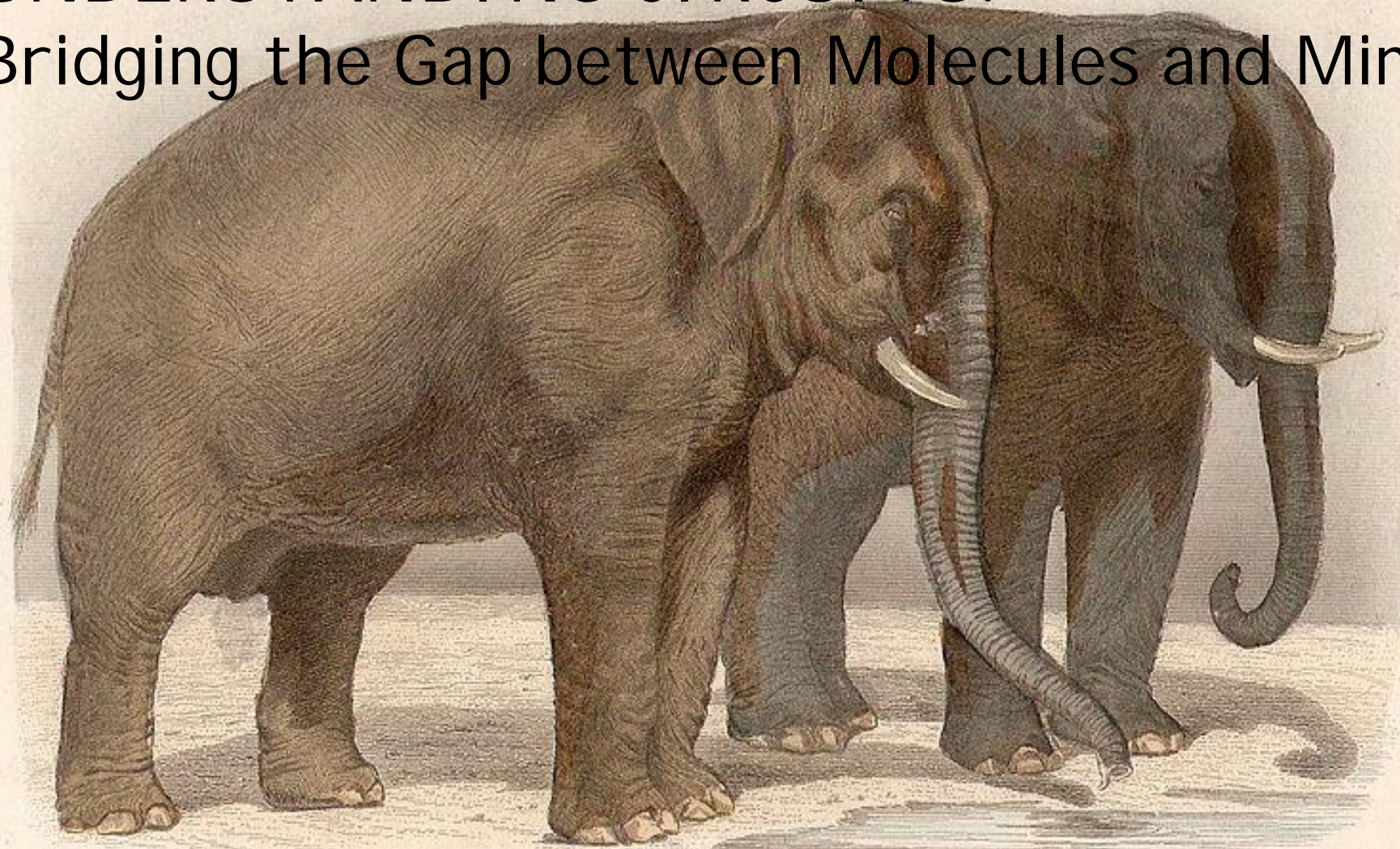


UNDERSTANDING CIRCUITS: Bridging the Gap between Molecules and Mind



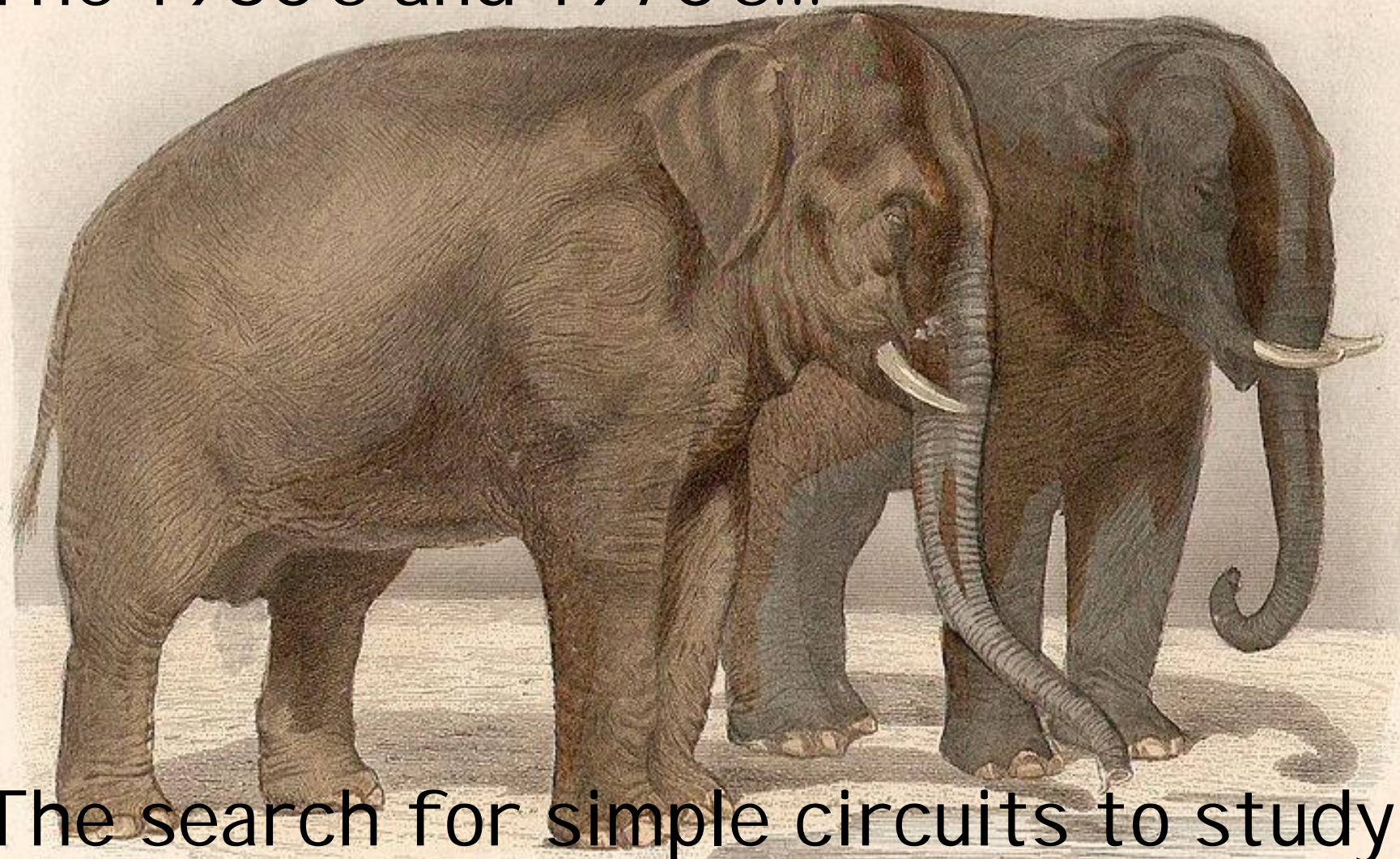
EVE MARDER Brandeis University
June 24, 2008

O ELEPHANTE.

Magalhães & Moniz, Editores

Rodriguez sc.

The 1960's and 1970's...



The search for simple circuits to study how the nervous system generates behavior.....

H. Gobin del.

Imp. Lemercier, Paris.

RATARD sc.

O ELEPHANTE.

