



Timeframe of study

(Level) of question

Proximate (how):
An explanation in terms of immediate factors, relevant and potentially measurable in current time.

Ultimate (why)
An explanation in terms of the process and forces of evolution.

Snap shot:
An explanation of the current form of a behavior in terms of present-day

Story:
An explanation of the current form of the behavior in terms of a sequence

Mechanism
(a.k.a. causation)

Causal explanations in terms of what the behavior is and how the behavior is constructed. These explanations can include physical morphology, molecular mechanisms or other underlying biological factors

Aristotle: material cause

Ontogeny
(a.k.a. development)

Developmental explanations for sequential changes across the lifespan of an individual. Often these explanations are concerned with the degree to which the behavior can be changed through learning.

Aristotle: formal cause

Adaptive Value
(a.k.a. function or survival value)

Functional explanations regarding the utility of the current form of the behavior with regard to increasing an organisms lifetime reproductive success.

Aristotle: final cause

Phylogeny
(a.k.a. evolution)

Evolutionary explanations that describe the history of the behavior, such as which ancestor first possessed this trait, what was the antecedent to this behavior, and what selective pressures in the past have shaped this behavior.

Aristotle: efficient cause



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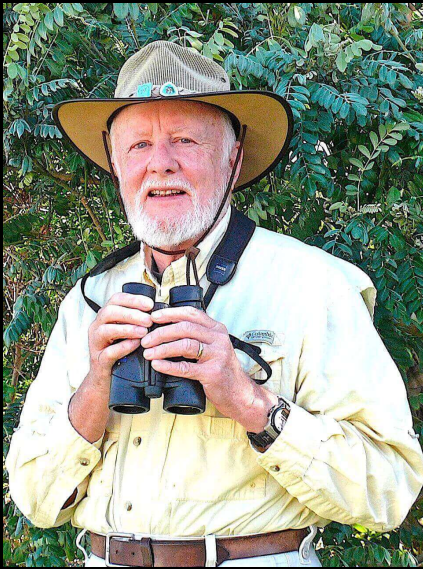
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Snap shot:

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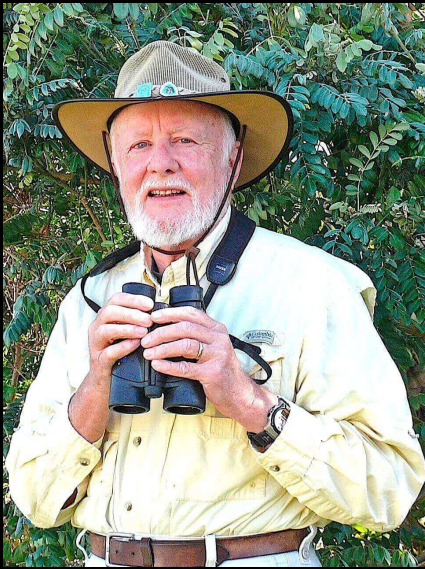
An explanation of the current form of the behavior in terms of a sequence



Jack Hailman
1976

Level

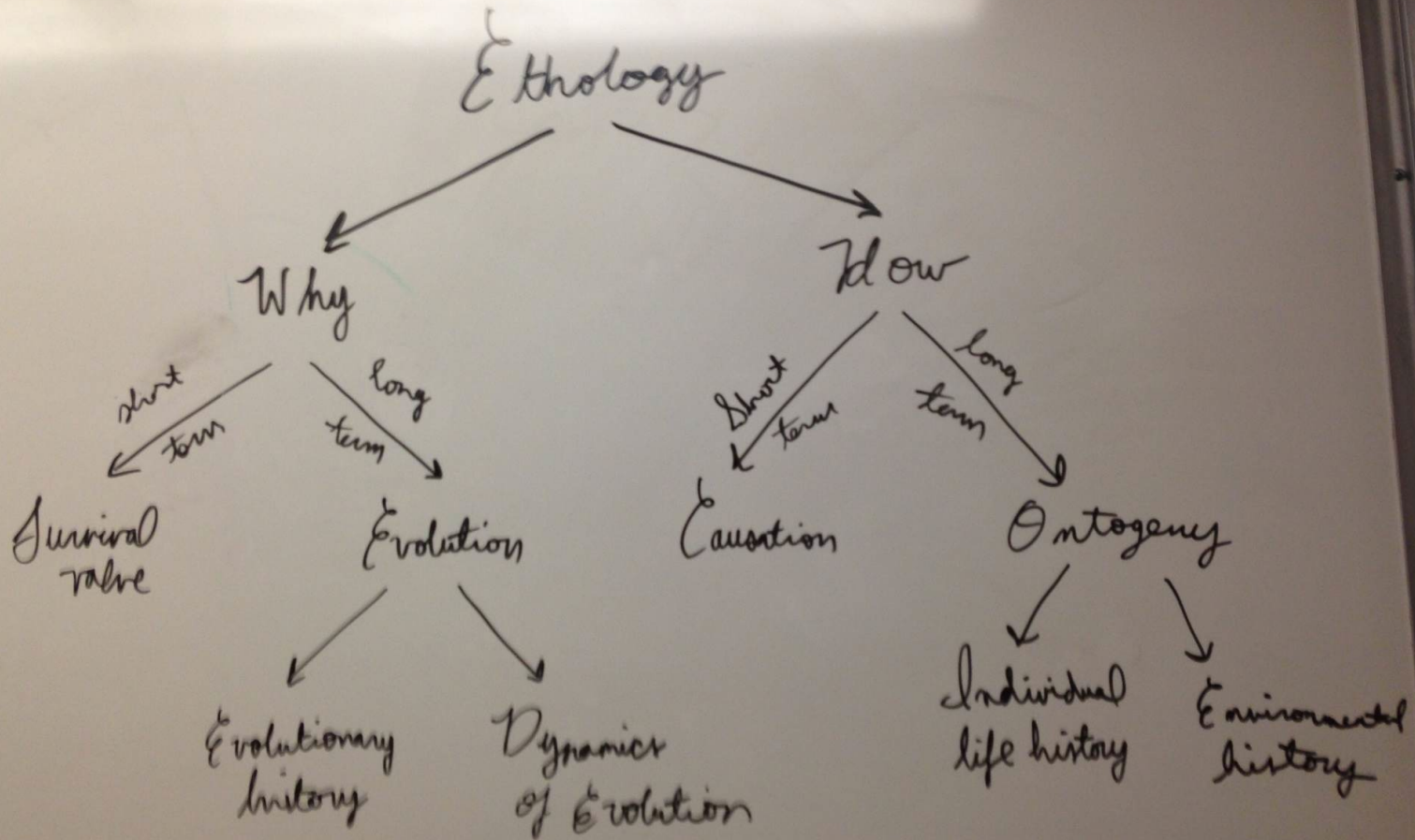
		Type of Determinant	
		cause	origin
Level	Individual	Dynamic Control <small>Aristotle: material cause</small>	Ontogenetic Development <small>Aristotle: formal cause</small>
	Population	Adaptive Function But consequences can't be causes without being teleological <small>Aristotle: final cause</small>	Phylogenetic Origin <small>Aristotle: efficient cause</small>



