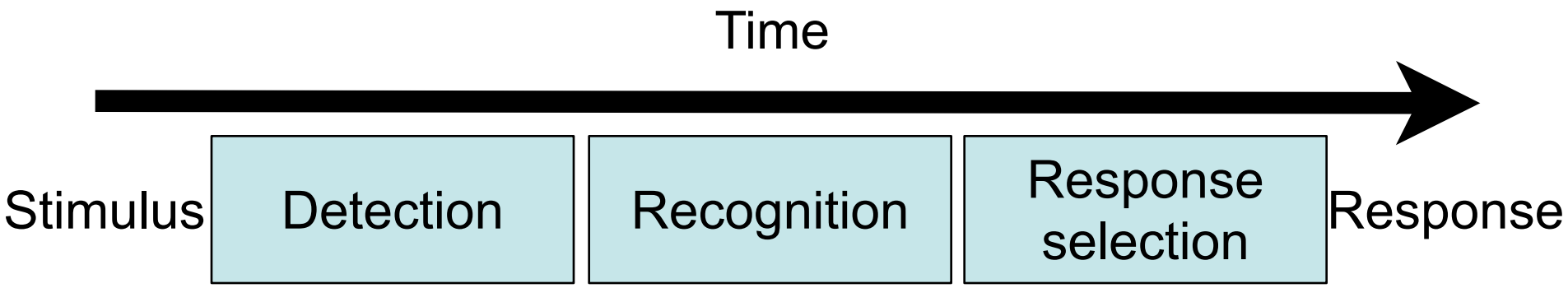
- Subject is presented with a vowel than:

- A (recognition):
  - repeat vowel
- B (recognition, detection):
  - repeat one of two vowels
- C (recognition, detection, response selection):
  - repeat one ignore second vowel

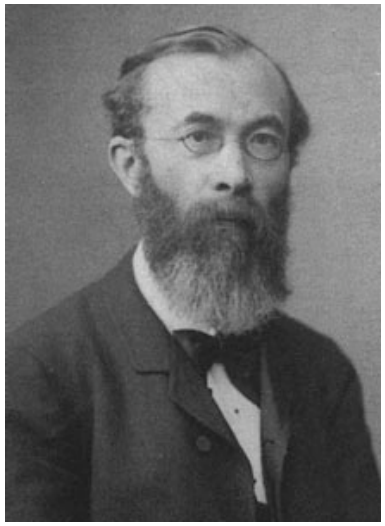
Results

A: 201 msec, B: 237 msec, C: 287 msec

- recognition: 201 msec
- detection: 36 msec
- response selection: 50 msec



Wundt's Structural Psychology



Wilhelm Wundt (1832-1920)

The data of the psychologist consists of the objective description of the elements of conscious experience and their relationship

The “HARD” problem of consciousness

Chalmers

The explanatory GAP

Levine

“What conceivable connection exists between definite movements of definite atoms in my brain on the one hand, and on the other hand such primordial, indefinable, undeniable facts as these: I feel pain or pleasure; I taste something sweet, or smell a rose, or hear an organ, or see something red, and the certainty that immediately follows: Therefore I am?”.

Emil Du Bois-Reymond, “The Limits of Science” keynote address to the Congress of German Scientists and Physicians in Leipzig (14 August 1872)

Peripheralism vs Externalism

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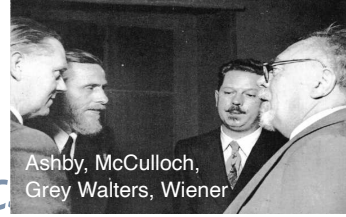

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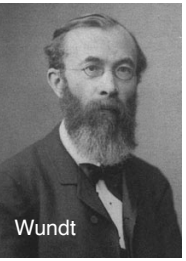

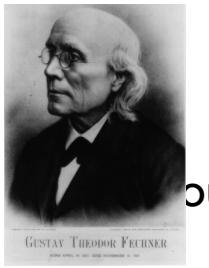

1880

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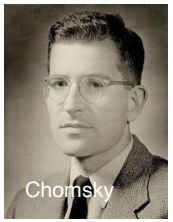