Magalhães & Moniz, Editores

The lure of identified neurons and behaviors amenable to analysis

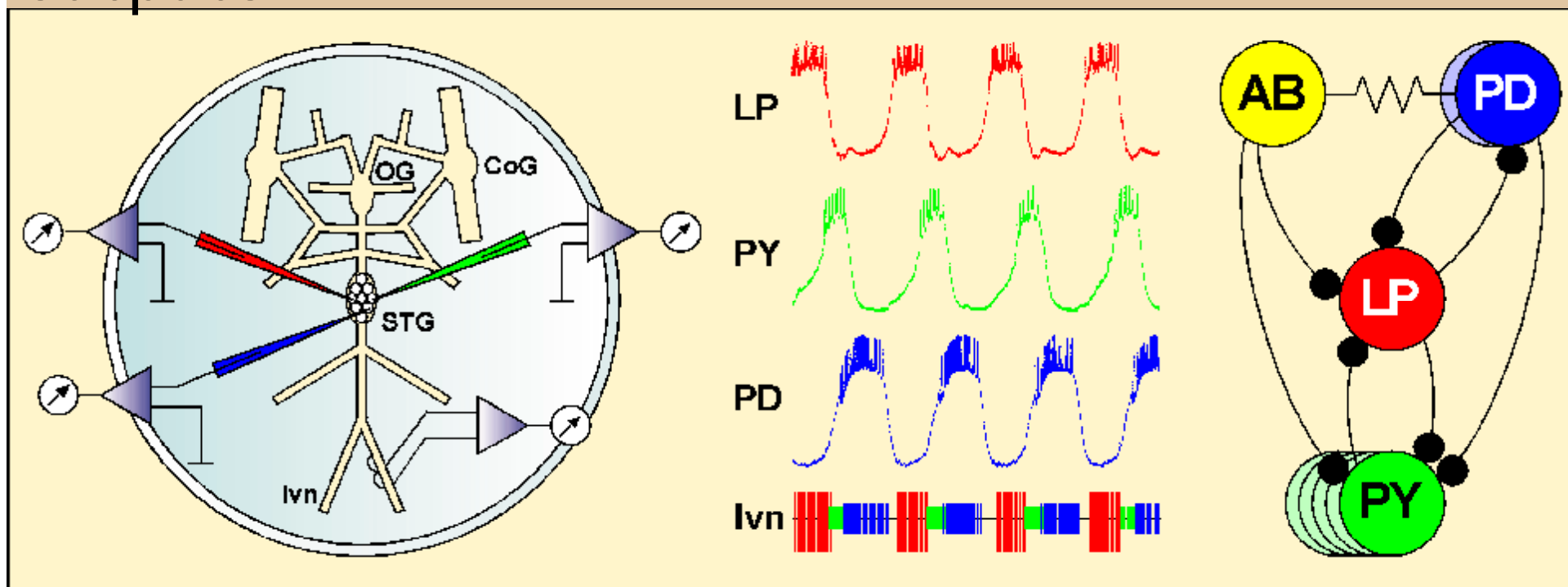
leech, *Aplysia*, *Tritonia*,
cockroach, locust, snails

crayfish, lobsters, crabs,
frogs, electric fish, lamprey

The Strategy

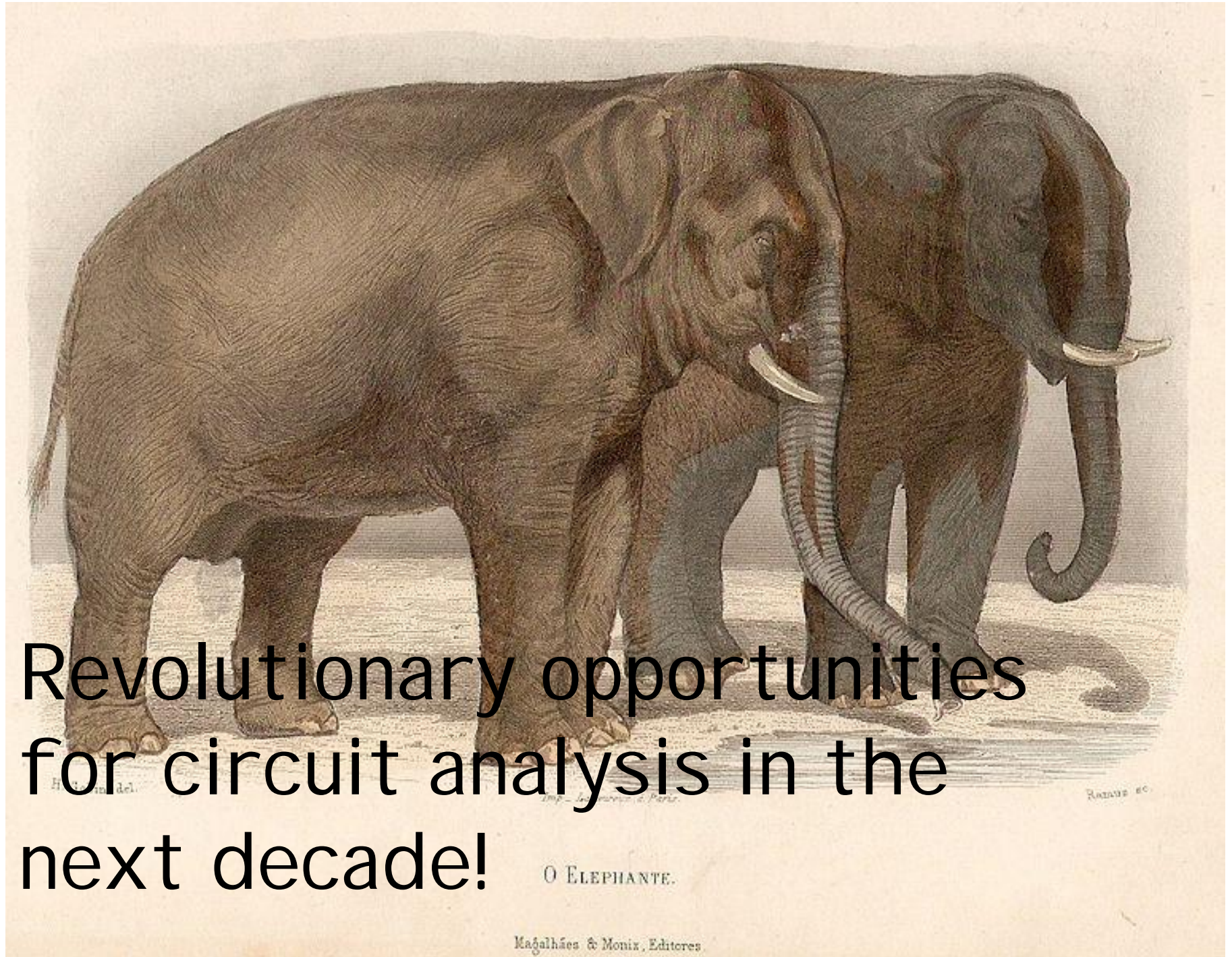
- Define behavior
- Develop preparations that allowed recording from identified neurons during the behavior
- Determine the connectivity among neurons thought to participate in the behavior
- Perturb individual circuit elements to deduce their role in circuit dynamics and behavior