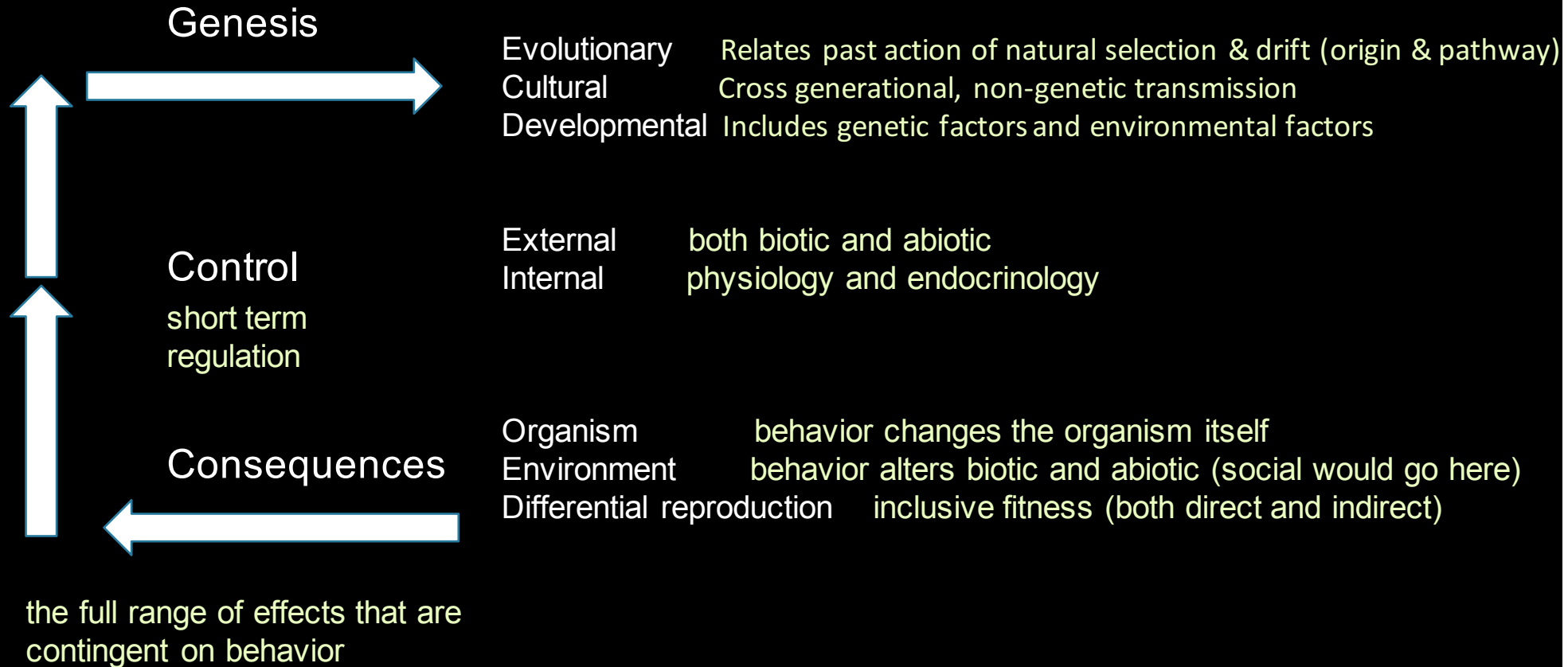
Jack Hailman
1977

Level

		Time of Determinant	
		Immediate Cause	Antecedent Origin
Level	Individual	Control <small>Aristotle: material cause</small>	Ontogeny <small>Aristotle: formal cause</small>
	Population	Preservation But consequences can't be causes without being teleological <small>Aristotle: final cause</small>	Phylogeny <small>Aristotle: efficient cause</small>



What is the influence of all past events
irrespective of timeframe (a dynamic
interpretation of history)



This allows one to drop the proximate ultimate dichotomy (how? and why? Are of little help)

3 main headings need to be addressed; Genesis, Control, & Consequences.

Genesis: What is the influence of past events (all relevant past events irrespective of timeframe)? This question represents a dynamic interpretation of history on three different timescales.

Evolution: This timescale relates past action of natural selection to other processes that influence gene frequency (such as drift which Tinbergen sort of ignored). It encompasses both the origin and the evolutionary pathway

Culture: This timescale covers cross generational, non-genetic transmission beyond culture you could talk about extended phenotypes, like a termite mound, maternal effects, epigenetic effects. It is basically one form of ontogeny but draws specific attention to the fact that the influence need not be within a single lifetime.

Development: This timescale begins with conception and includes genetic factors as well as environmental factor. The emphasis is on the dynamic nature.

Control: This is short term regulation of behavior. There is no set boundary between short term effects and development they sort of blend together. There are both external (outside the skin: including other animals as well as abiotic environment) and internal (physiology & endocrinology) factors in Control of behavior.

Consequences: This heading covers the full range of effects that are contingent on behavior or produced by behavior. This includes effects multiple levels.

consequences for the organism: A behavior has results on the organism itself. Even simply collecting information changes the internal state of the organism.

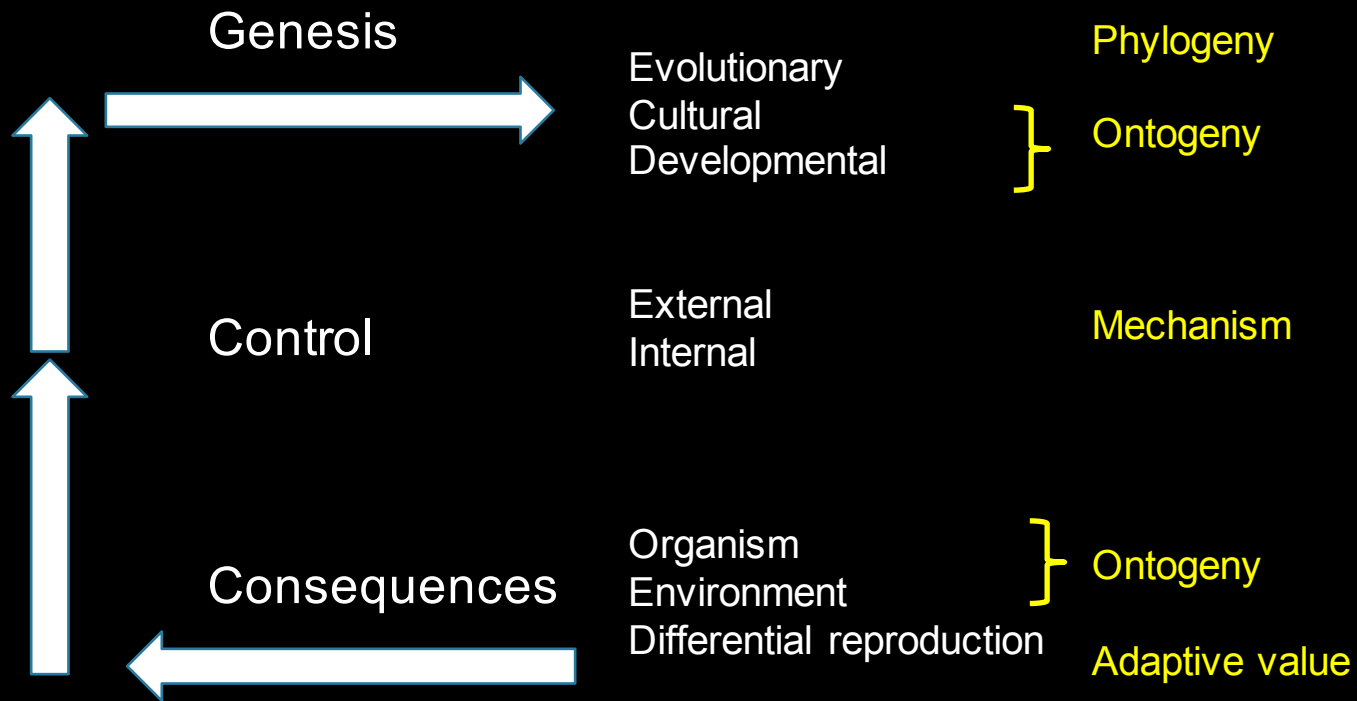
consequences for the environment: The extended phenotype, both abiotic and social are how the behavior changes the animal's surroundings.

