

Kognitionspsychologie: Session 1

Introduction

Rui Mata, HS 2024

Version: October 1, 2024

Rui Mata: Education and Main Academic Positions

2002

Licenciatura (MSc.) in Psychology
University of Lisbon, Portugal

2002-2006

Predocctoral Fellow, **Max Planck Research School LIFE**
Max Planck Institute for Human Development, Germany.

2006-2007

Postdoctoral fellow, **University of Michigan**, USA

2007-2010

Postdoctoral fellow, **University of Lisbon**, Portugal,
and **Stanford University**, USA

2010-2012

Research Scientist, **University of Basel**, Switzerland

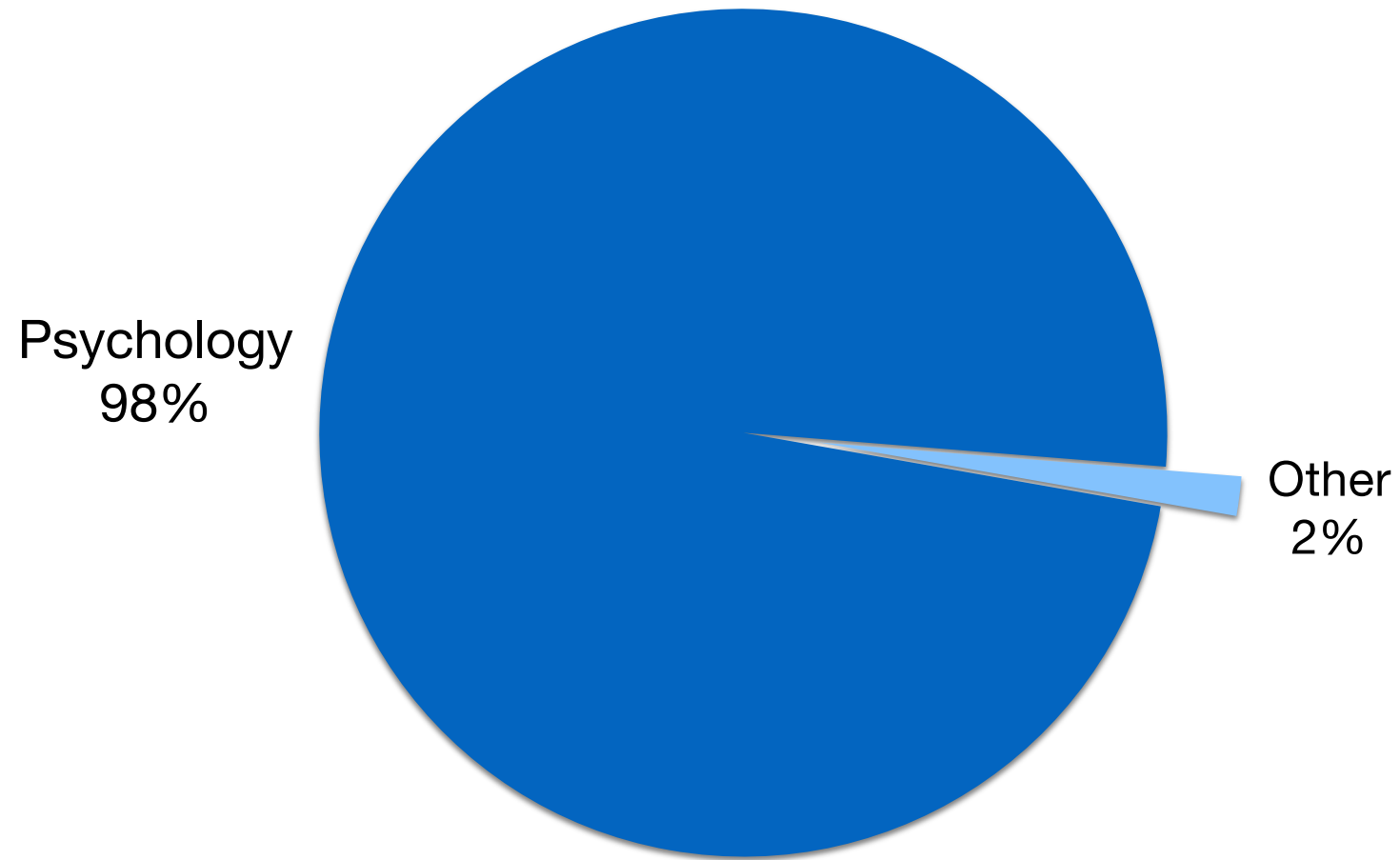
2012-2014

Senior Research Scientist, Center for Adaptive Rationality,
Max Planck Institute for Human Development, Germany

