

SCIENTIFIC REPRESENTATIONS:  
A PHILOSOPHICAL PERSPECTIVE

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PRINCIPLES & PRACTICE OF DATA VISUALIZATION

DECEMBER 6<sup>TH</sup> 2016

## WHAT IS AN IMAGE?

“THE GREEK SENSE OF “IMAGE”—IF WE MAY USE THIS WORD AT ALL—IS “A COMING TO FORE”, *PHANTASIA*, UNDERSTOOD AS “COMING INTO PRESENCE”. THUS WE ARE APPROACHING THE VERY INTIMATE RELATIONS BETWEEN PRESENCE, IMAGE, CHANGE AND PHANTASIA. HERE WE COME TO THE FANTASTIC INTERSECTION. EVERYTHING THAT COMES INTO PRESENCE ARRIVES CHANGES, SUBSTITUTING ITSELF FOR ITSELF. THIS IS THE ORIGINAL ONTOLOGICAL PHANTASM. PRESENCE ORIGINALLY EXCHANGES ITSELF IN RETURN FOR ITS MODIFICATION.”

C. MALABOU, *PLASTICITY AT THE DUSK OF WRITING*, 2009.

“THE ORIGINAL IMAGING IS IN FACT THE HISTORY OF PRESENCE. ORIGINALLY, PRESENCE IS CHANGE BECAUSE IT REFLECTS A COMING INTO IMAGE— PHANTASIA. TO BE PRESENT IS TO ENTER PHANTASIA, THAT IS, THE VERY MOBILITY THAT SHOWS (ITSELF).”

C. MALABOU, *PLASTICITY AT THE DUSK OF WRITING*, 2009.

PHANTASIA OR FANTASY:

THE GREEK ROOT “*PHOS*” DERIVED FROM “*PHAOS*” : LIGHT  
AND PHANEIN: TO SHOW, TO APPEAR

PHAMTON, FANTASY, FANCY: AN APPEARANCE

EMPHASIS: GREEK, EM: IN

PHOTOGRAPH: LIGHT-WRITING

PHENOMENON: EARLIER SPELLING PHAENOMENON/PHAINOMAI:  
TO BE SHOWN, OR TO APPEAR. ORIGINALLY WAS ANYTHING  
PERCEPTIBLE TO THE SENSES

ON TRUTH:

“TRUTH IS A QUALIFICATION WHICH APPLIES TO APPEARANCE ALONE. REALITY IS JUST ITSELF, AND IT IS NONSENSE TO ASK WHETHER IT BE TRUE OR FALSE. TRUTH IS THE CONFORMATION OF APPEARANCE TO REALITY.”

A. N. WHITEHEAD, *ADVENTURES OF IDEAS*, 1933



ALFRED NORTH WHITEHEAD  
(1861-1947)

“WE UNDERSTAND A STATEMENT AS BEING TRUE IN A GIVEN SITUATION WHEN OUR UNDERSTANDING OF THE STATEMENT FITS OUR UNDERSTANDING OF THE SITUATION CLOSELY ENOUGH FOR OUR PURPOSES”

G. LAKOFF AND M JOHNSON, *METAPHORS WE LIVE BY*,1980

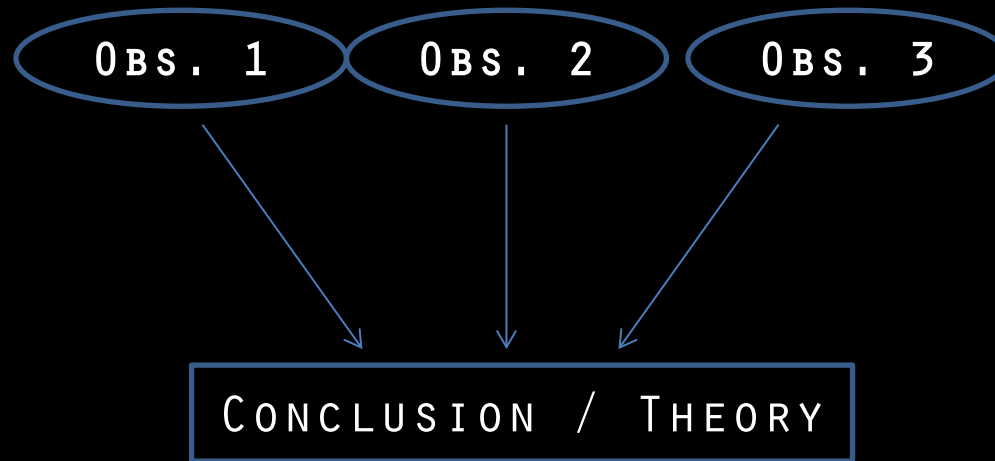
“TRUTH IS RELATIVE TO UNDERSTANDING, WHICH MEANS THAT THERE IS NO ABSOLUTE STAND POINT FROM WHICH TO OBTAIN ABSOLUTE OBJECTIVE TRUTHS ABOUT THE WORLD. THIS DOES NOT MEAN THAT THERE ARE NO TRUTHS; IT MEANS ONLY THAT TRUTH IS RELATIVE TO OUR CONCEPTUAL SYSTEM, WHICH IS GROUNDED IN, AND CONSTANTLY TESTED BY, OUR EXPERIENCES AND THOSE OTHER MEMBER OF OUR CULTURE...”