consequences for differential reproduction: These also cover inclusive fitness (fitness of relatives that share genes) These consequences dictate how the behavior feeds back to influence future evolutionary change.

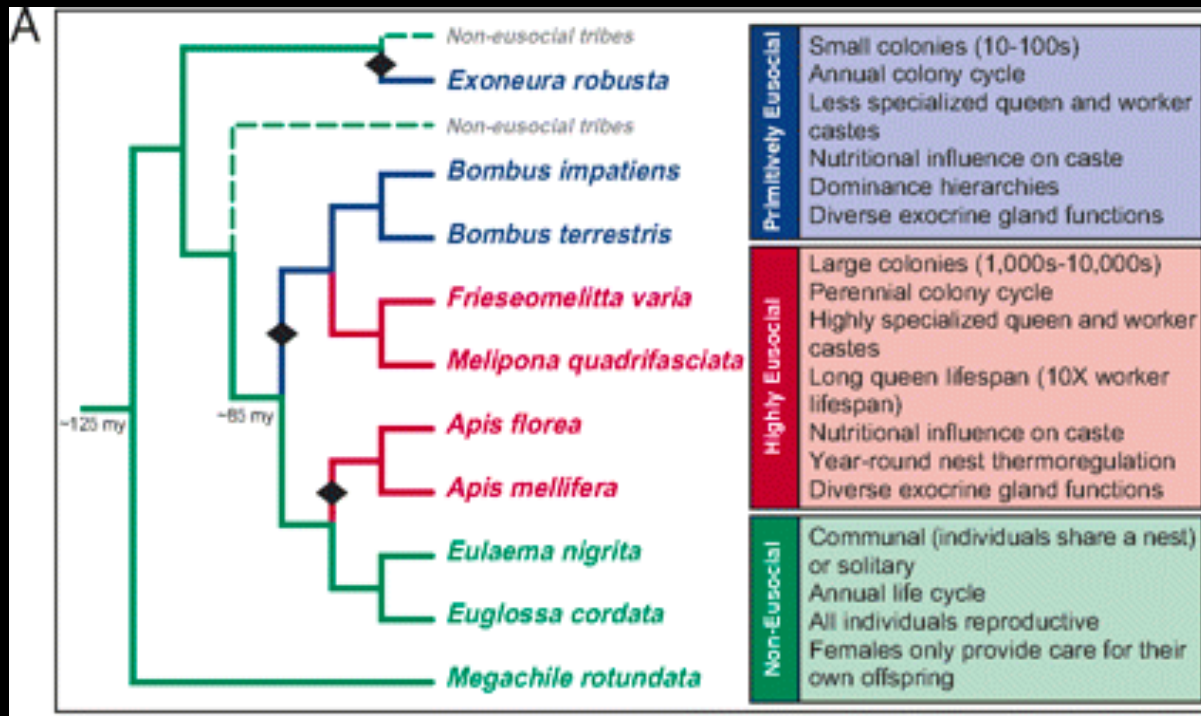
By dropping the proximate vs. ultimate dichotomy one escapes the implication that consequences of behaviors are somehow causal to the event or behavior under study. This makes it clear that the consequences are a significant influence for FUTURE events. Consequences cannot be causal of the contemporaneous event.

In this scheme, evolution and adaptive value are clearly differentiated rather than being lumped as "ultimate.

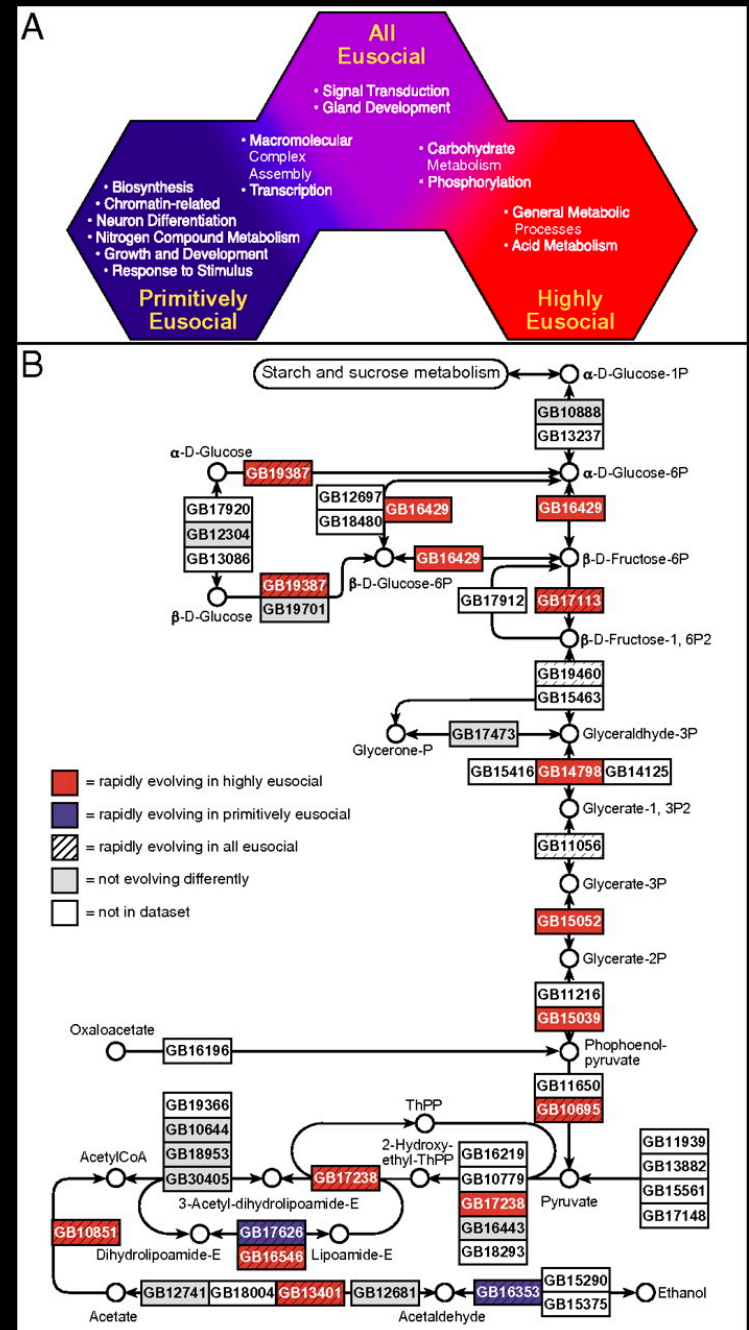
All headings are valued equally and necessary for a complete understanding of the behavior under study.