since 2014

Prof. Cognitive & Decision Sciences, **University of Basel**

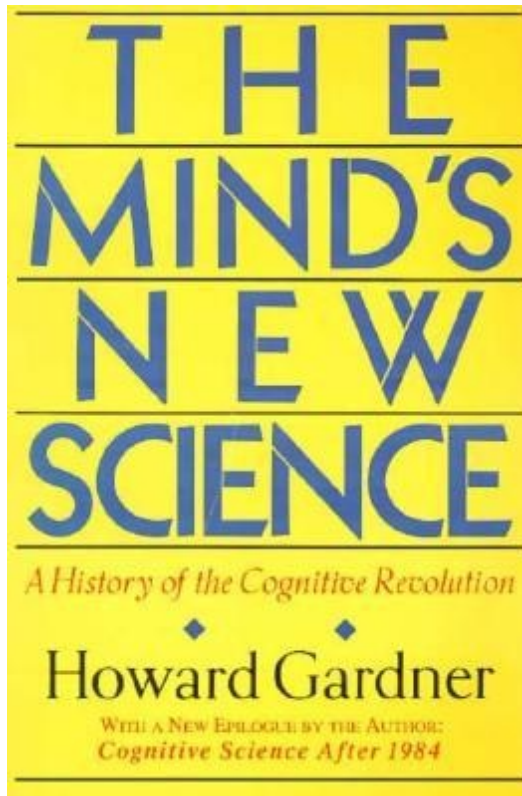
You



Learning Objectives for the Semester

You will...

- learn about central theories and models in key areas of psychology
- become familiarized with common methods used in psychology
- learn about examples of applications of psychology to real-world contexts
- reflect about the need for pluralistic explanations in psychology



„The safest general characterization of the European philosophical tradition is that it consists of a series of footnotes to Plato“

Alfred North Whitehead

Gardner, H. (1985). *The mind's new science: A history of the cognitive revolution*. New York: Basic Books.

WHAT IS NEW UNDER THE SUN?



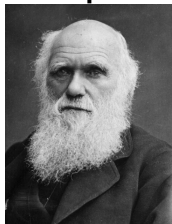
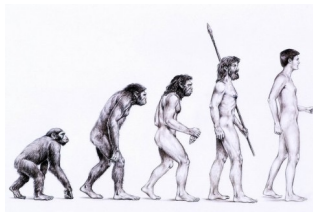
Is there nothing new under the sun?

Example

Person

Discipline

Evolution

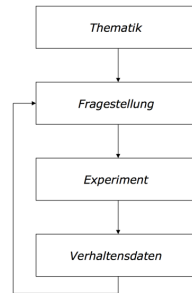


Charles Darwin

Biology

1838

Empirical Method



Wilhelm Wundt

Psychology

1879

Information Theory

ENIAC: Electronic Numerical Integrator And Computer

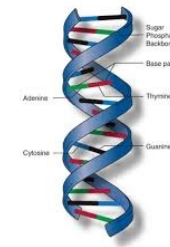


Claude Shannon

Computer Science

1948

DNA Structure

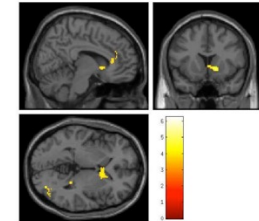


James Watson & Francis Crick + Rosalind Franklin

Genetics

1953

fMRI



Seiji Ogawa

Medicine

1992

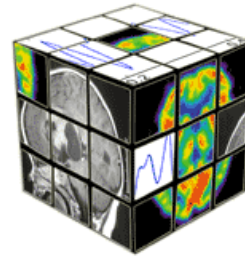
Learning Objectives for Today

- Place psychology within the Cognitive/Neuro/Affective Sciences
- Discuss pluralistic explanations: Aristotle, Marr, Tinbergen
- Discuss the role of evolutionary explanations in psychology
- Become familiarized with the course structure and the syllabus

Psychology and the other sciences...



