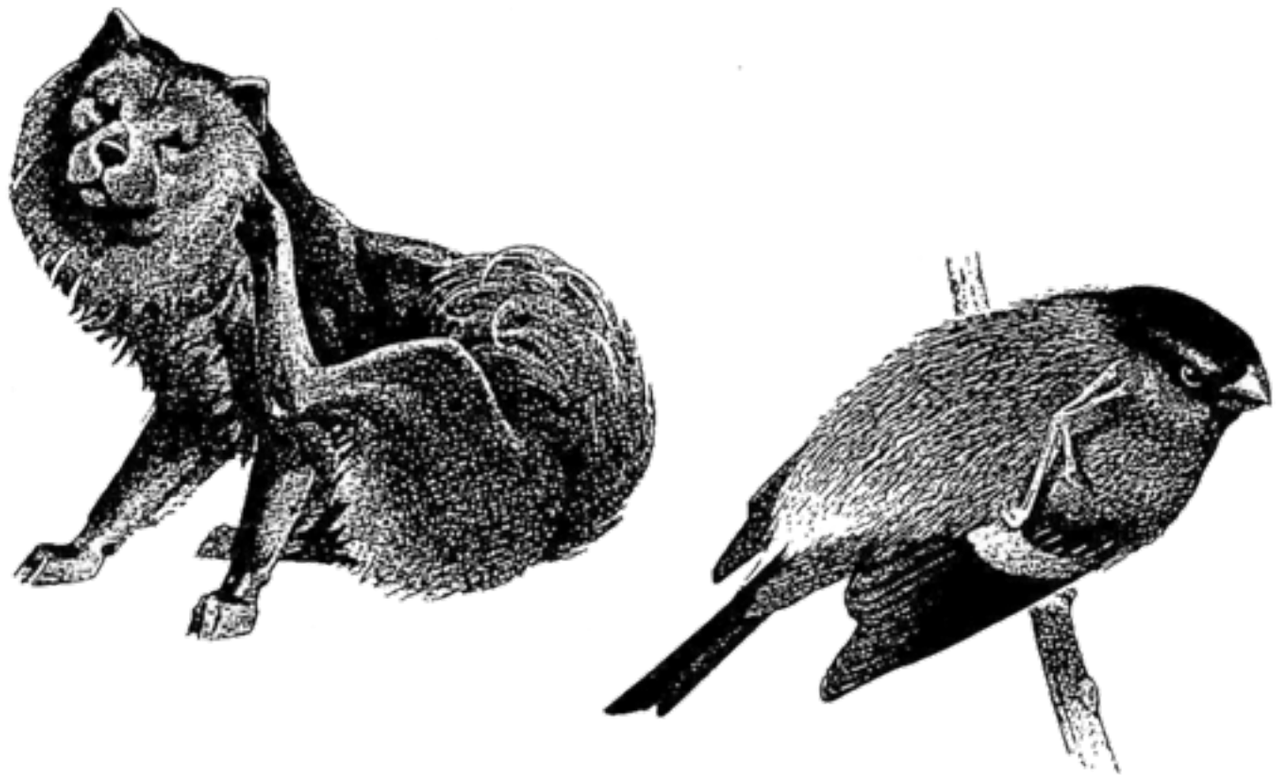
Will behavioral homology survive the age of developmental plasticity?



Mark S. Blumberg, Ph.D.