Lessons learned from small circuits: the circuit is necessary but not sufficient to account for dynamics; circuits are not “hard-wired”, but neuromodulation, history, and behavioral state can reconfigure circuit outputs



Impediments to understanding larger circuits in vertebrate brains

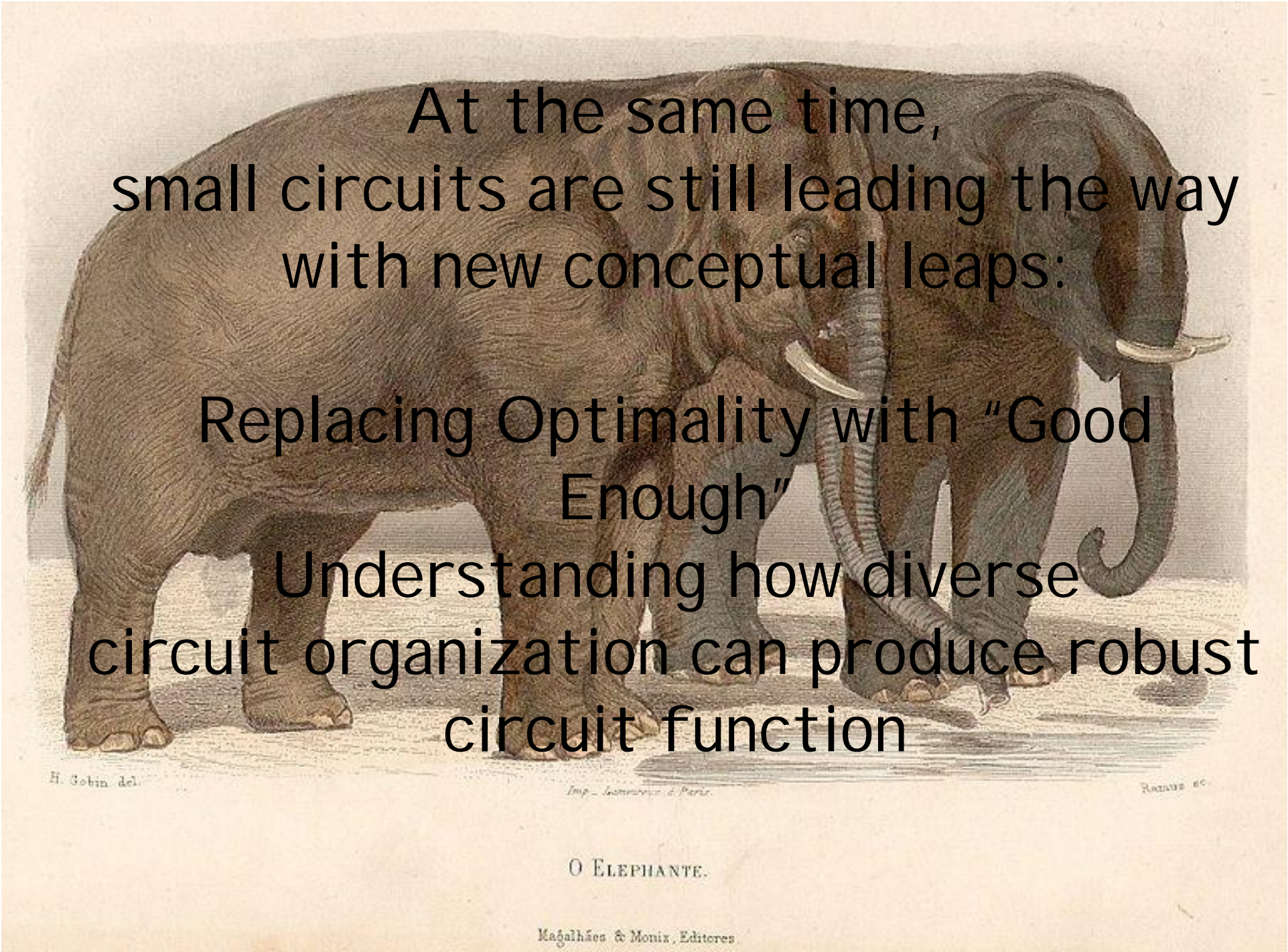
- Difficulty in identifying neurons
- Difficulty in perturbing individual classes of neurons
- Difficulty in recording from enough of the neurons at the same time, with high enough spatial and temporal resolution