<http://cognitivesciencesociety.org/>
(1979)



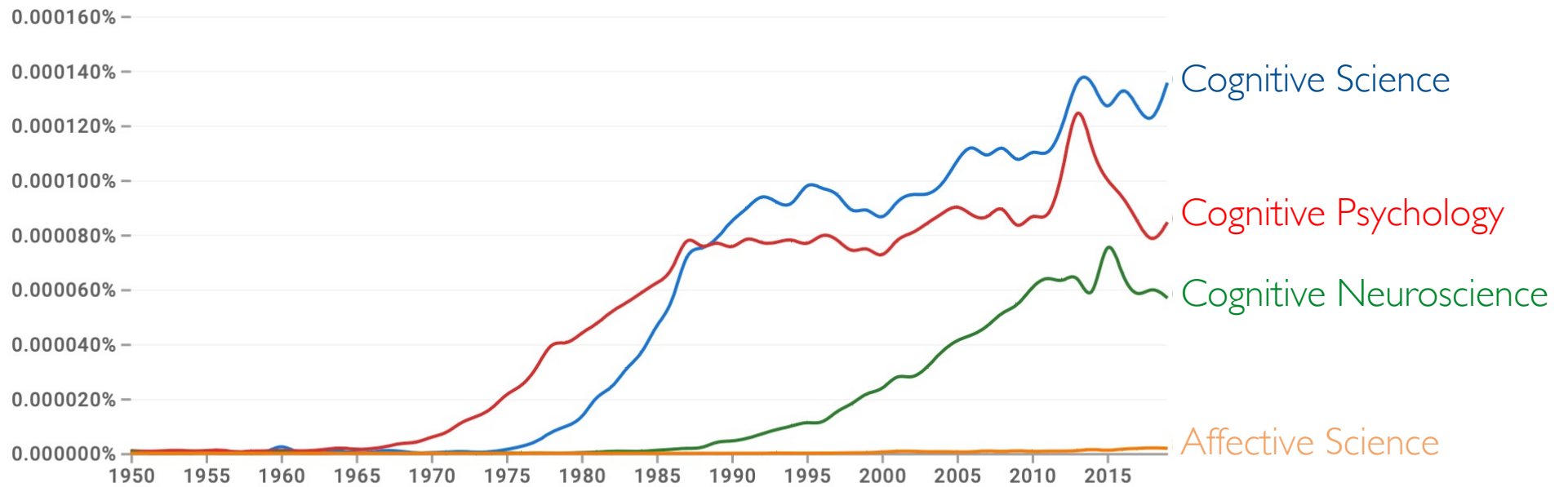
Cognitive
Neuroscience
Society

<http://www.cogneurosociety.org>
(1994)

**The Society for
Affective Science**

<http://www.society-for-affective-science.org>
(2012)

The formation of societies can be seen as a symptom of attempts to place psychology in contact with a larger set of ideas and research agendas across the last few decades; from a focus on explanations of cognition as representation and computation (Cognitive Science), the role of biological implementation for behavior (Cognitive Neuroscience), to the affective and motivational bases of human behavior (Affective Science).



(click on line/label for focus, right click to expand/contract wildcards)

Google books Ngram Viewer

Frequency of use of the terms *Cognitive Science*, *Cognitive Psychology*, *Cognitive Neuroscience*, and *Affective Science* in the last ca. 70 years