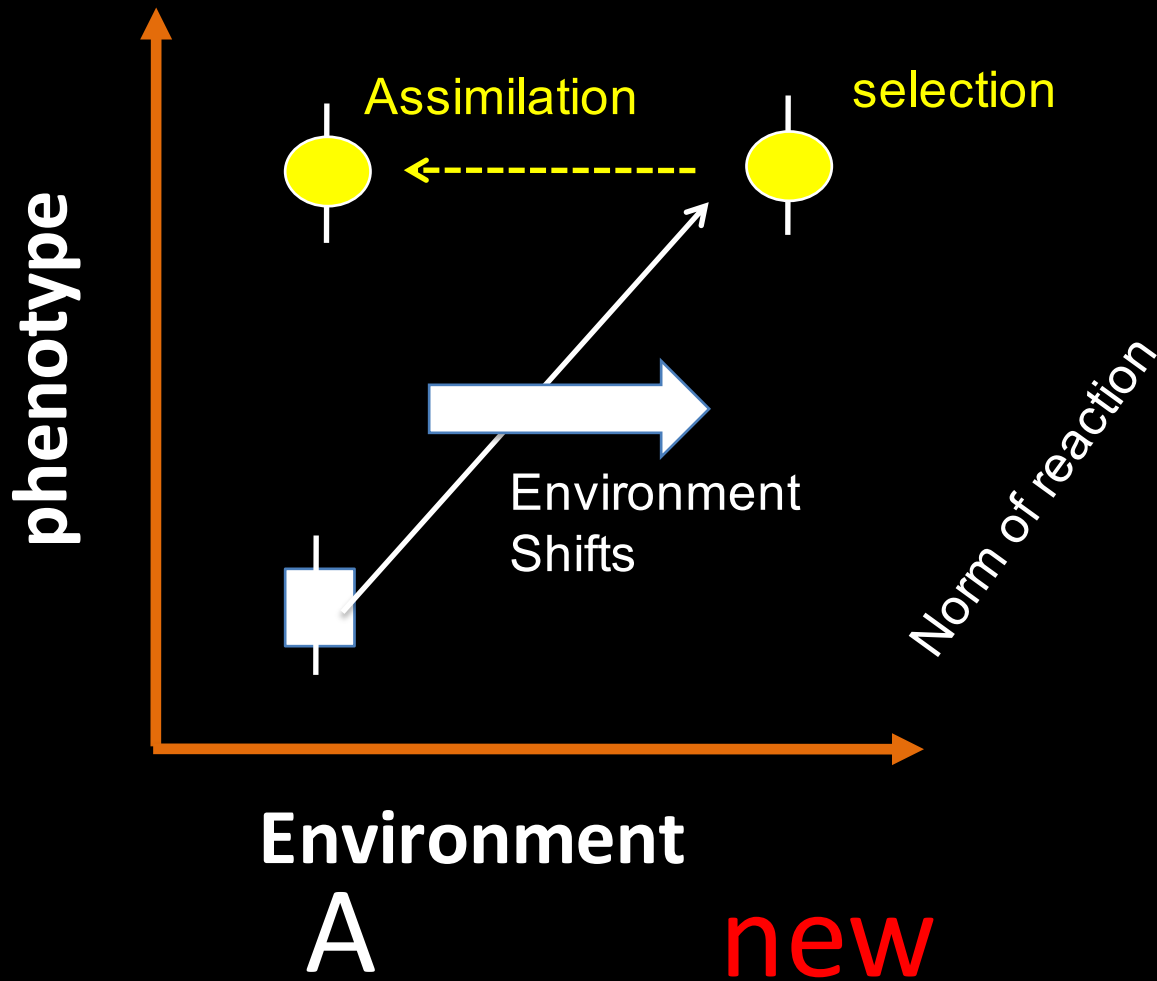
Genomic Basis of Eusociality



“to understand the genetic changes involved in the evolution of eusociality... we examined patterns of molecular evolution across three independent origins of eusociality ... and found found a shared set of 212 genes with a molecular signature of accelerated evolution...”