G. LAKOFF AND M JOHNSON, *METAPHORS WE LIVE BY*,1980

THE SCIENTIFIC METHOD AND THE PLACE OF THE VISUAL IMAGE

# INDUCTIVE REASONING

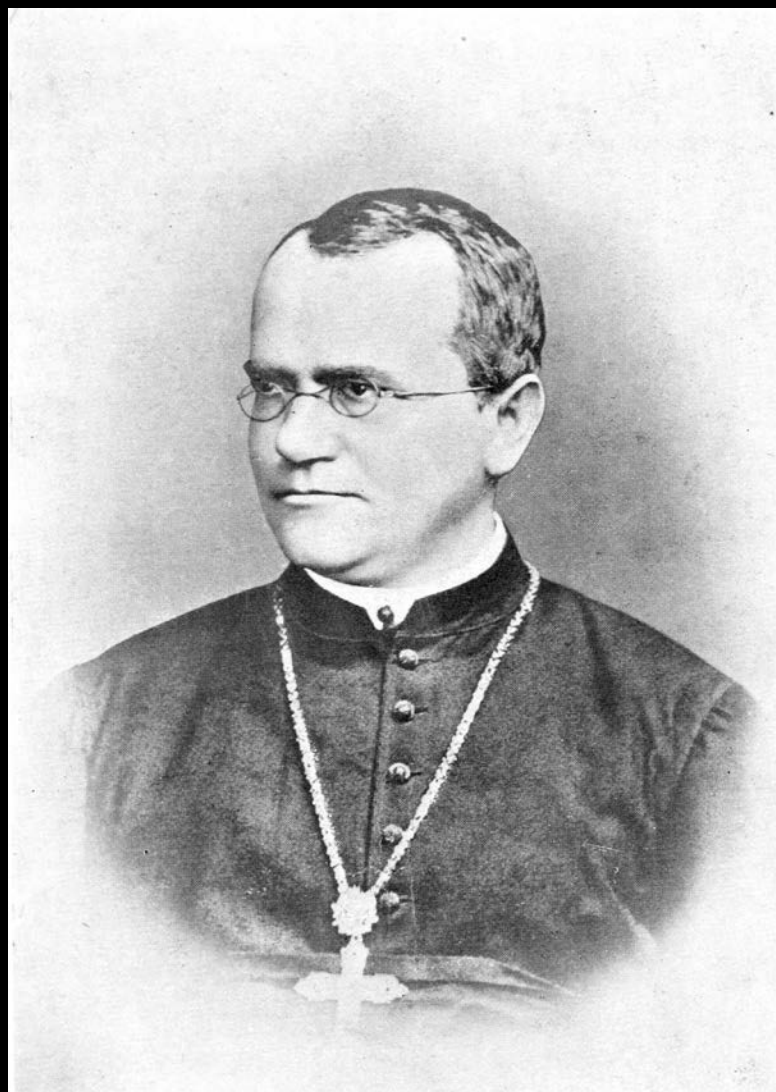
*THEORY BUILDING APPROACH*



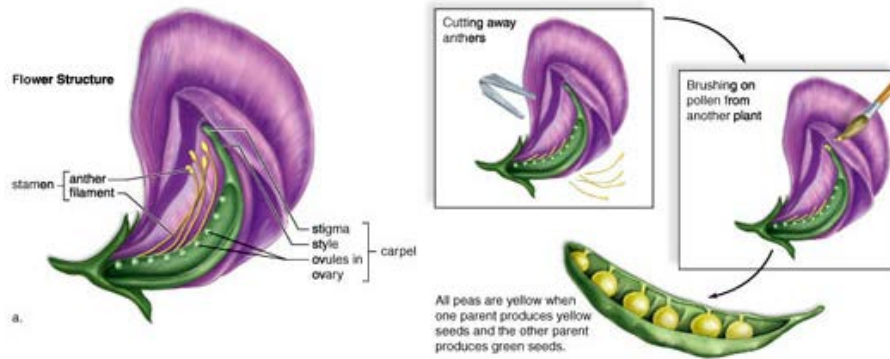


FRANCIS BACON  
(1561-1626)



















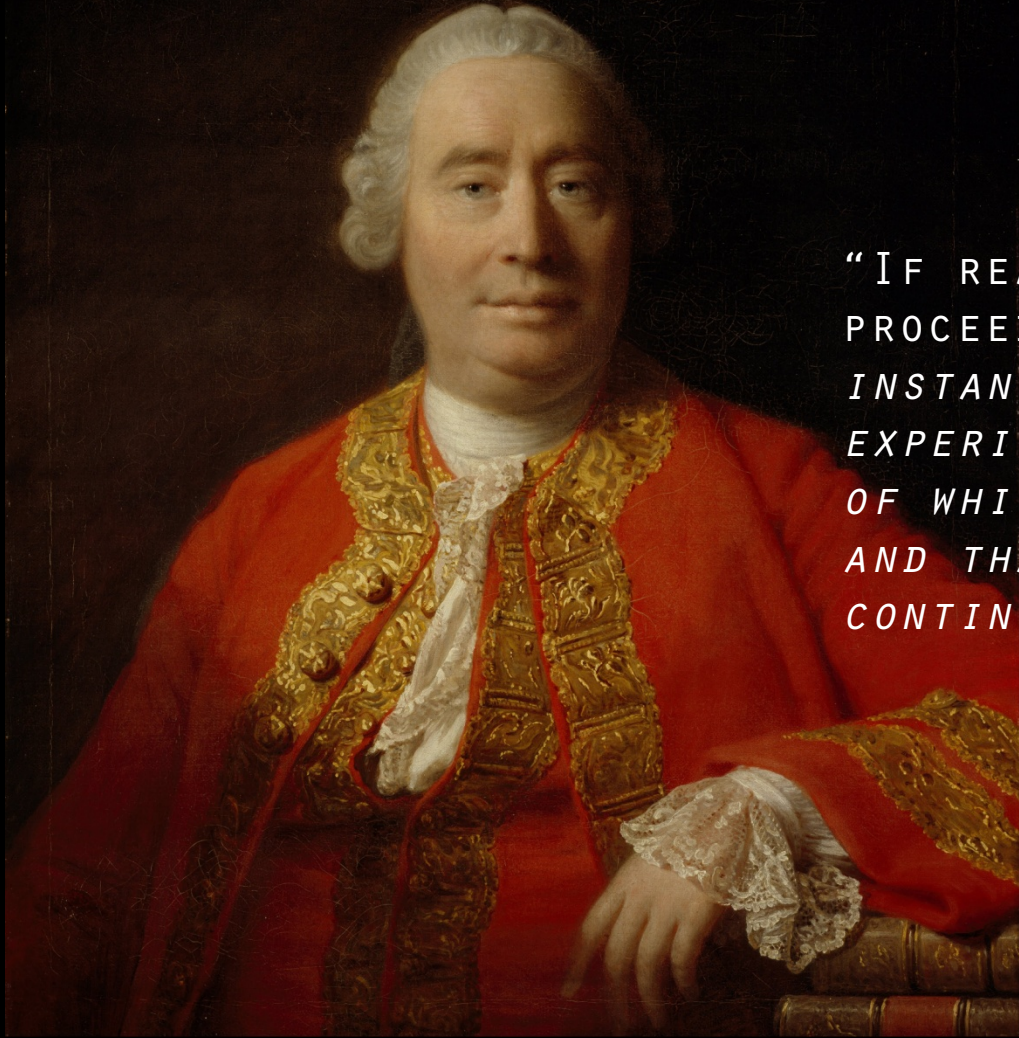
GREGOR MENDEL  
(1822-1884)



TO EXPLAIN HIS RESULTS MENDEL PROPOSED THE FOLLOWING CONCLUSIONS:

1. PARENTS DO NOT TRANSMIT THEIR PHYSIOLOGICAL TRAITS OR FORMS DIRECTLY TO THEIR OFFSPRING. RATHER, THEY TRANSMIT DISCRETE INFORMATION ABOUT THE TRAITS, CALLED *FACTORS* (= *GENES*) THAT ACTS IN THE OFFSPRING TO PRODUCE TRAITS.
2. EACH INDIVIDUAL, WITH RESPECT TO EACH TRAIT, CONTAINS TWO FACTORS, WHICH MAY CODE FOR THE SAME FORM OF THE TRAIT OR WHICH MAY CODE FOR TWO ALTERNATIVE FORMS OF THE TRAIT (= *DIPLOID* AND *ALLELES*).