Revolutionary opportunities
for circuit analysis in the
next decade!

WHY NOW?

- Genetic markers for cell identification
- Use of light to excite or inhibit targeted sets of neurons
- Optical methods for recording large ensembles of neurons
- New methods for multichannel recordings in slice and *in vivo*
- Advances in computational tools



At the same time,
small circuits are still leading the way
with new conceptual leaps:

Replacing Optimality with "Good
Enough"

Understanding how diverse
circuit organization can produce robust
circuit function

H. Sobin del.

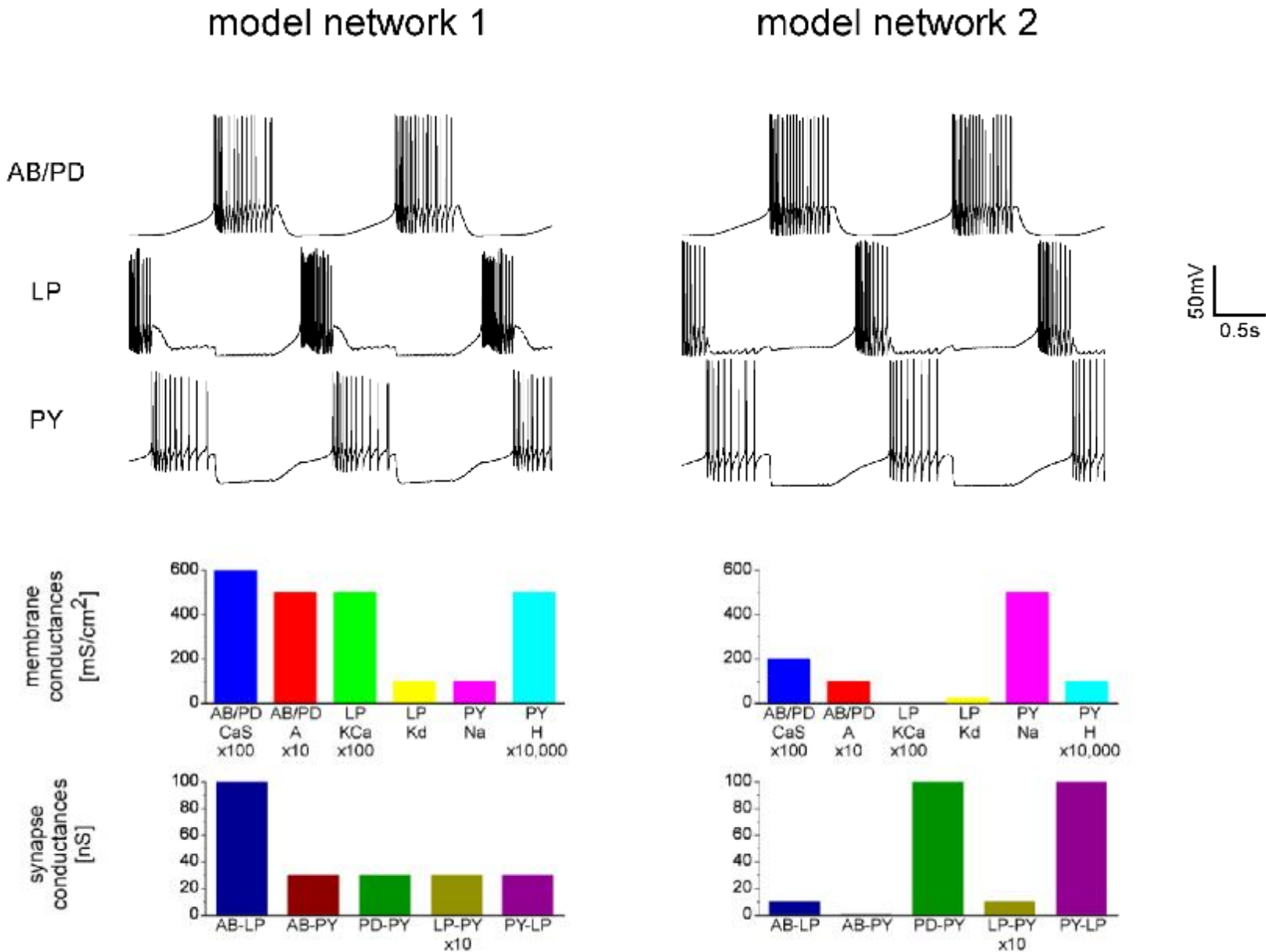
Imp. - Leconte & Paris.