Genetic Assimilation



Spalding



Baldwin



Waddington



Schmalhausen



Pigglucci

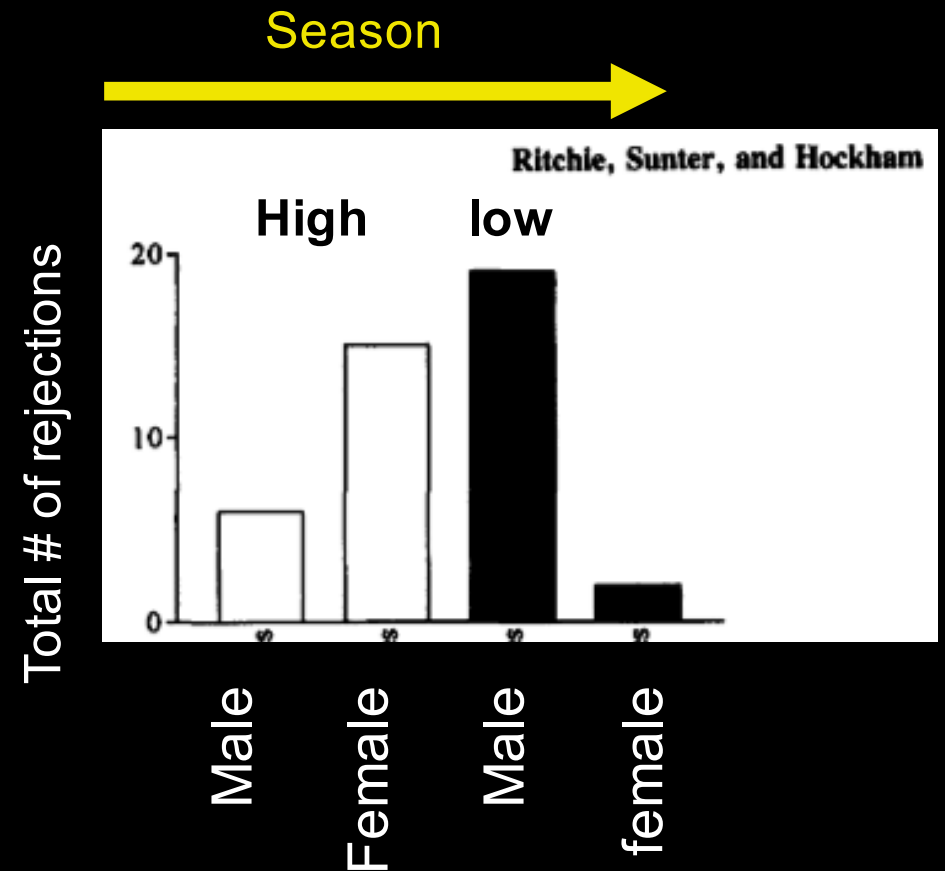
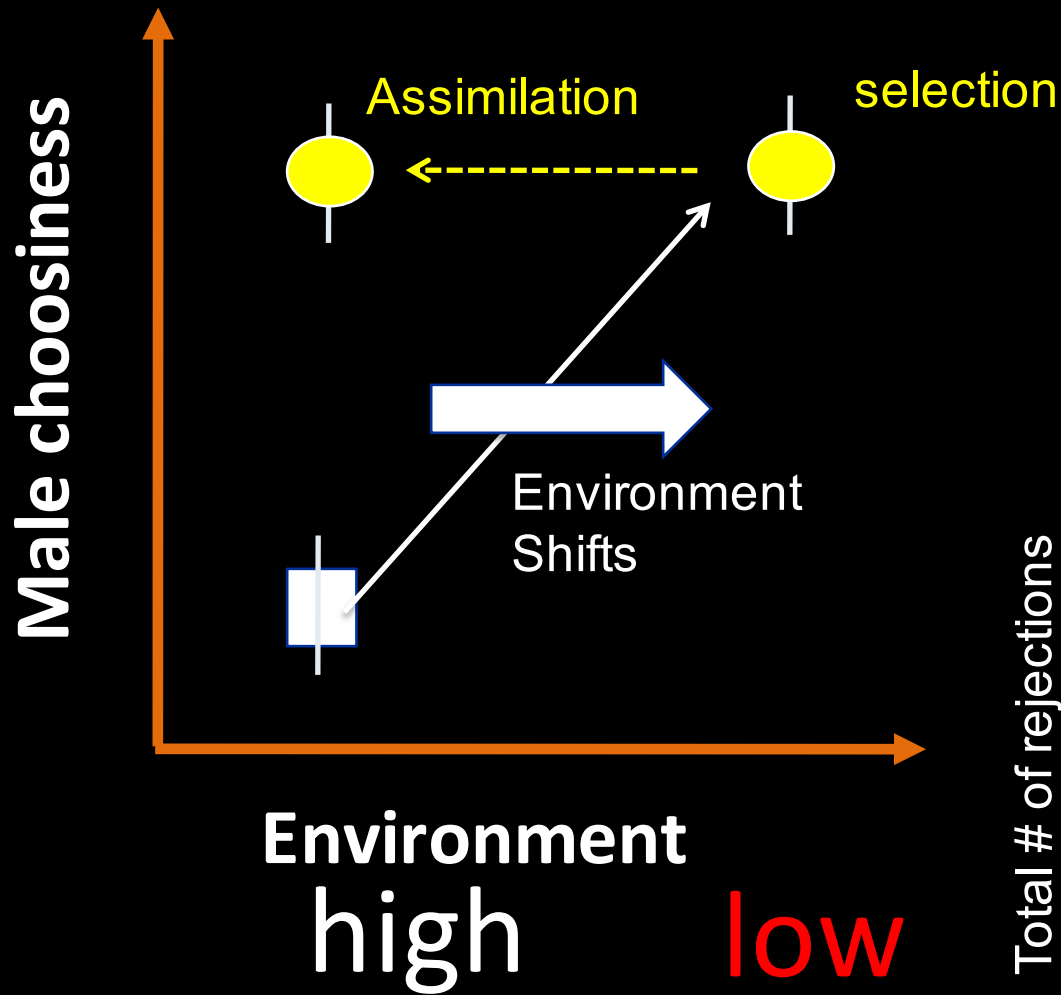


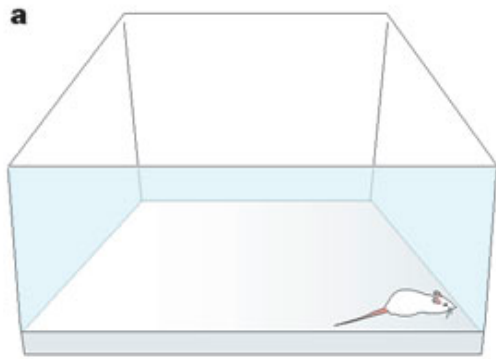
West-Eberhard



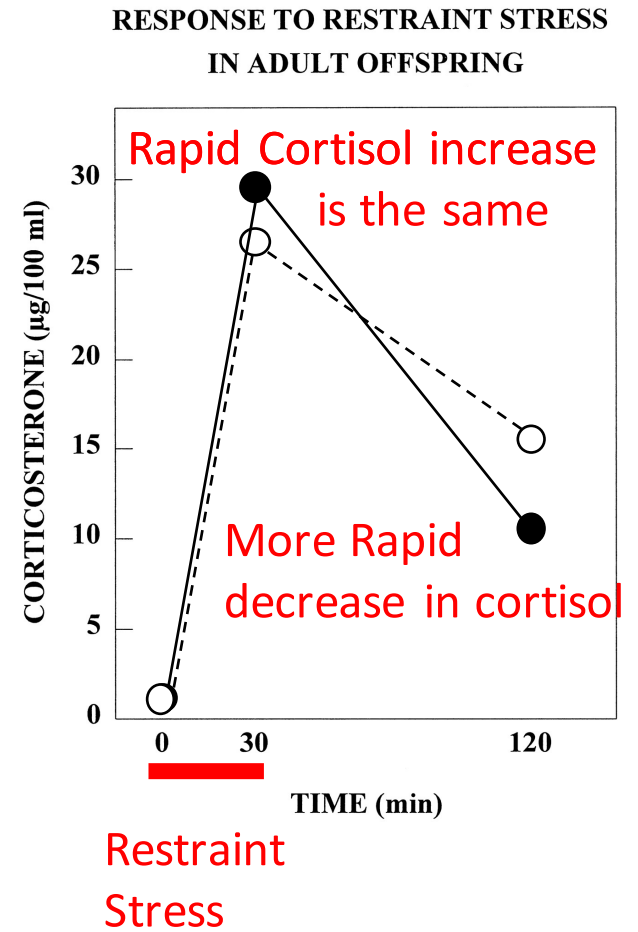
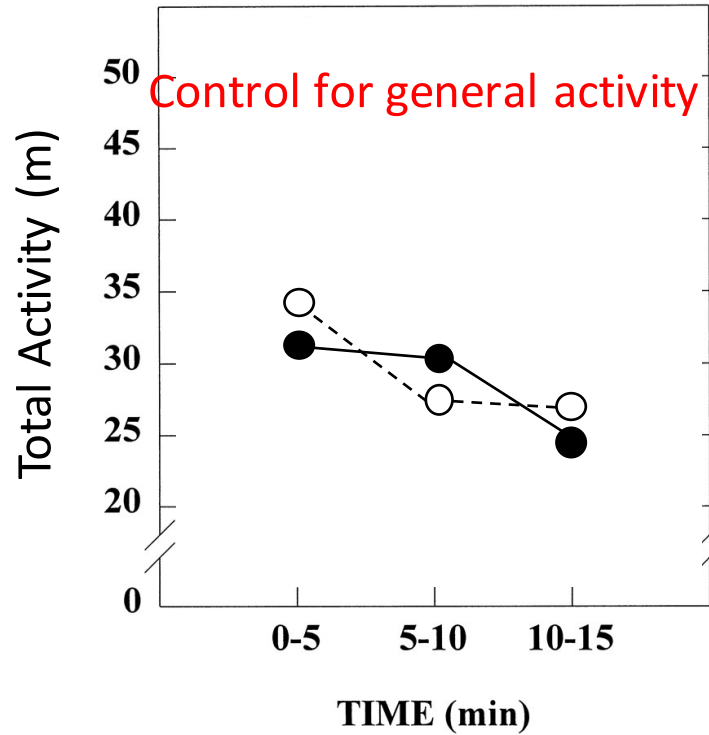
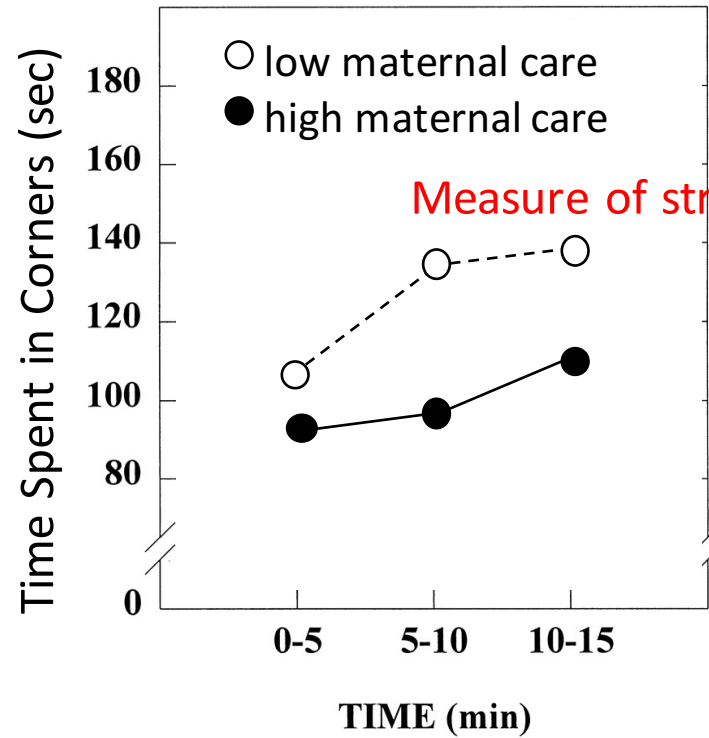
Genetic Assimilation of Behavior