Pluralistic Explanations

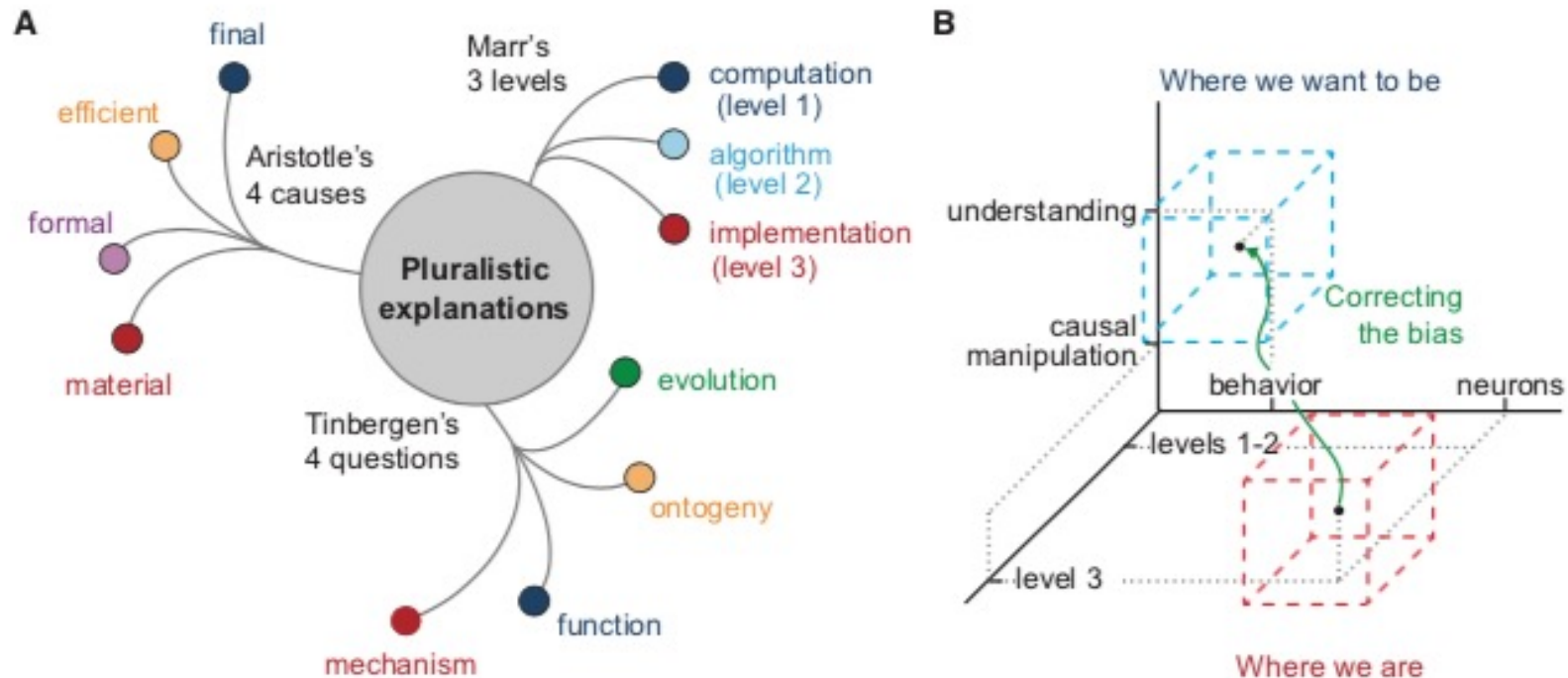


Figure 4. The Future History of Pluralistic Explanation

(A) That understanding of a phenomenon is multidimensional has long been appreciated. Aristotle posited four kinds of explanation: to explain “why” something changes, a polyhedral notion of causality is necessary; one that includes not only the material cause (what it is made out of), but also the other three “whys”: formal (what it is to be), efficient (what produces it), and final (what it is for). Tinbergen also devised four questions about behavior: to go beyond its proximate causation (mechanism) to also considering its evolution, development, and real-world function. Marr’s three levels are also shown.

(B) Three-dimensional space with axes of understanding-manipulation, behavior-neurons, and Marr’s levels. The red box is where we are and the blue is where we should be.