Character	Dominant vs. recessive trait	F <sub>2</sub> generation		Ratio
		Dominant form	Recessive form	
Flower color	 X  Purple X White	705	224	3.15:1
Seed color	 X  Yellow X Green	6022	2001	3.01:1
Seed shape	 X  Round X Wrinkled	5474	1850	2.96:1
Pod color	 X  Green X Yellow	428	152	2.82:1
Pod shape	 X  Inflated X Constricted	882	299	2.95:1
Flower position	 X  Axial X Terminal	651	207	3.14:1
Plant height	 X  Tall X Dwarf	787	277	2.84:1



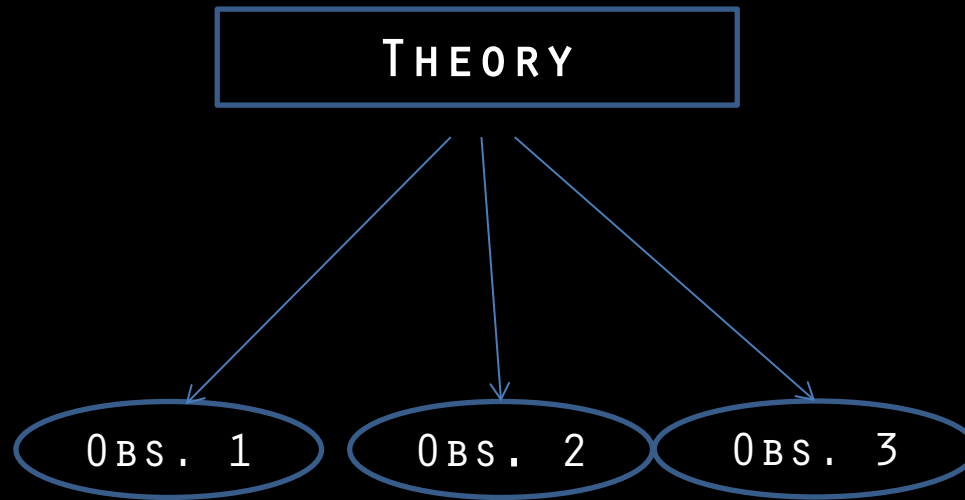
DAVID HUME  
(1711-1776)

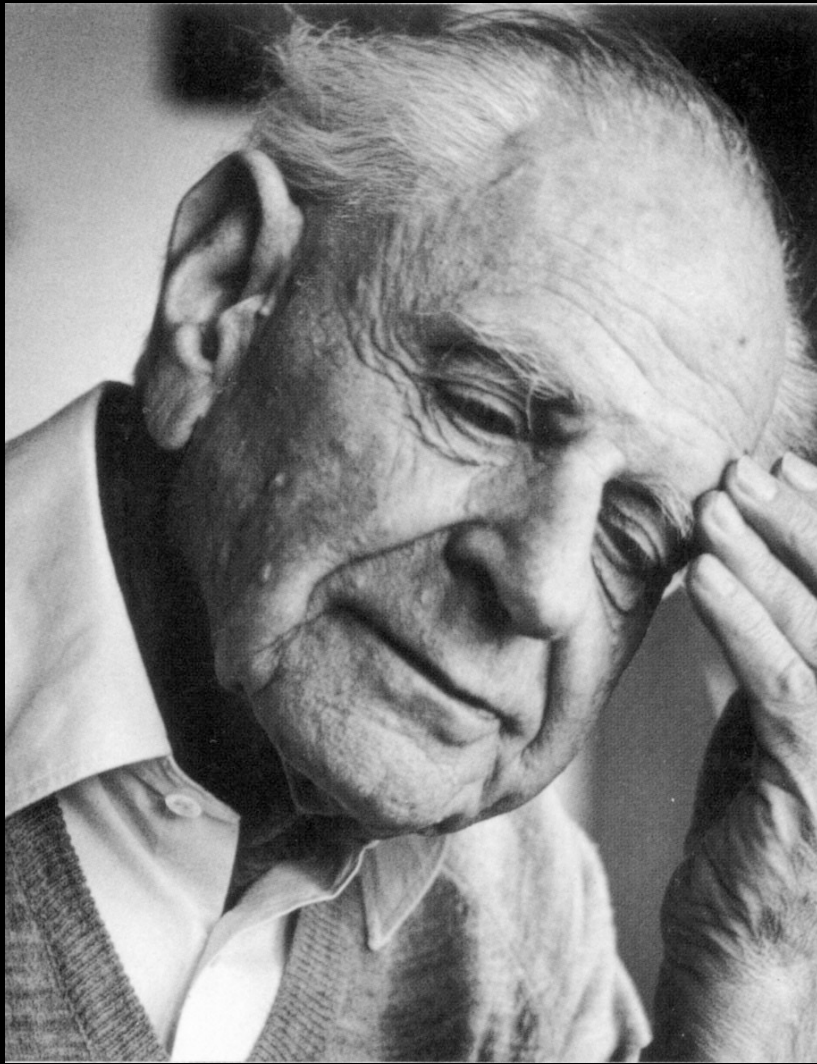
"IF REASON DETERMINED US, IT WOULD PROCEED UPON THAT PRINCIPLE, THAT INSTANCES, OF WHICH WE HAVE NO EXPERIENCE MUST RESEMBLE THOSE OF WHICH WE HAVE HAD EXPERIENCE, AND THAT THE COURSE OF NATURE CONTINUES ALWAYS UNIFORMLY THE SAME."