Ephippiger ephippiger





OPEN FIELD TEST





Mother
high licking/grooming

High Maternal Care

Pup

Epigenetic regulation of gene expression occurs during a critical period

High maternal care

low methyl/high express = low stress

Low maternal care

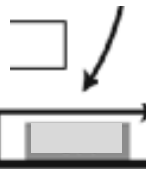
high methyl/low express = high stress



Increased
serotonin release

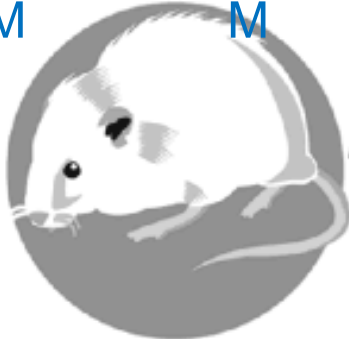
Demethylation of exon
1 at 11A binding site
In **Cortisol Receptor**
enhancer in
Hippocampus

Increased expression
of NGF1A Transcription
factor hippocampus



Sustained
increase in
Cort R
expression
over life time

CGGGGGCG
M M



Adult

High adult Cort R
in Hippocampus
turns off the
stress response
rapidly

demethylation is the activated state by
good maternal care, default is to be methylated

Hippocampus

#

Hypothalamus(PVN)

> CRF

Pituitary (anterior)

> ACTH via blood

Adrenal Cortex

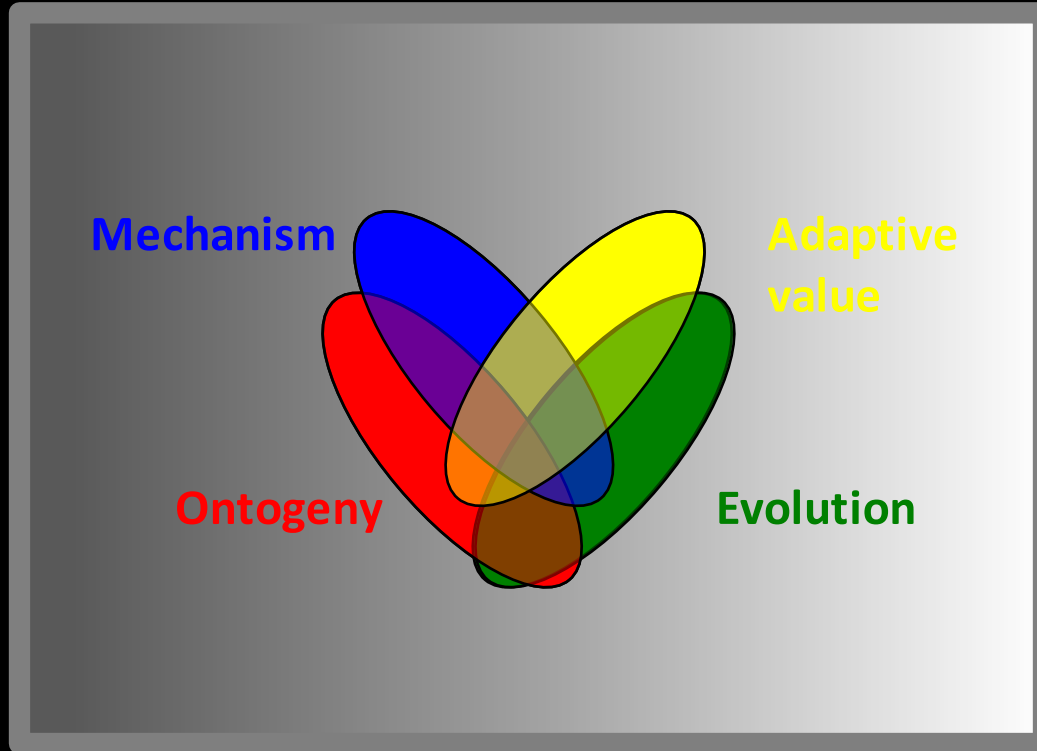
> Cortisol via blood

Michael Meaney

<http://www.nature.com/neuro/journal/v7/n8/full/nn1276.html>

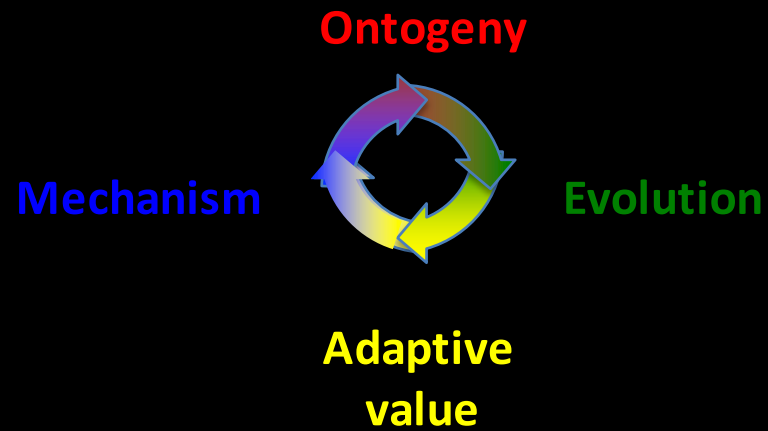
Integrating Tinbergen's 4 explanations:

Proximate



Ultimate

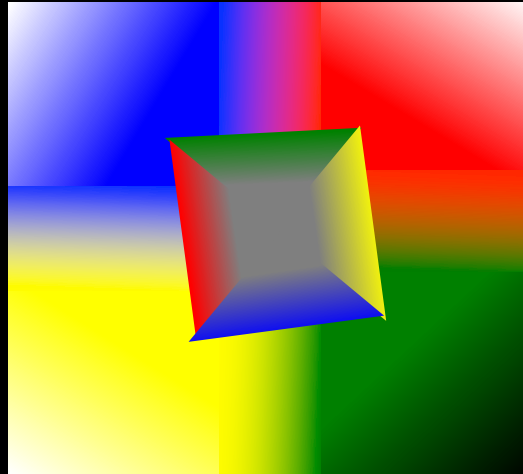
Integrating Tinbergen's 4 explanations:



Integrating Tinbergen's 4 explanations:

Mechanism

Adaptive
value

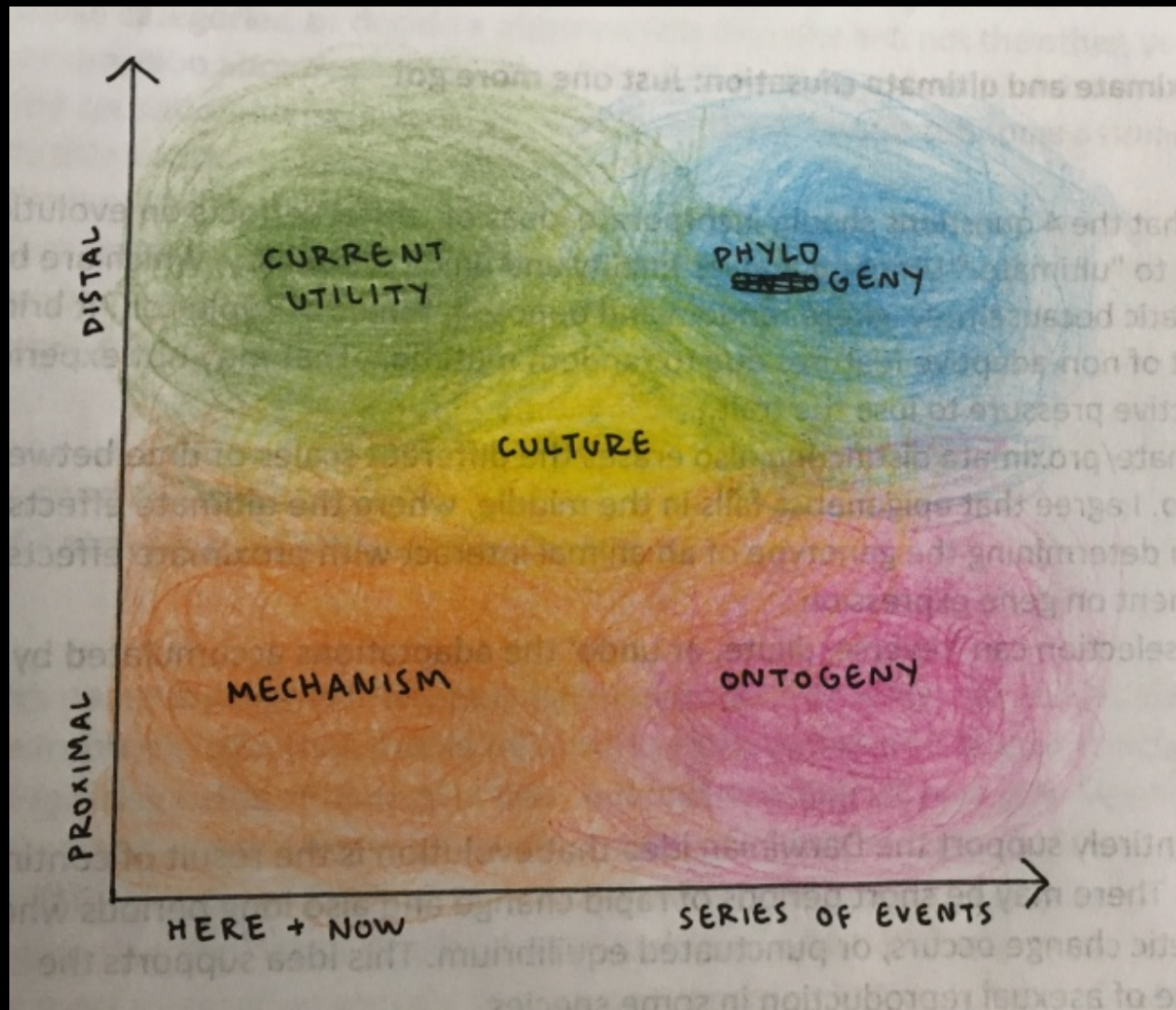


Ontogeny

Evolution

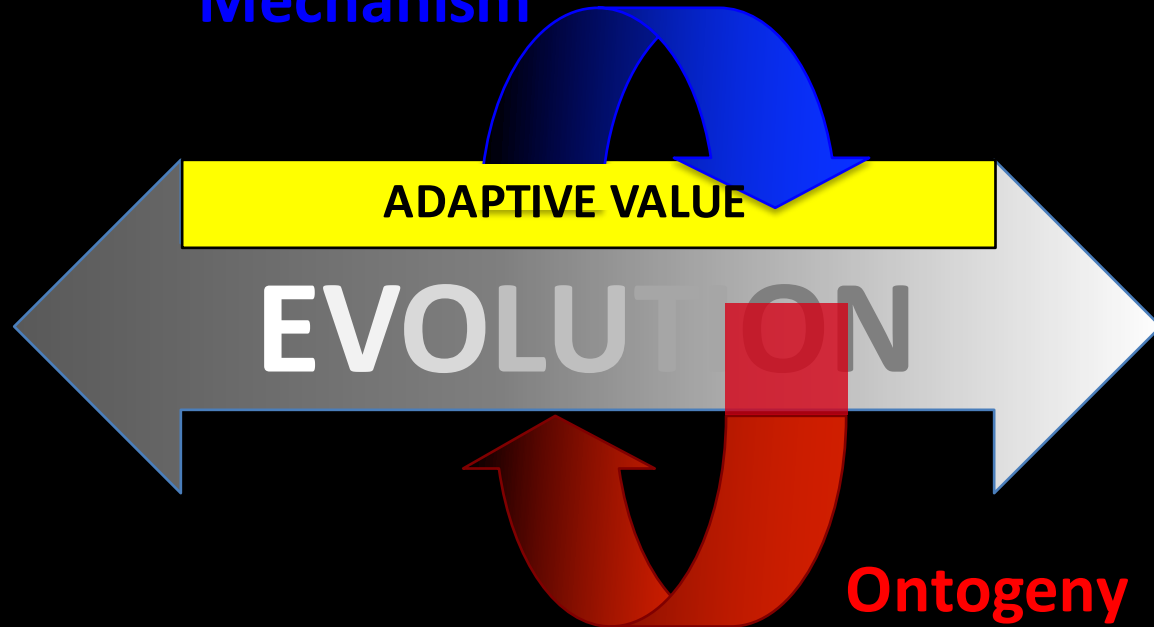
Proximate

Ultimate



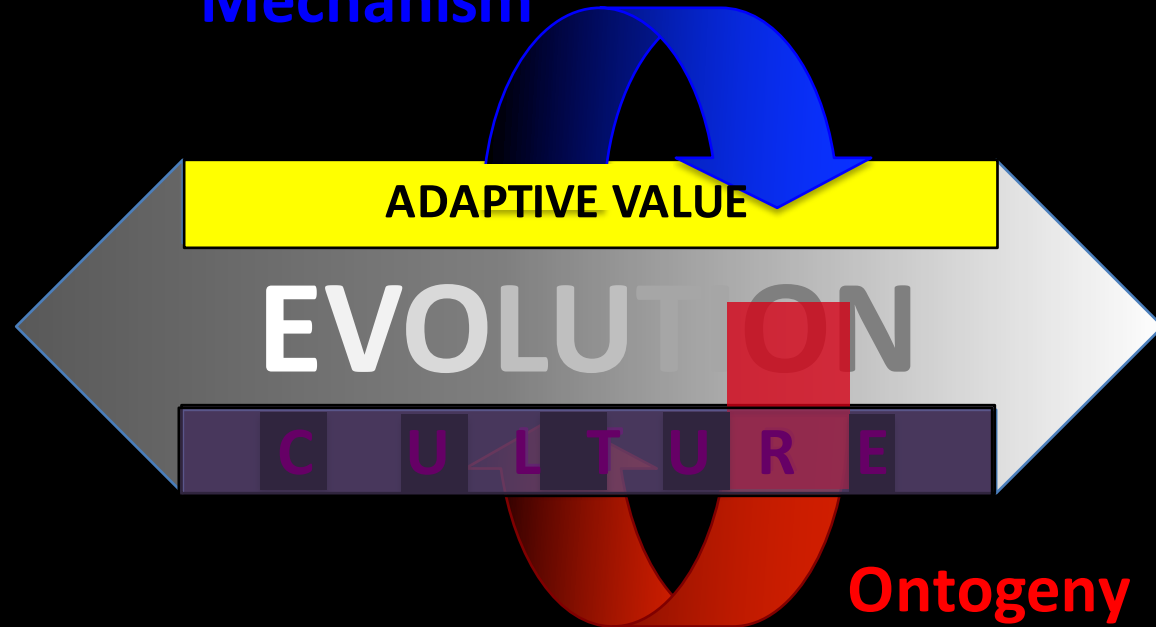
Integrating Tinbergen's 4 explanations:

Mechanism