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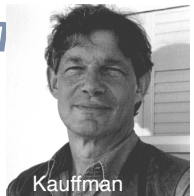
Artificia

Brain



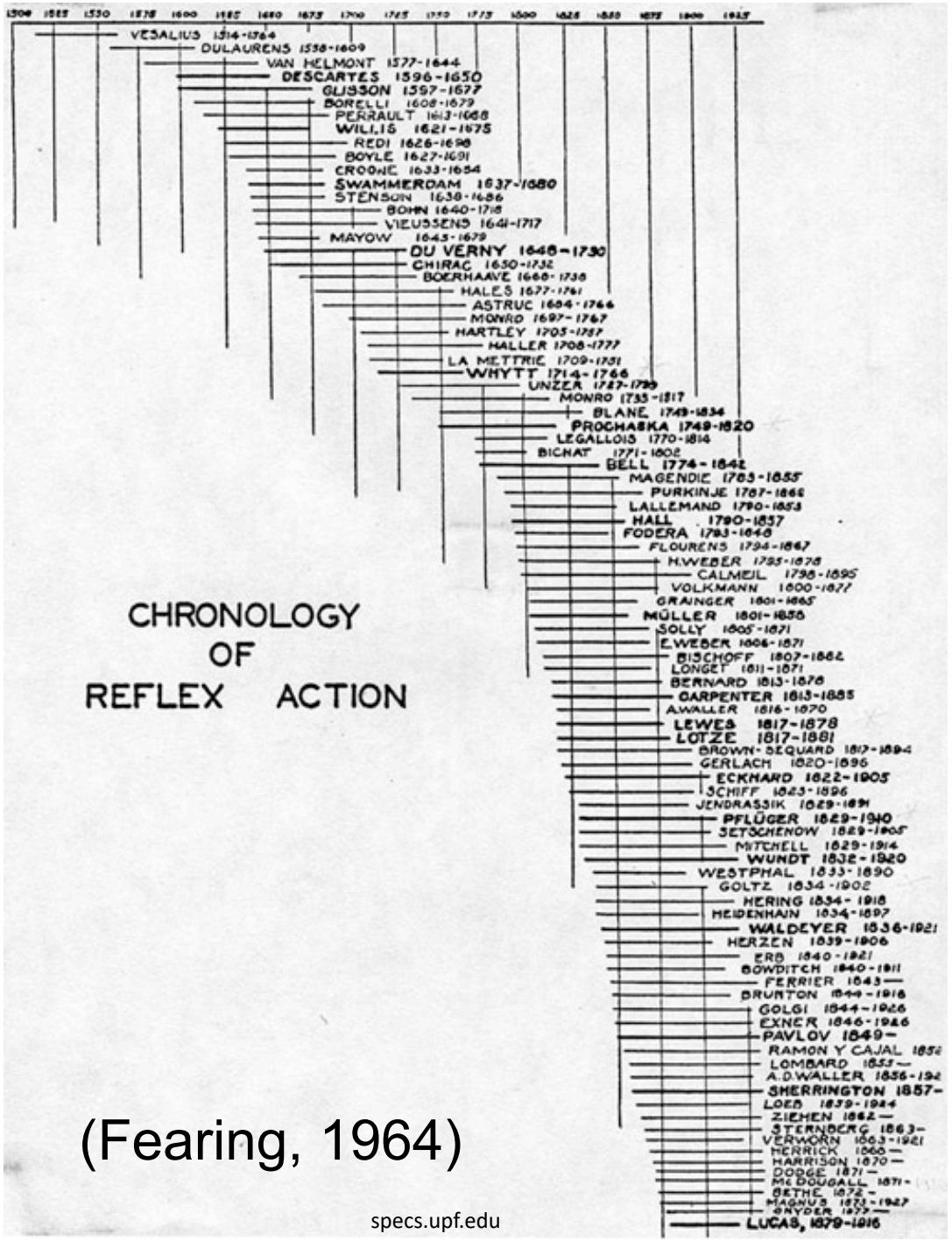
Big Data

DL/ML

2016, In Press) IEEE Expert; ESF; Conn. Sci.