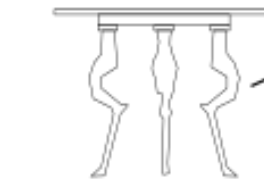
Krakauer, J. W., Ghazanfar, A. A., Gomez-Marín, A., Maclver, M. A., & Poeppel, D. (2017). Neuroscience needs behavior: Correcting a reductionist bias. *Neuron*, 93(3), 480–490. <http://doi.org/10.1016/j.neuron.2016.12.041>

Aristotle's four causes

Material Cause:
Wood



Final Cause:
Dining



Formal Cause:
Design



Efficient Cause:
Carpentry

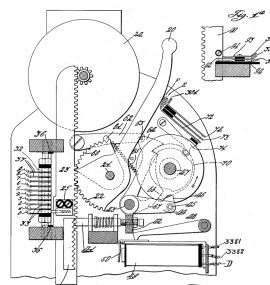
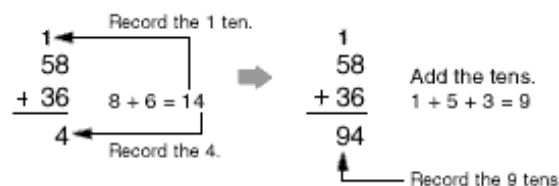
Marr's levels

- **Computational level:** What is the goal of a given process/computation?
- **Algorithmic level:** How can a goal be achieved using a particular set of inputs/outputs, which algorithm describes the required transformations?
- **Implementational level:** How is an algorithm physically implemented (e.g., neural activity)?



Addition

$$S_T = Z_1 + \dots + Z_N$$



David Marr (1945-1980)

Studied mathematics and physiology but later worked as a professor of Psychology at MIT. He integrated results from psychology, artificial intelligence, and neurophysiology to produce a new model of vision. He is particularly famous for proposing a three level view of how to understand information processing systems (see left).

Marr, D. C., & Poggio, T. (1977). From understanding computation to understanding neural circuitry. *Neurosciences Research Program Bulletin*, 15(3), 470–488.

Tinbergen's four questions

Tinbergen argued that there are complementary categories of explanations, involving different kinds and objects of explanation.

FOUR AREAS OF BIOLOGY: FOUR QUESTIONS		Two objects of explanation	
		<u>Developmental/historical</u> A sequence that results in the trait	<u>Single form</u> The trait at one slice in time
Two kinds of explanations	<u>Proximate</u> Explains how organisms work by describing their mechanisms and their ontogeny	<u>Ontogeny</u> Q: How does the trait develop in individuals? A: Description of the trait's forms at sequential life stages, and the mechanisms that control development.	<u>Mechanism</u> Q: What is the structure of the trait; how does it work? A: Description of the trait's anatomy, physiology, regulation, and how the trait works to accomplish a function.
	<u>Evolutionary</u> Explains how a species came to its current form by describing a sequence of forms, and how they were influenced by selection and other evolutionary factors.	<u>Phylogeny</u> Q: What is the phylogenetic history of the trait? A: Description of the history of the trait as reconstructed from its phenotype and genotype precursors	<u>Adaptive significance</u> Q: How have variations in the trait interacted with environments to influence fitness in ways that help to explain the trait's form? A: Description of how variations in the trait have influenced fitness



Nikolaas Tinbergen (1907-1988)