THE TREATISE OF HUMAN NATURE

# DEDUCTIVE REASONING

*THEORY TESTING APPROACH*



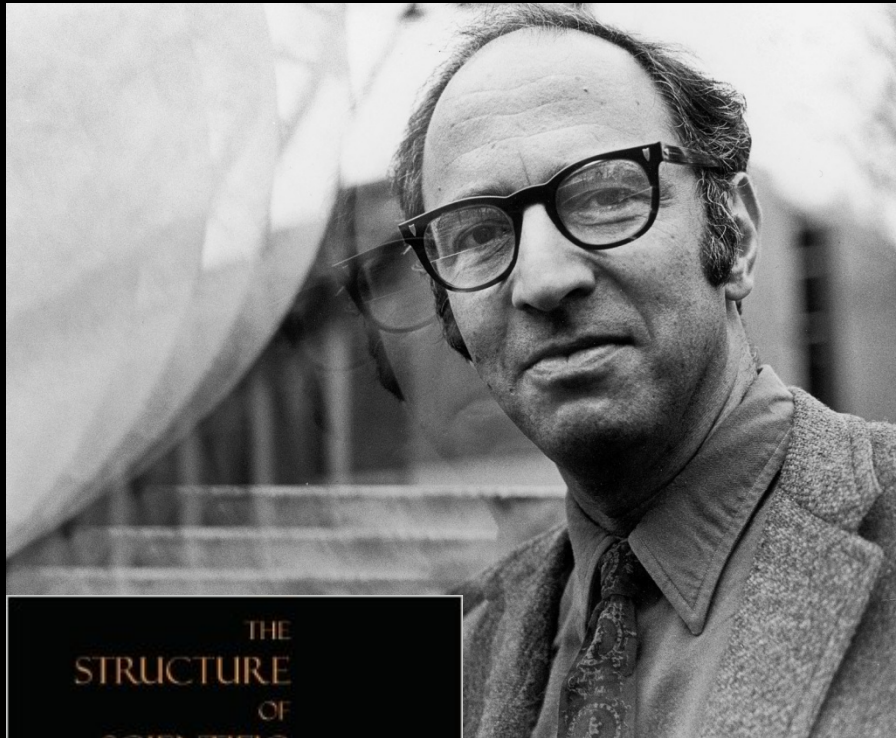


KARL POPPER  
(1902-1995)

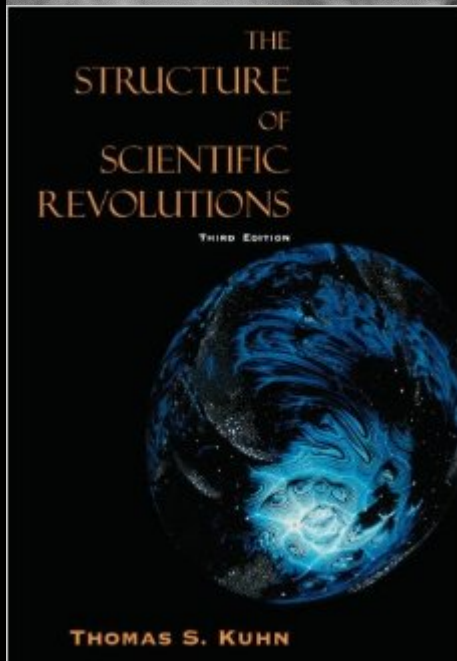
“ONLY THE FALSITY OF THE  
THEORY CAN BE INFERRED FROM  
EMPIRICAL EVIDENCE, AND  
THIS INFERENCE IS A PURELY  
DEDUCTIVE ONE.”

K. POPPER, *CONJECTURES AND REFUTATIONS*





THOMAS KUHN  
(1922-1996)



"IN A SCIENCE, ON THE OTHER HAND, A PARADIGM IS RARELY AN OBJECT FOR REPLICATION. INSTEAD, LIKE AN ACCEPTED JUDICIAL DECISION IN THE COMMON LAW, IT IS AN OBJECT FOR FURTHER ARTICULATION UNDER NEW OR MORE STRINGENT CONDITIONS".

"SCIENTIFIC REVOLUTIONS ARE INAUGURATED BY A GROWING SENSE THAT AN EXISTING PARADIGM HAS CEASED TO FUNCTION ADEQUATELY IN THE EXPLORATION OF AN ASPECT OF NATURE TO WHICH THAT PARADIGM ITSELF HAD PREVIOUSLY LED THE WAY"

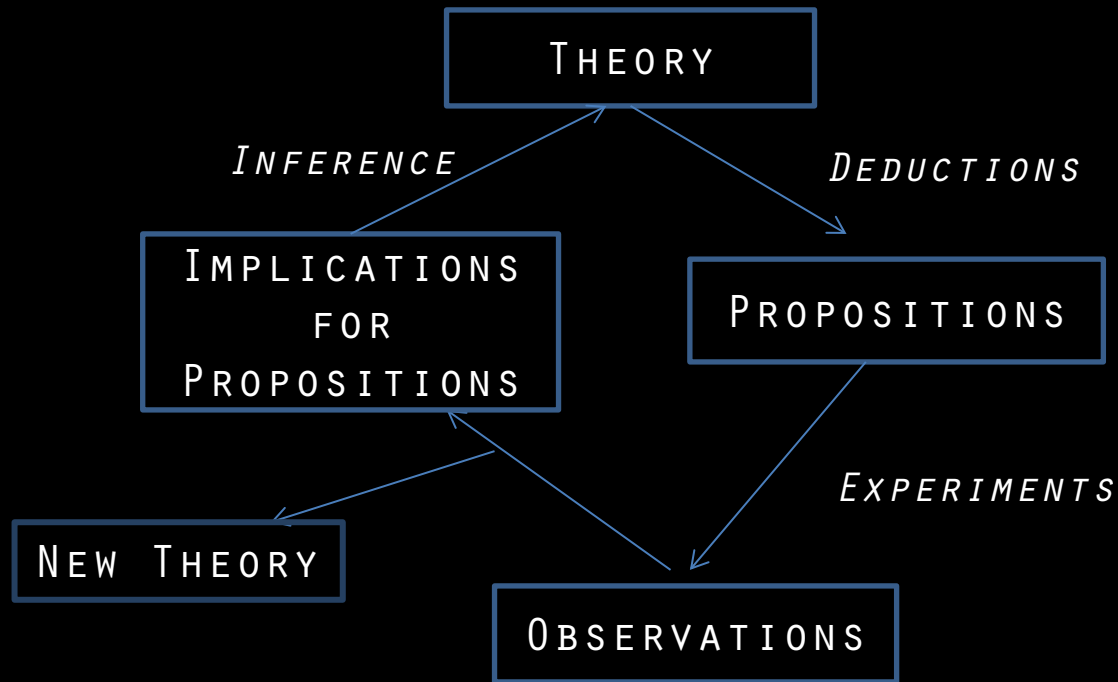
"PARADIGMS GAIN THEIR STATUS BECAUSE THEY ARE MORE SUCCESSFUL THAN THEIR COMPETITORS IN SOLVING A FEW PROBLEMS THAT THE GROUP OF PRACTITIONERS HAS COME TO RECOGNIZE AS ACUTE"