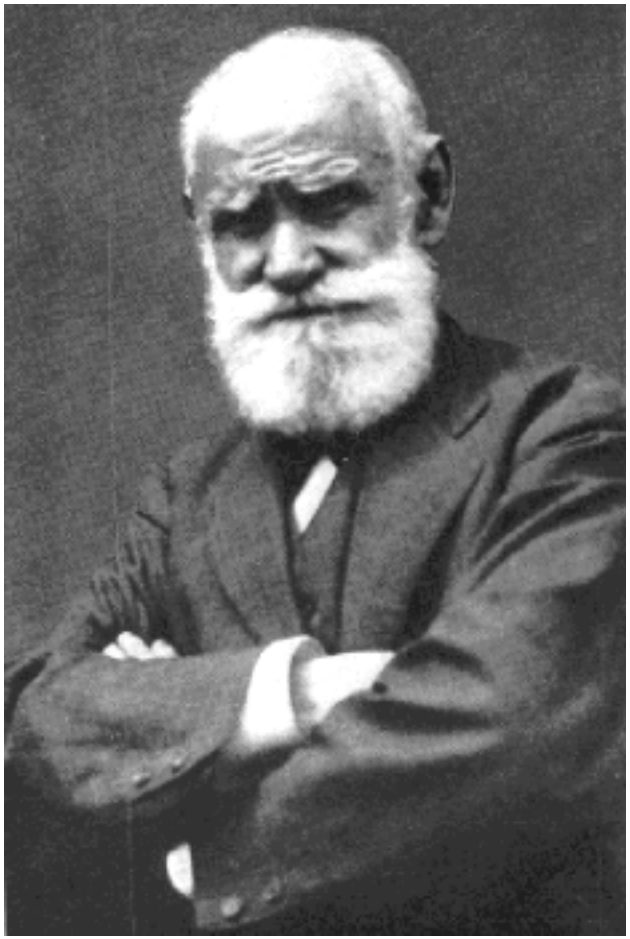
The reflex as the atom of mind and behavior

- From Whytt (18th century-frog scratch reflex, animal electricity) to Sherrington (early 20th century) reflexes were studied using the spinal cord.
- Sechenov (19th century) innate and acquired reflexes.
- Sherrington:
  - Reflex=reception->conduction->end-effect
  - Reflex="like a penny in the slot machine, physical, and not psychical."
  - Basic unit of neural organization is the reflex-arc


VESALIUS 1514-1564
DULAURENS 1538-1609
VAN HELMONT 1577-1644
DESCARTES 1596-1650
GLISSON 1597-1677
BORELLI 1608-1679
PERRAULT 1613-1688
WILLIS 1621-1675
REDI 1626-1698
BOYLE 1627-1691
CROONE 1633-1684
SWAMMERDAM 1637-1680
STENSON 1638-1686
BOHN 1640-1718
VIEUSSENS 1641-1717
MAYOW 1643-1679
DU VERNY 1648-1730
CHIRAC 1650-1732
BOERHAAVE 1668-1738
HALES 1677-1761
ASTRUC 1684-1766
MONRO 1697-1767
HARTLEY 1705-1757
HALLER 1708-1777
LA METTRIE 1709-1751
WHYTT 1714-1766
UNZER 1727-1799
MONRO 1733-1817
BLANE 1749-1834
PROCHASKA 1749-1820
LEGALLOIS 1770-1814
BICHAT 1771-1802
BELL 1774-1842
MAGENDIE 1783-1855
PURKINJE 1787-1868
LALLEMAND 1790-1853
HALL 1790-1857
FODERA 1793-1846
FLOURENS 1794-1867
H.WEBER 1795-1878
CALMEIL 1798-1895
VOLKMANN 1800-1877
GRAINGER 1801-1865
MÜLLER 1801-1858
SOLLY 1805-1871
E.WEBER 1806-1871
BISCHOFF 1807-1882
LONGET 1811-1871
BERNARD 1813-1878
CARPENTER 1813-1885
A.WALLER 1816-1870
LEWES 1817-1878
LOTZE 1817-1881
BROWN-SEQUARD 1817-1894
GERLACH 1820-1896
ECKHARD 1822-1905
SCHIFF 1823-1896
JENDRASSIK 1829-1891
PFLÜGER 1829-1910
SETSCHENOW 1829-1905
MITCHELL 1829-1914
WUNDT 1832-1920
WESTPHAL 1833-1890
GOLTZ 1834-1902
HERING 1834-1918
HEIDENHAIN 1834-1897
WALDEYER 1836-1921
HERZEN 1839-1906
ERB 1840-1921
BOWDITCH 1840-1911
FERRIER 1843—
BRUNTON 1849-1918
GOLGI 1844-1926
EXNER 1846-1926
PAVLOV 1849—
RAMON Y CAJAL 1852
LOMBARD 1853—
A.D.WALLER 1856-192
SHERRINGTON 1857—
LOEB 1859-1924
ZIEHEN 1862—
STERNBERG 1863—
VERWORN 1863-1921
HERRICK 1868—
HARRISON 1870—
DODGE 1871—
MCDOUGALL 1871-
BETHE 1872—
MAGNUS 1873-1927
SNYDER 1877—
LUCAS, 1879-1916
CHRONOLOGY
OF
REFLEX ACTION
(Fearing, 1964)