Romaine sc.

O ELEPHANTE.

Maçalhães & Moniz, Editores

Similar network activity; disparate circuit parameters

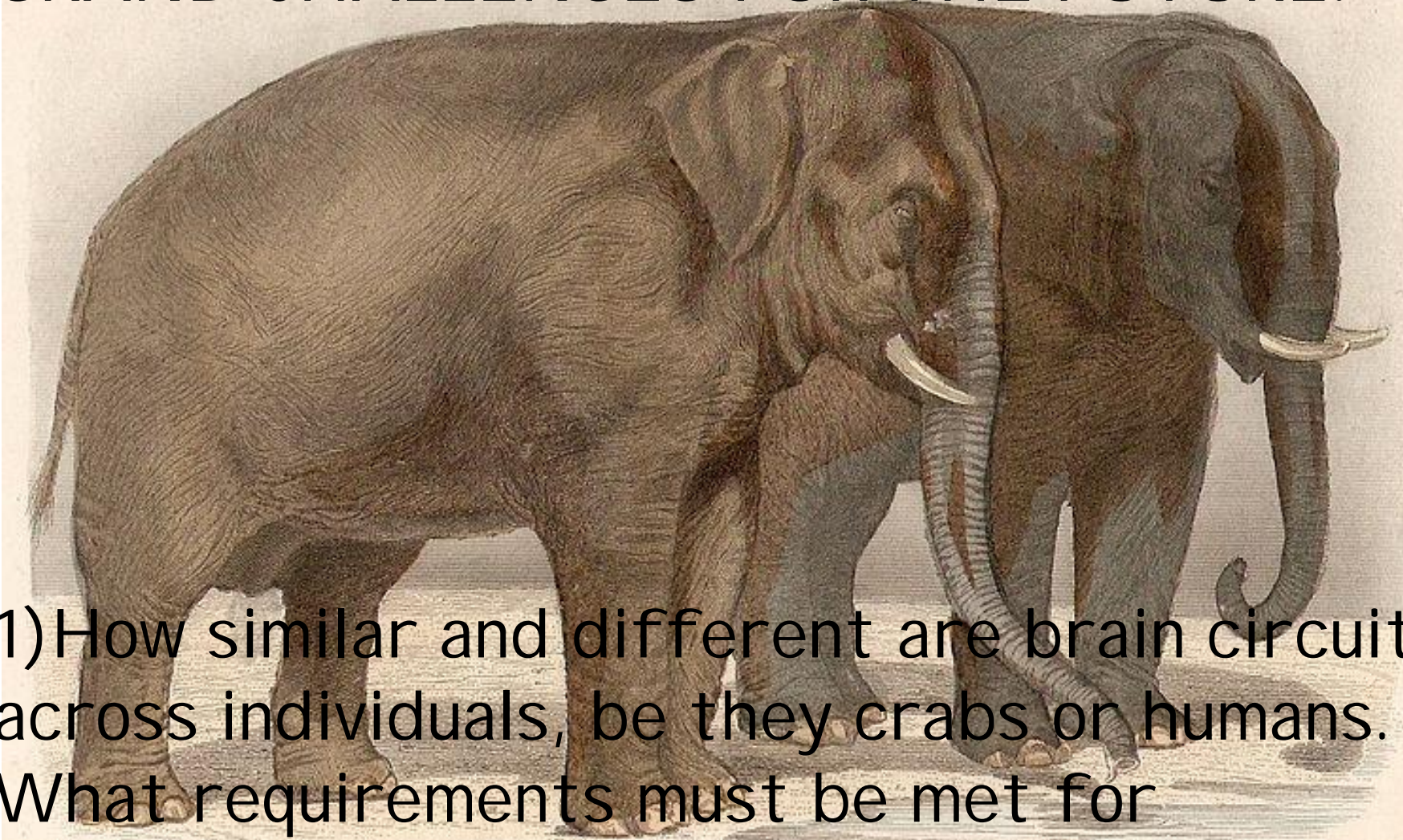


THE POTENTIAL TRAP OF USING GENETIC ORGANISMS AND BENEFITTING FROM ALL OF THEIR ADVANTAGES:



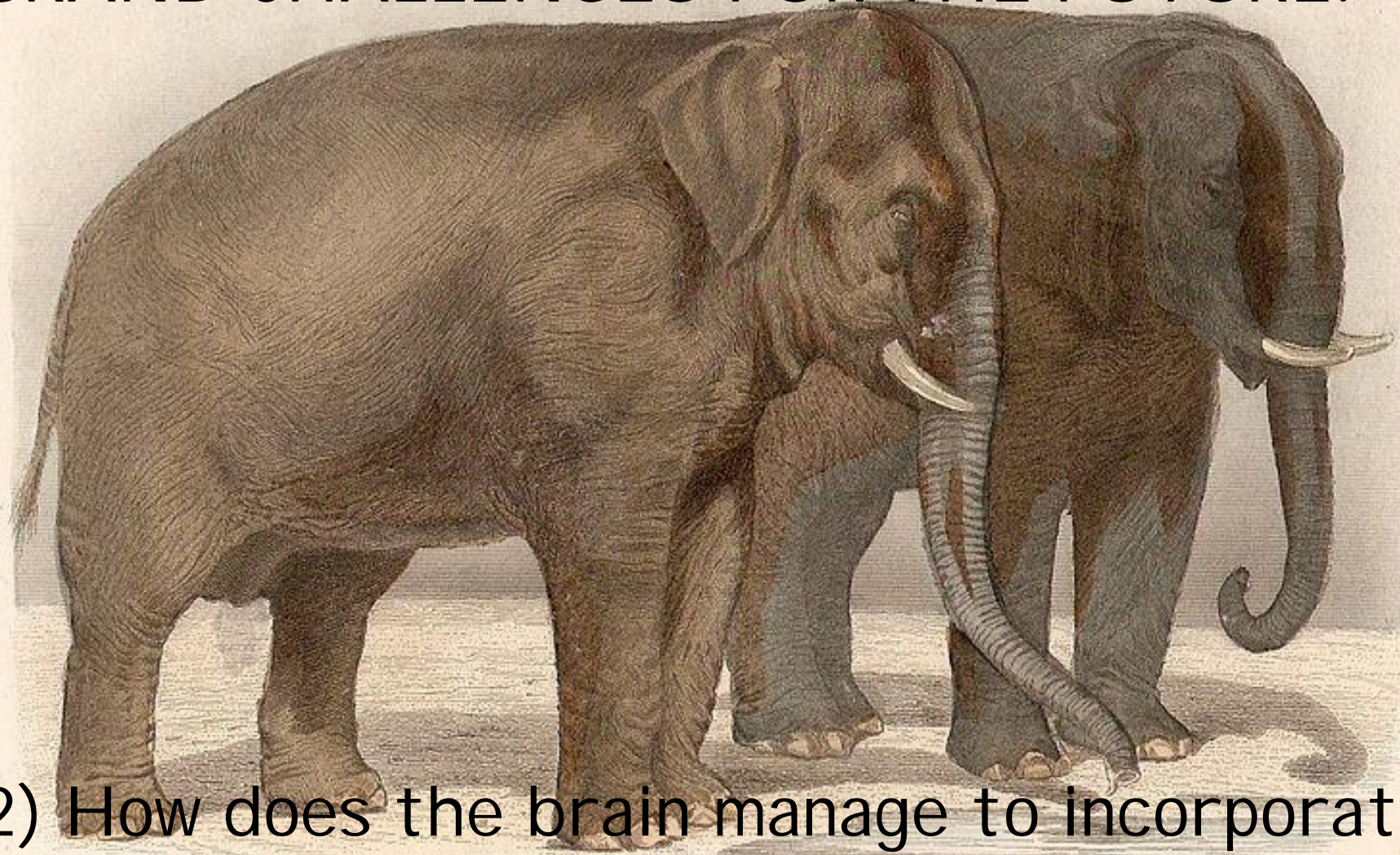
LOSING TRACK OF THE DIVERSITY
IN NATURAL POPULATIONS

GRAND CHALLENGES FOR THE FUTURE:



1) How similar and different are brain circuits across individuals, be they crabs or humans. What requirements must be met for “normal circuit function” and how is disease seen in disordered circuit organization?