T. KUHN, *THE STRUCTURE OF SCIENTIFIC REVOLUTIONS*, 1962



GEORGES SEURAT  
*UN DIMANCHE APRÈS-MIDI À L'ÎLE DE LA GRANDE JATTE*

# HYPOTHETICO-DEDUCTIVE REASONING





# DIVISION OF LANGUAGE BY KARL BÜHLER

LANGUAGE HAS THREE POSSIBLE FUNCTIONS:

1-EXPRESSION; 2-AROUSAL; 3-DESCRIPTION

ANIMAL + HUMAN

HUMAN

“IF”

“WHEN”

“NOT”

ALLOW FOR LOGICAL INFERENCES

THE VISUAL IMAGE IS SUPREME IN ITS CAPACITY FOR  
AROUSAL, ITS USE FOR EXPRESSIVE PURPOSES IS  
PROBLEMATIC, AND UNAIDED IT LACKS THE  
POSSIBILITY OF MATCHING THE STATEMENT FUNCTION  
OF LANGUAGE.

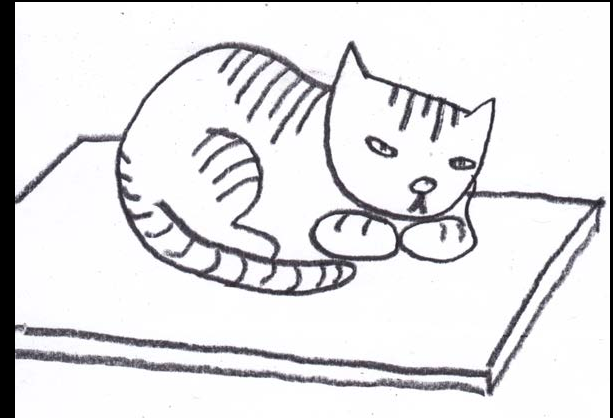
E.H. GOMBRICH, *THE VISUAL IMAGE*, 1972

AROUSAL



CLAUDE MELLAN, "THE NAPKIN OF ST. VERONICA", 1649

UNAIDED THE VISUAL IMAGE LACKS THE POSSIBILITY  
OF MATCHING THE STATEMENT FUNCTION OF LANGUAGE



“THERE IS NO ELEPHANT ON THE MAT”

“IF THE CAT SITS ON THE MAT...”

“THE CAT SAT ON THE MAT”

“THE CAT SITS ON THE MAT”

“A CAT SITS ON THE MAT”

JOINTLY THE MEDIA OF WORD AND IMAGE INCREASE  
THE POSSIBILITY OF CORRECT CONSTRUCTION

E.H. GOMBRICH, *THE VISUAL IMAGE*, 1972



THE CHANCE OF CORRECT READING OF THE IMAGE  
IS GOVERNED BY 3 VARIABLES:

**THE CODE, THE CAPTION AND THE CONTEXT.**



CODE: BLACK TILES FOR SOLID FORM

CAPTION: BEWARE OF THE DOG (CAVE CANEM)

CONTEXT: ENTRANCE OF A HOUSE IN POMPEII

CODE :



STILL LIFE, JAN SIMONSZ



STILL LIFE WITH A BOTTLE OF RUM, PABLO PICASSO

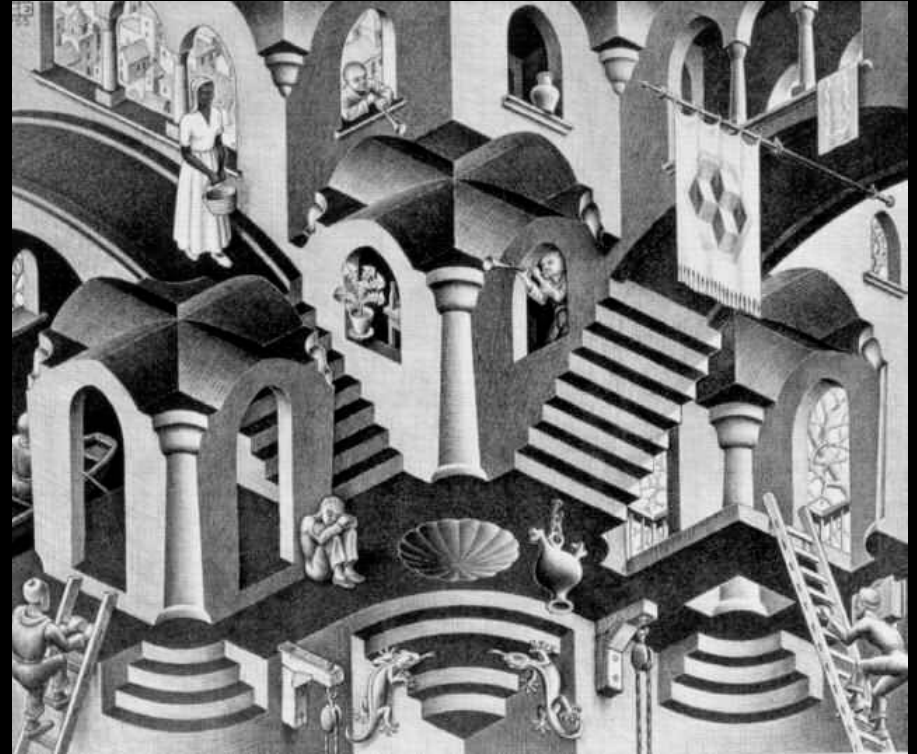
G. H. GOMBRICH, *HOW TO READ A PAINTING*, 1961



CODE :