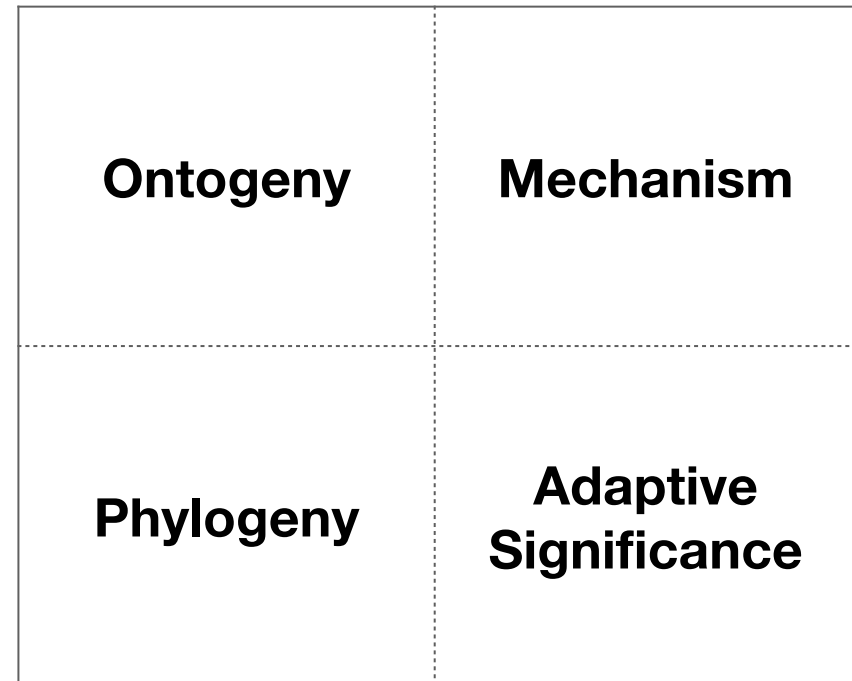
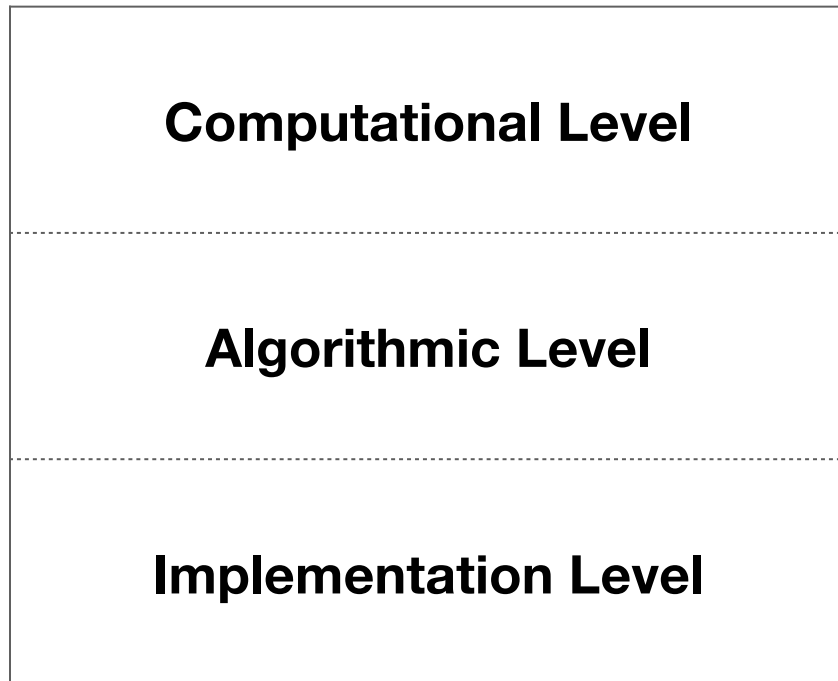
Ethologist, received the Nobel Prize for Medicine in 1973 for “discoveries concerning organization and elicitation of individual and social behaviour patterns”. Tinbergen had a large impact on the field of ethology (i.e., the science of animal behavior) with his book *The Study of Instinct* (1951), in which he proposed to investigate innate behaviour that is not acquired or changed by learning.

Nesse, R. (2013), Tinbergen's four questions, organized: A response to Bateson and Laland. *Trends in Ecology and Evolution*, 28(12), 681-682.

Tinbergen, N. (1963) On aims and methods of ethology. *Z. Tierpsychol*, 20, 410–433.

https://en.wikipedia.org/wiki/Tinbergen%27s_four_questions

Marr's Levels vs. Tinbergen's Questions



Summary

- **Psychology over time:** historically, psychology has had different foci; since the “cognitive revolution” there has been a focus on understanding cognition (e.g., perception, memory, language) resorting to concepts of representation and computation; more recently, there has been increased focus on biological implementation (cognitive neuroscience) and understanding both cognition and affect/motivation (affective science).
- **Pluralistic explanations:** philosophy (Aristotle) and the natural sciences (Marr, Tinbergen) have accepted that natural phenomena are multi-faceted and their understanding requires various forms of explanation; today, different but somewhat related views on relevant forms of explanation coexist (Marr’s levels: computational, algorithmic, implementation; Tinbergen’s questions: ontogeny, mechanism, phylogeny, adaptive significance).