Departments of Psychology and Biology and Delta Center

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Summary

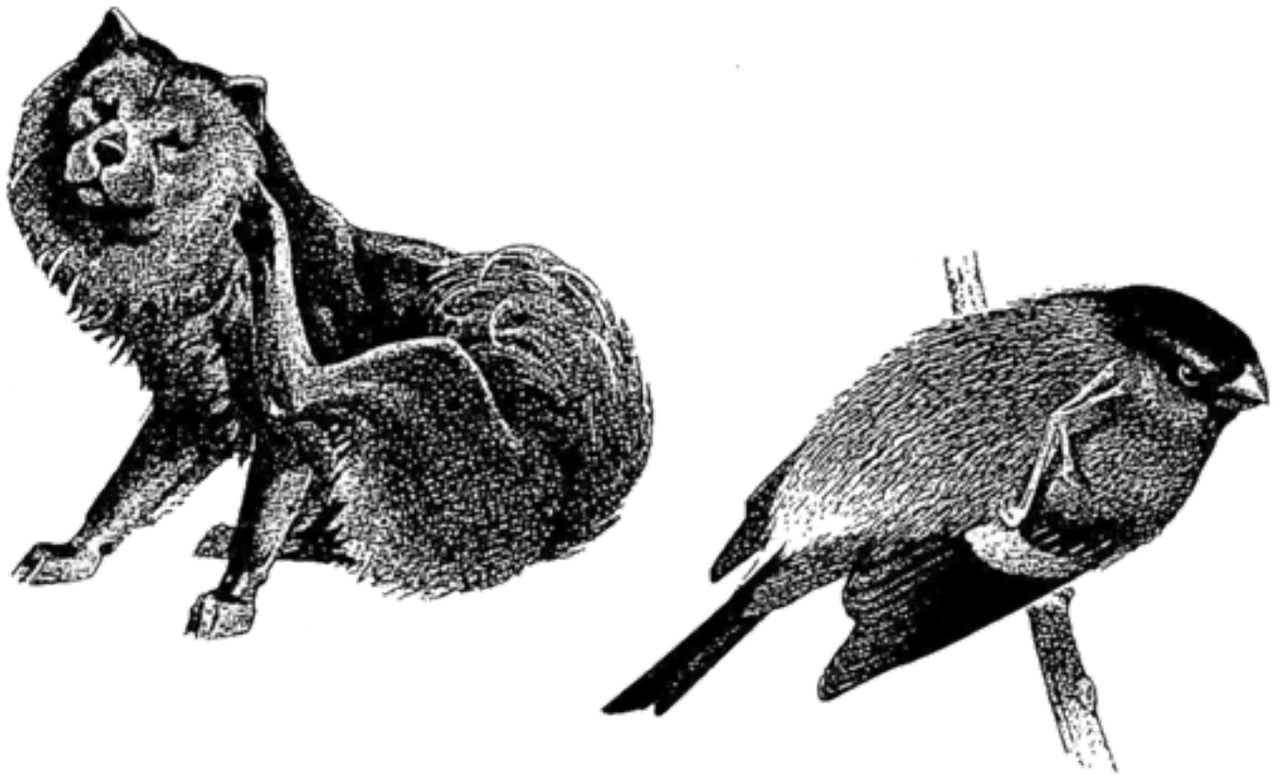
- Lorenz aspired to create a science of behavioral homology built on his understanding of instinct.
- However, his notion of instinct was flawed.
- In particular, developmental plasticity poses a threat to conventional notions of instinct.
- Without a clear understanding of instinct, behavioral homology is in trouble.

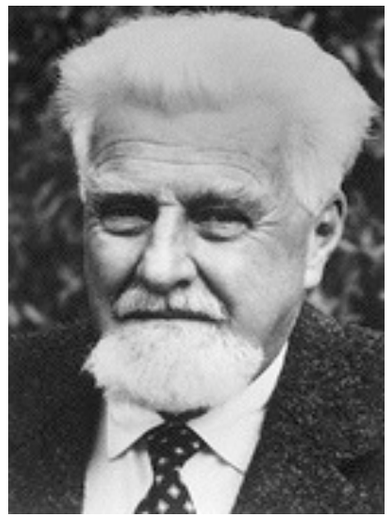
Lorenz: From bones to behavior

"Is it not possible that beneath all the variations of individual behavior there lies an inner structure of inherited behavior which characterizes all the members of a given species, genus or larger taxonomic group—just as the skeleton of a primordial ancestor characterizes the form and structure of all mammals today?"