ROYALIST PRINT FORM  
THE FRENCH REVOLUTION



M.C. ESCHER, *SOLID AND HOLLOW*,  
1955

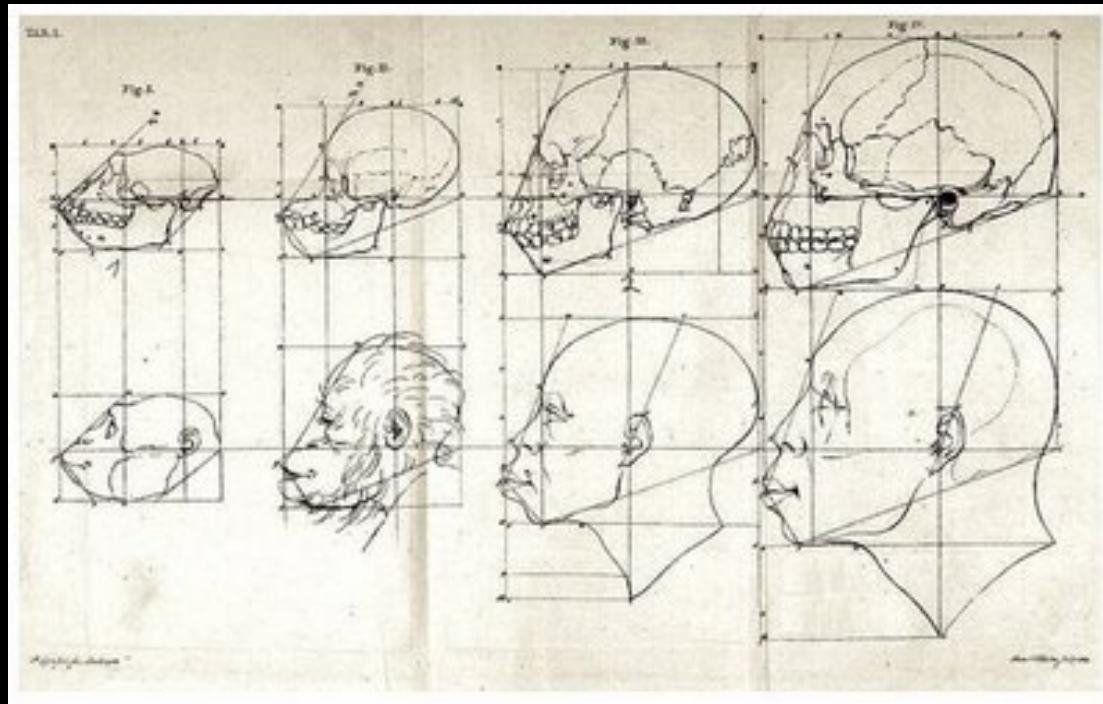


CAPTION:



MAGRITTE, THIS IS NOT A PIPE

CONTEXT :



THE FACIAL ANGLE  
(PETRUS CAMPER 1791)

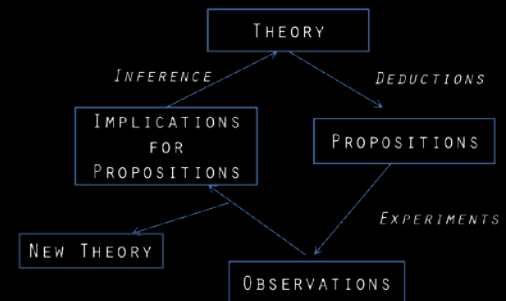
WHAT A PICTURE MEANS TO THE VIEWER IS STRONGLY DEPENDENT ON HIS PAST EXPERIENCE AND KNOWLEDGE.

IN THIS RESPECT THE VISUAL IMAGE IS NOT A MERE REPRESENTATION OF "REALITY" BUT A SYMBOLIC SYSTEM

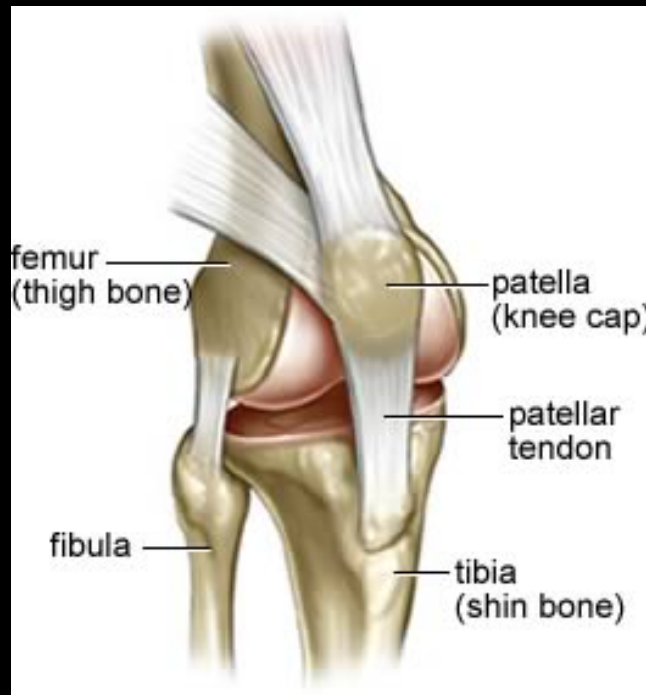
THE VERBAL AND CONTEXTUAL INFORMATION JOLTS US OUT OF THE BEHOLDER'S SHARE: THE CONTRIBUTION WE MAKE TO REPRESENTATIONS FROM THE STOCK OF IMAGES STORED IN YOUR MIND.

IN SCIENCE, IMAGES ARE THEORY-LADEN

HYPOTHETICO-DEDUCTIVE REASONING



THE EASIER IT IS TO SEPARATE CODE FROM CONTENT,  
THE MORE WE CAN RELY ON THE IMAGE TO COMMUNICATE  
A PARTICULAR KIND OF INFORMATION.