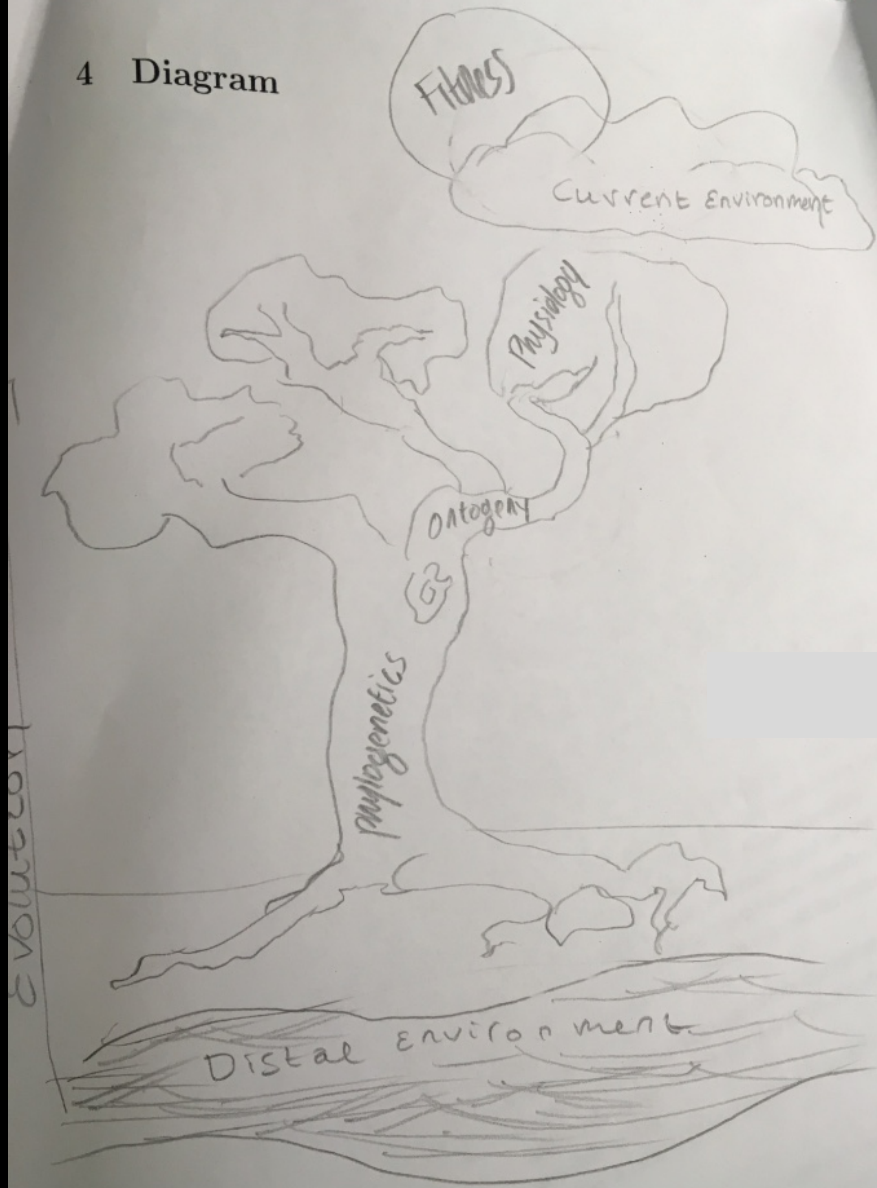
Integrating Tinbergen's 4 explanations:

Mechanism



Ontogeny

4 Diagram



Integrating Tinbergen's 4 explanations:

Integrative Biology

Mechanism
Development

Adaptive
Value



Evolution



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Friday 4:10 September 14th B19

Dr. Derek Applewhite

“Understanding the regulation of the cytoskeleton.”