Lorenz, 1958

Example: Overwing scratching

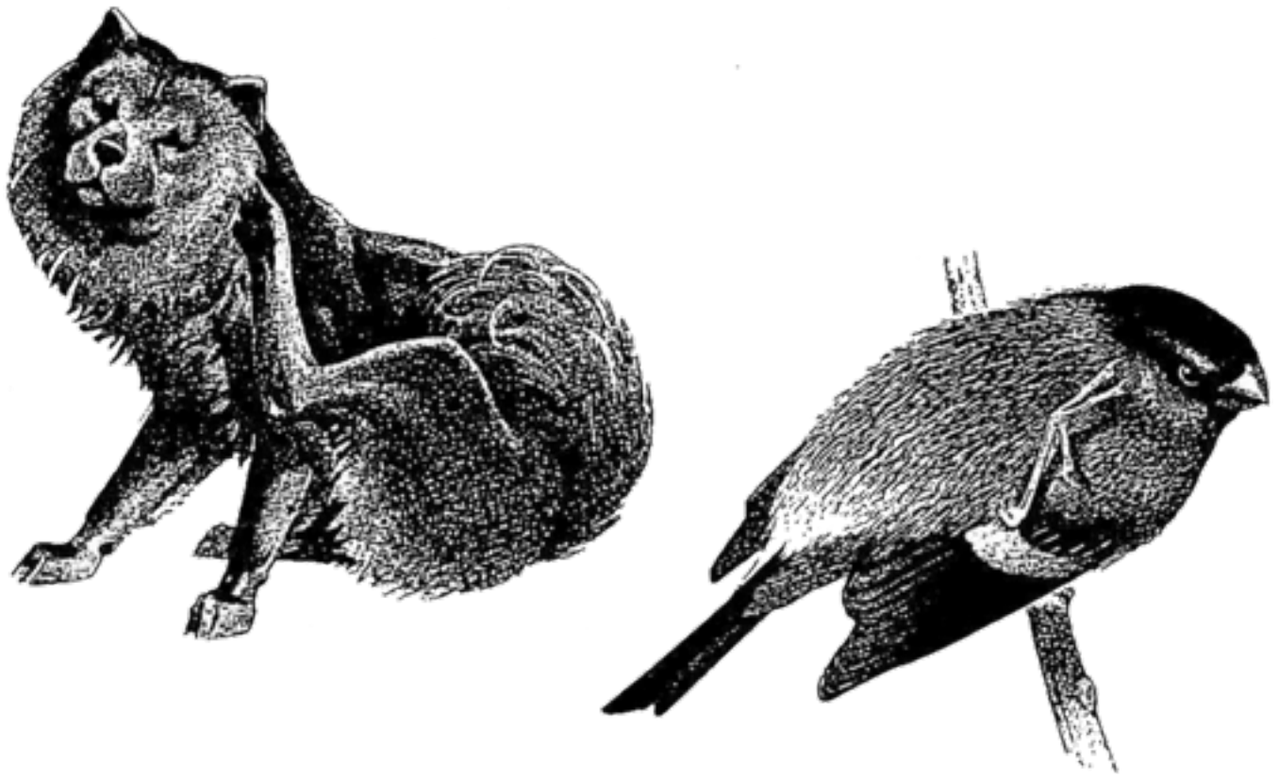


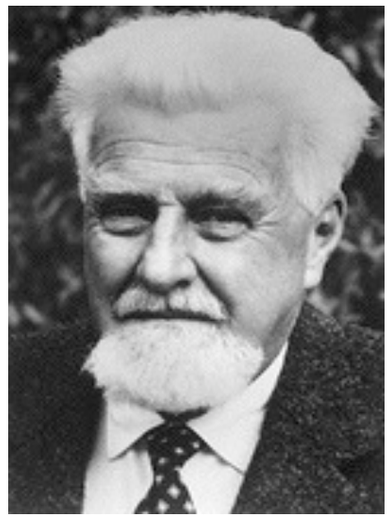


Konrad Lorenz

"I do not see how to explain this clumsy action unless we admit that it is inborn. Before the bird can scratch, it must reconstruct the old spatial relationship of the limbs of the four-legged common ancestor which it shares with mammals."