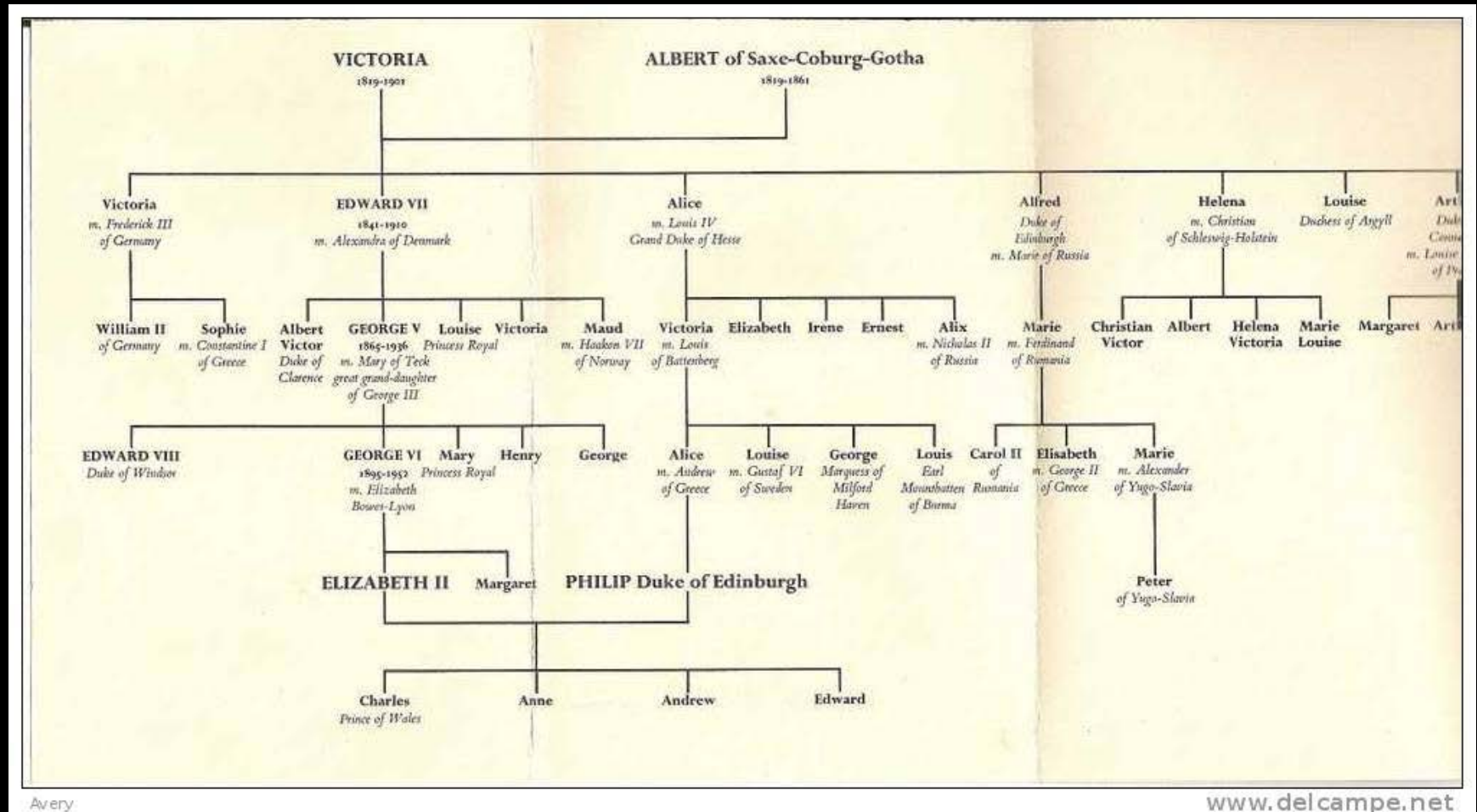
HOW DOES REPRESENTATION REPRESENTS?

“IN THE CASE OF REPRESENTATION BY PICTURES, SCALE MODELS, DIAGRAMS AND MAPS: BY SELECTIVE RESEMBLANCE AND SELECTIVE (EVEN SYSTEMATIC) NON RESEMBLANCE”

THIS PROCESS IS EFFECTIVE IF THE SELECTION IS UNDERSTOOD OR CONVEYS INFORMATION

B.C. VAN FRAASSEN, *SCIENTIFIC REPRESENTATION*, 2008

CHART OR DIAGRAMS THAT ARE SO POWERFUL AT DISPLAYING RELATIONS THAT ARE ORIGINALLY NOT VISUAL BUT TEMPORAL OR LOGICAL (EXAMPLE OF A FAMILY TREE)



Avery

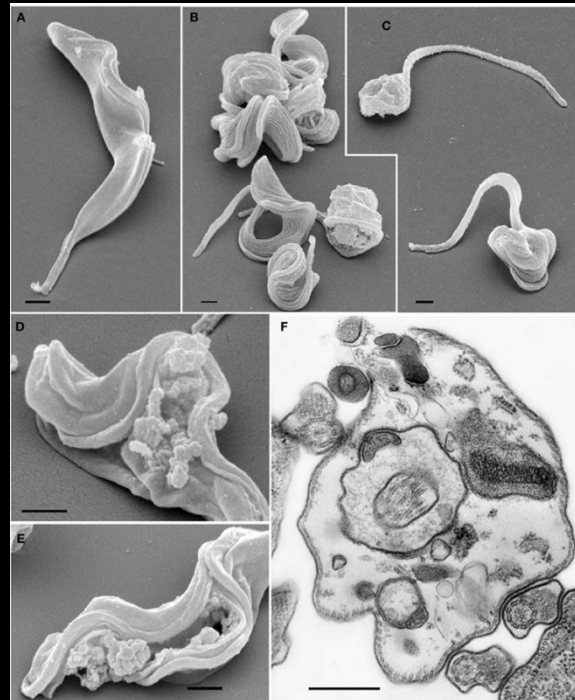
www.delcampe.net

## FAMILY TREE OF QUEEN VICTORIA

[HTTP://WWW.DFILES.ME/QUEEN-VICTORIA-FAMILY-TREE-TO-QUEEN-ELIZABETH.HTML](http://www.dfiles.me/queen-victoria-family-tree-to-queen-elizabeth.html)

# THE ROLES OF THE VISUAL IMAGE IN SCIENCE:

1- SCIENTIFIC IMAGES DO NOT AIM AT RECORDING THE VISIBLE,  
THEIR PURPOSE IS TO MAKE VISIBLE.



EFFECTS OF *KOLA ACUMINATA* PROANTHOCYANIDIN  
(50  $\mu$ g) ON BLOODSTREAM FORM TRYPANOSOMES  
OBSERVED BY SCANNING AND TRANSMISSION  
ELECTRON MICROSCOPY

2- THE VISUAL MODEL SERVES AS AN **ORGANIZING TEMPLATE** FOR WHATEVER OTHER POTENTIALLY RELEVANT INFORMATION THE AGENT MIGHT POSSESS, REGARDLESS OF HOW THAT INFORMATION IS ENCODED. THE VISUAL IMAGE GUIDES THE AGENT'S RECALL OF STORED INFORMATION BY PROVIDING A GUIDE TO WHAT, WITHIN THE AGENT'S DIVERSE STORE OF INFORMATION, IS MOST RELEVANT TO BE THE REQUIRED PROBABILITY JUDGMENT.