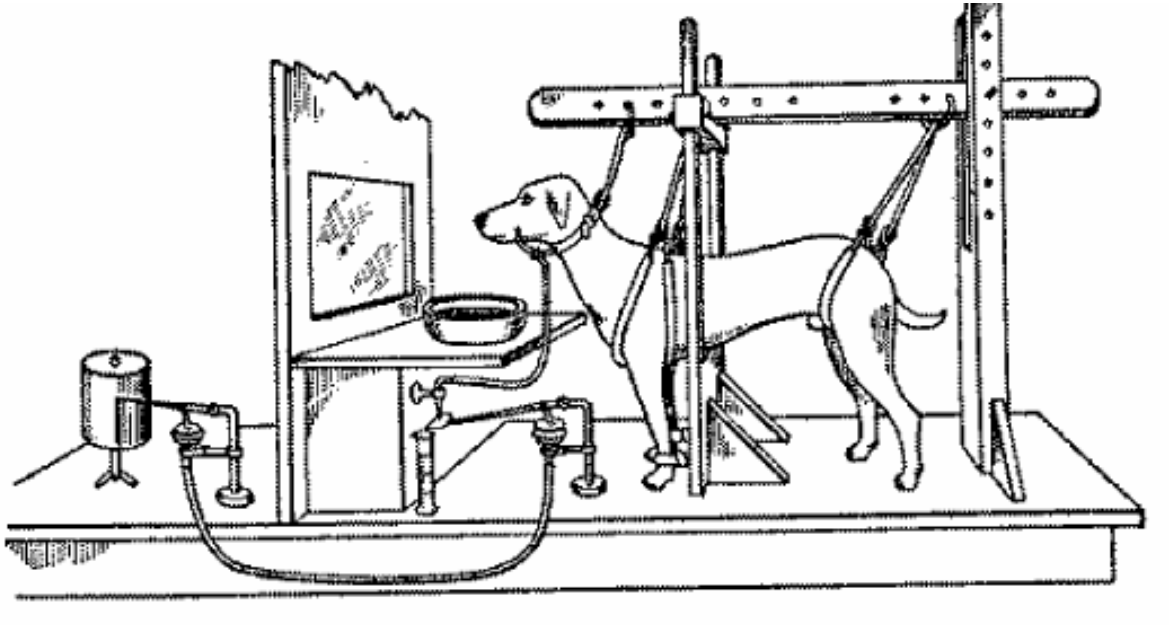
reflexes, taxes & behavioral patterns

The physiological study of learning & memory starts here



I. Pavlov (1849-1936)

Study of the digestive system

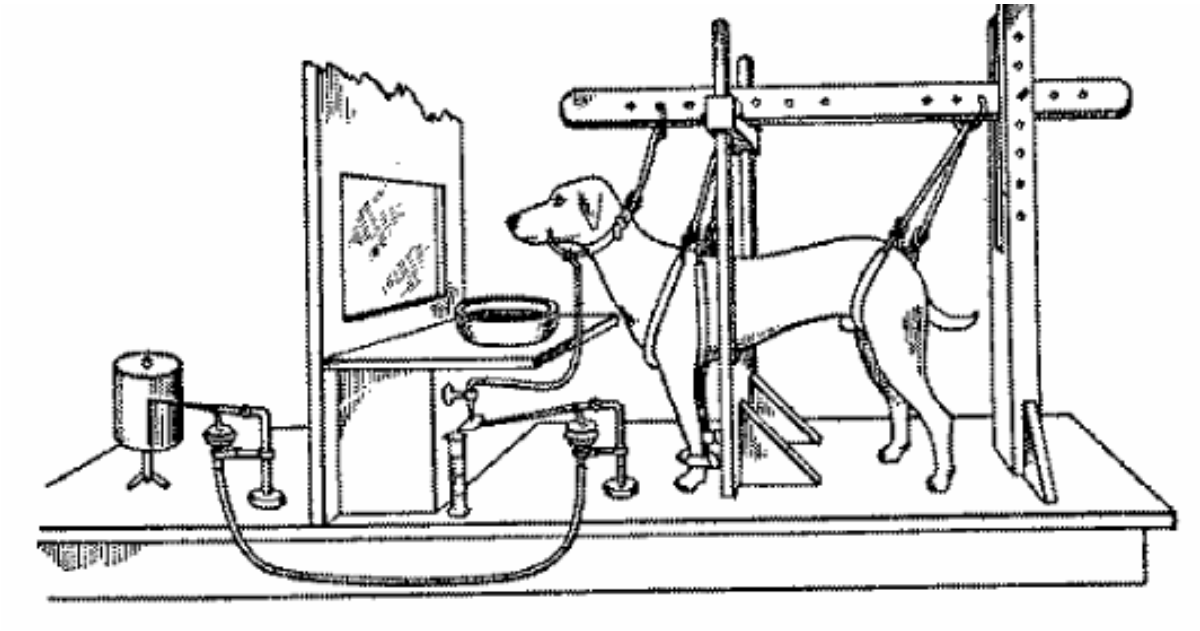


The study of the psychic reflex

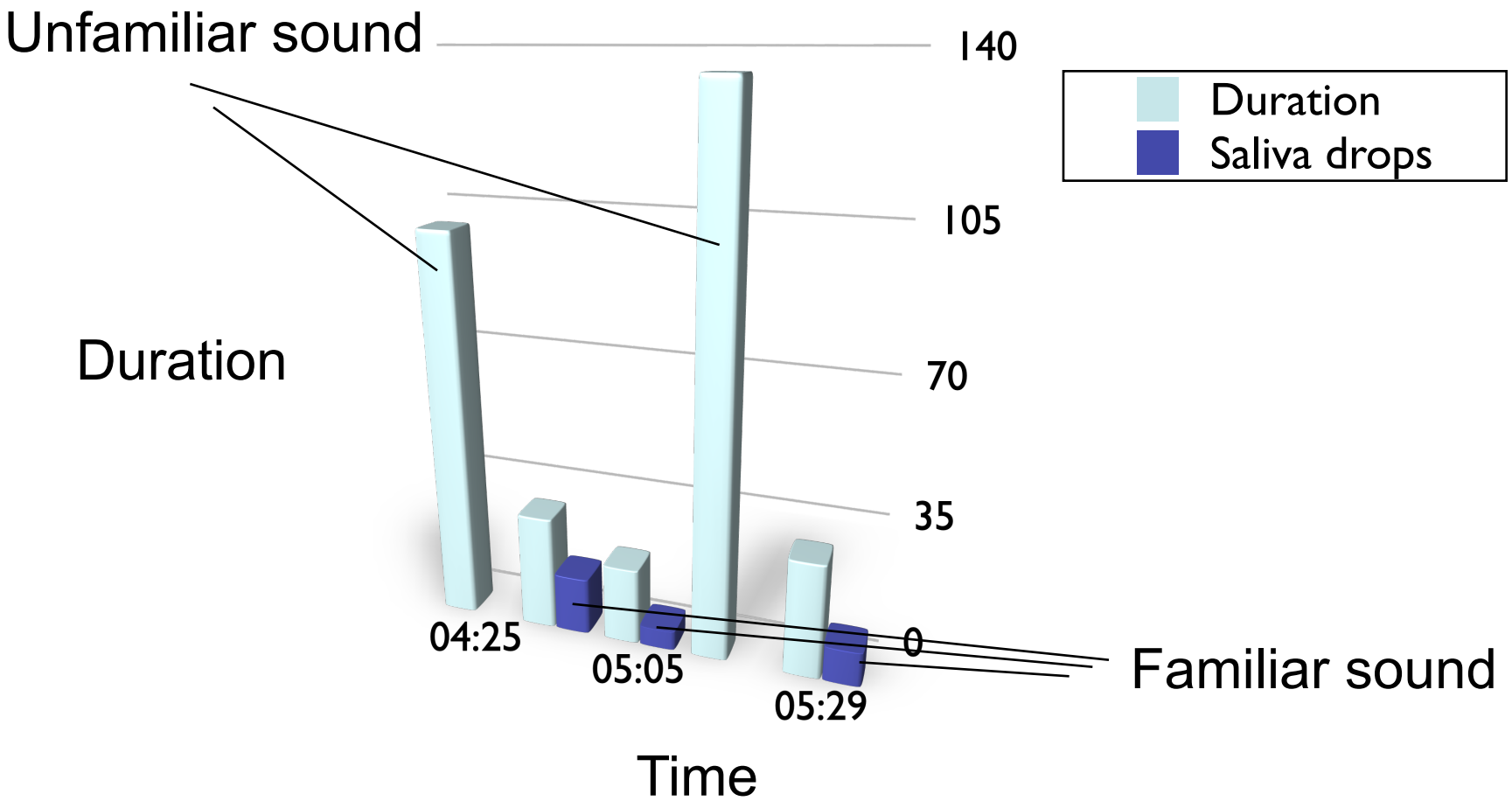
``The dog sees, hears and sniffs all these things, directs his attention to them, tries to obtain them if they are eatable or agreeable, but turns away from them and evades their introduction into the mouth if they are undesired or disagreeable. Every one would say that this is a psychical reaction of the animal, a psychical excitation of the salivary glands. How should the physiologist treat such facts? How can he state them, how analyze them? What are their common and what their individual characteristics? To understand these phenomena, are we obliged to enter into the inner state of the animal, and to fancy his feelings and wishes as based on our own? For the investigator, I believe there is only one possible answer to the last question - an absolute ``No".``