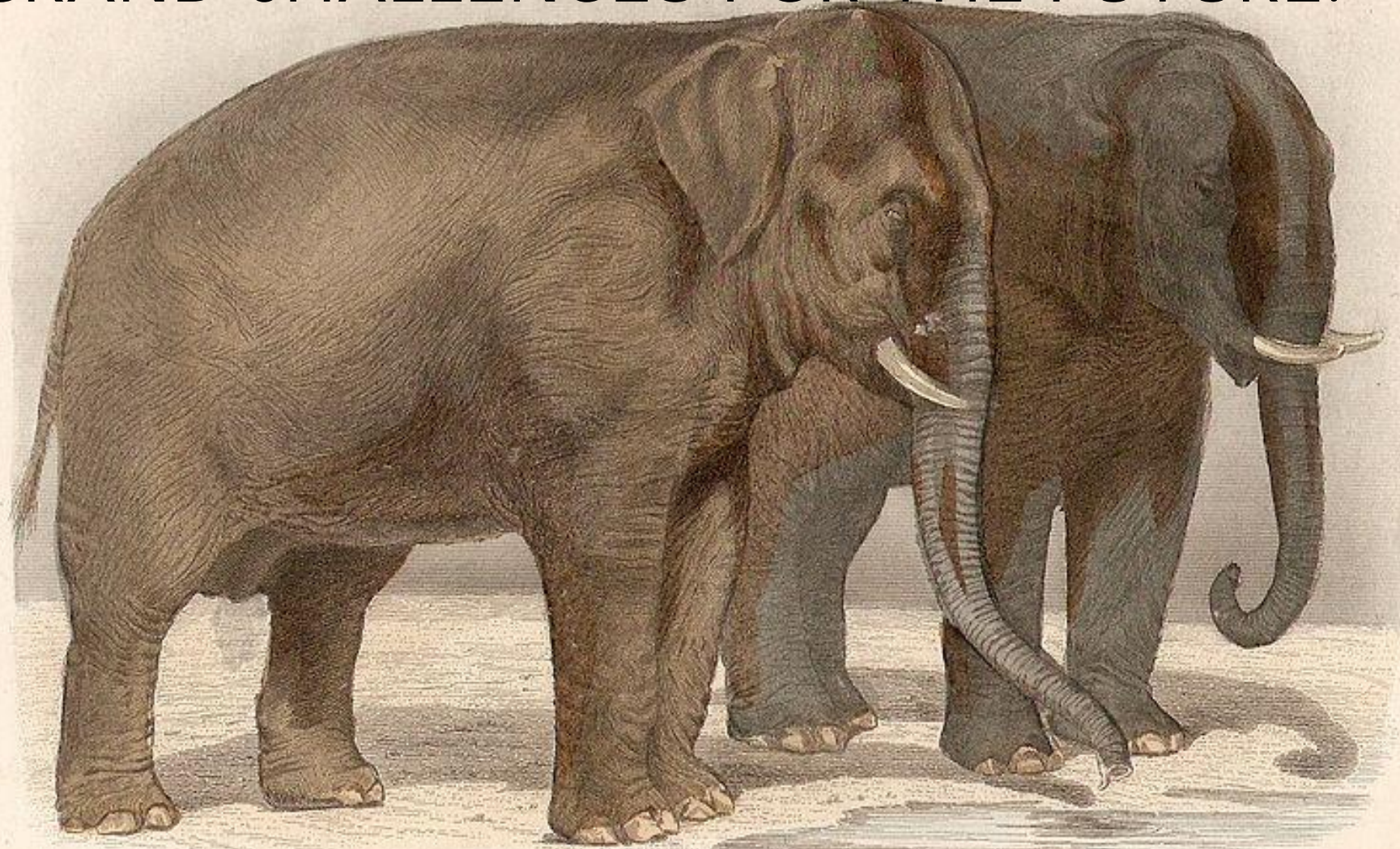
GRAND CHALLENGES FOR THE FUTURE:



2) How does the brain manage to incorporate change into circuits without destroying their function?

O ELEPHANTE.

GRAND CHALLENGES FOR THE FUTURE:



3) How do circuit structure and function arise as a consequence of genetic and experiential factors?