R.N. GIERE, VISUAL MODELS AND SCIENTIFIC JUDGMENT IN "SCIENCE WITHOUT LAWS", 1999



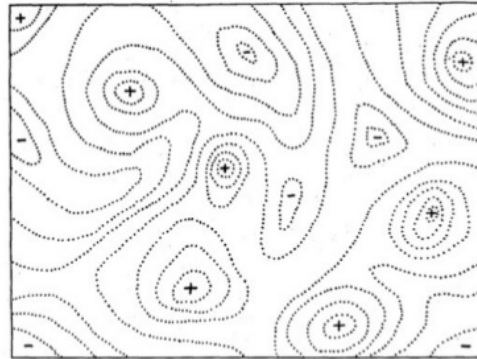
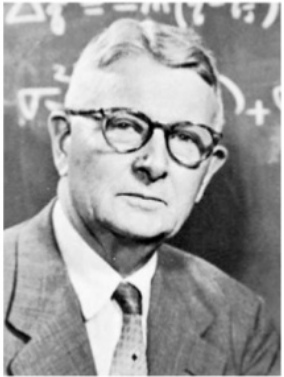
PERIODIC TABLE OF THE ELEMENTS

Reihen	Gruppo I. — R <sup>0</sup>	Gruppo II. — R <sup>0</sup>	Gruppo III. — R <sup>0</sup> <sup>3</sup>	Gruppo IV. RH <sup>4</sup> R <sup>0</sup> <sup>2</sup>	Gruppo V. RH <sup>5</sup> R <sup>0</sup> <sup>3</sup>	Gruppo VI. RH <sup>6</sup> R <sup>0</sup> <sup>3</sup>	Gruppo VII. RH R <sup>0</sup> <sup>7</sup>	Gruppo VIII. — R <sup>0</sup> <sup>4</sup>
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	So=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Su=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Co=140	—	—	—	—
9	(—)	—	—	—	—	—	—	—
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	—
12	—	—	—	Th=231	—	U=240	—	—



### 3-VISUAL IMAGE AS METAPHOR

#### WRIGHT'S IDEA OF AN ADAPTIVE LANDSCAPE:



First appearance of the adaptive landscape: Sewall Wright (1932) "The roles of mutation, inbreeding, crossbreeding and selection in evolution", communication at 6th International Congress of Genetics, Cornell University

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IN EVOLUTIONARY BIOLOGY, ADAPTIVE LANDSCAPES (TYPES OF EVOLUTIONARY LANDSCAPES) ARE USED TO VISUALIZE THE RELATIONSHIP BETWEEN GENOTYPES AND REPRODUCTIVE SUCCESS. . . . THE SET OF ALL POSSIBLE GENOTYPES, THEIR DEGREE OF SIMILARITY, AND THEIR RELATED FITNESS VALUES IS THEN CALLED AN ADAPTIVE LANDSCAPE

METAPHOR ETYMOLOGICALLY MEANS TRANSFER OR TRANSPORT.  
(META: ACROSS, OVER; PHEREIN: TO CARRY, BEAR)

THE METAPHOR IS A VEHICLE

“TO HAVE COMMAND OF METAPHOR IS TO HAVE AN EYE ON  
SIMILARITIES” ARISTOTLE

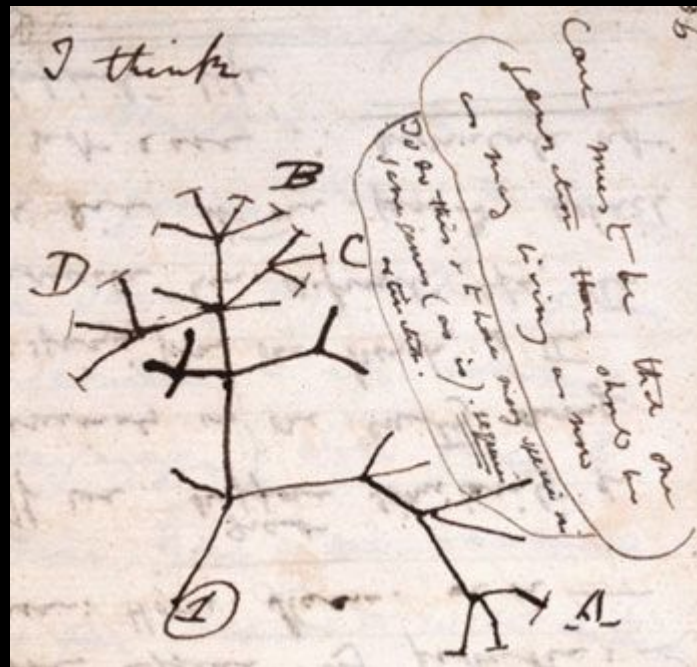
“THE CREATIVE MOMENT OF METAPHOR IS CONCENTRATED ON  
THIS GRASPING OF RESEMBLANCE, IN THE PERCEPTION OF  
ANALOGIES.”

“A NOVEL METAPHOR DOES NOT MERELY ACTUALIZE A  
POTENTIAL CONNOTATION, IT CREATES IT. IT IS A  
SEMANTIC INNOVATION, AN EMERGENT MEANING.”

P. RICOEUR, *CREATIVITY IN LANGUAGE*, 1973

IMAGES CAN SUGGEST FALSE TRAILS BUT LIKE SCIENTIFIC  
HYPOTHESIS CAN BE TESTED AND DISCARDED

THINKING IN PICTURE IS NOT SCIENCE BUT IT IS NOT  
UNRELATED TO SCIENCE EITHER.



FROM CHARLES DARWIN'S NOTEBOOK

“THE ORIGINAL IMAGING IS IN FACT THE HISTORY OF PRESENCE. ORIGINALLY, PRESENCE IS CHANGE BECAUSE IT REFLECTS A COMING INTO IMAGE— PHANTASIA. TO BE PRESENT IS TO ENTER PHANTASIA, THAT IS, THE VERY MOBILITY THAT SHOWS (ITSELF).”

C. MALABOU, *PLASTICITY AT THE DUSK OF WRITING*, 2009.



GASTON  
BACHELARD  
(1884-1962)

“THE SCIENTIFIC MIND CAN GO  
ASTRAY IF IT FOLLOWS  
TWO CONTRARY TENDENCIES: THE  
ATTRACTION OF  
THE SINGULAR AND THE  
ATTRACTION OF THE  
UNIVERSAL. WHERE  
CONCEPTUALIZATION IS  
CONCERNED, WE SHALL DEFINE  
THESE TWO TENDENCIES AS  
CHARACTERISTIC OF KNOWLEDGE  
IN INTENSION AND IN  
EXTENSION”

G. BACHELARD, THE FORMATION OF THE  
SCIENTIFIC MIND, 1938.