Pavlov (1928) Lectures on Conditioned Reflexes, pp. 50

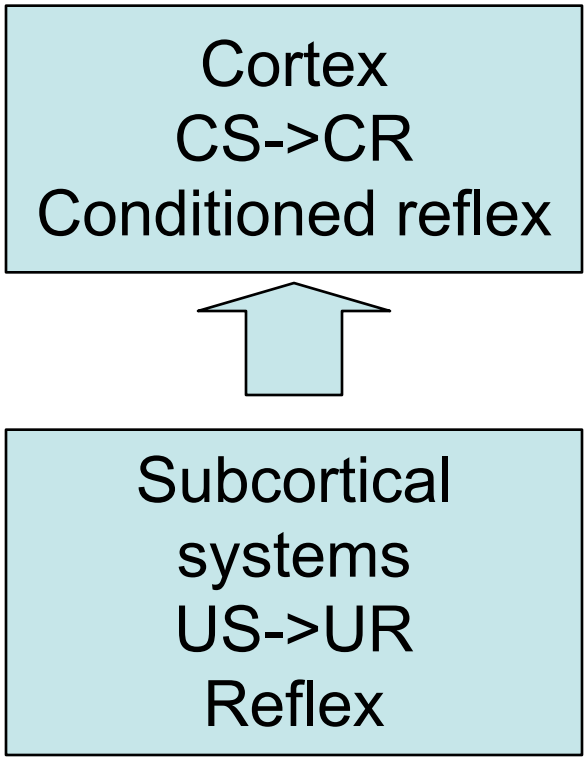
Pavlovian/Classical conditioning



Experiment 54 ´Margaret´



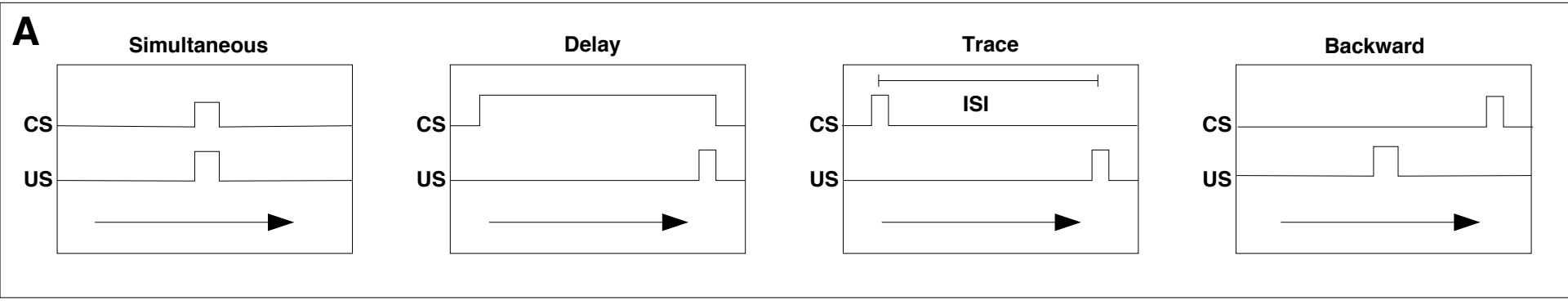
The Cortical Analyzer as the substrate of learning:

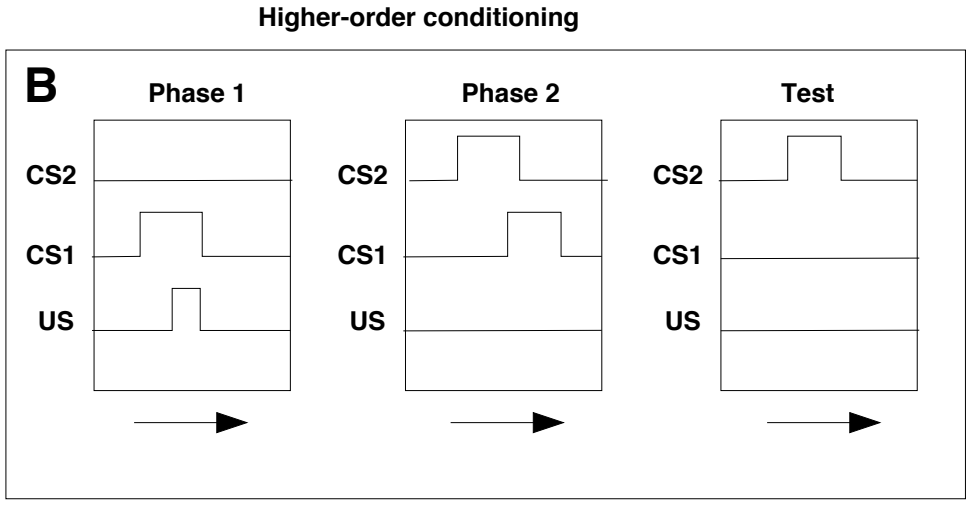


Cortical analyzer:

- convergence of CS (sound) and US (food)
- synthesize behavior
- generalize via irradiation
- allow differentiation
- Cortex as a dynamic mosaic of excitatory and inhibitory foci

variations on classical conditioning





Pavlov reported the best conditioning results when the CS preceded the US with a relatively short time interval or Inter Stimulus Interval (ISI)