Example: Overwing scratching

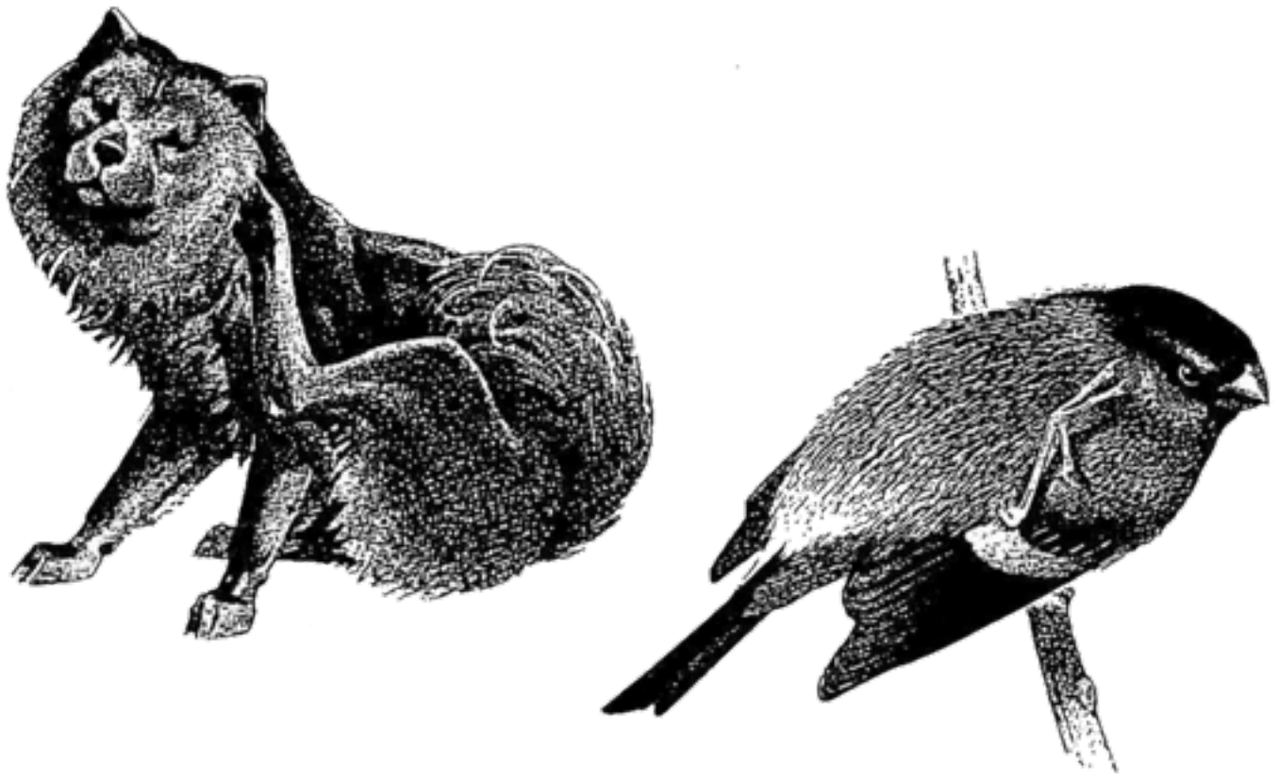


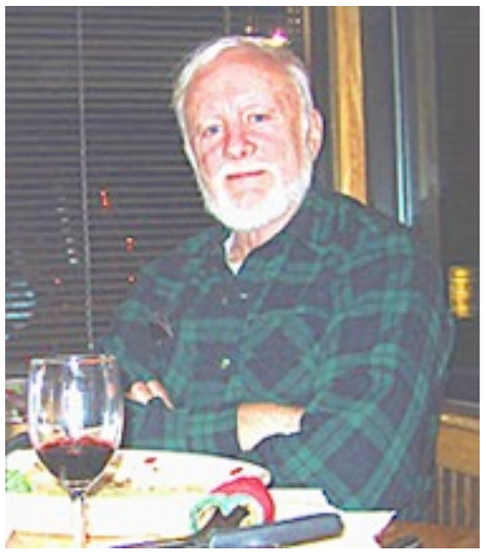


Konrad Lorenz

"Scratching behavior of a dog and a European bullfinch is part of their genetic heritage and is not changed by training."

However, underwing scratching occurs in...

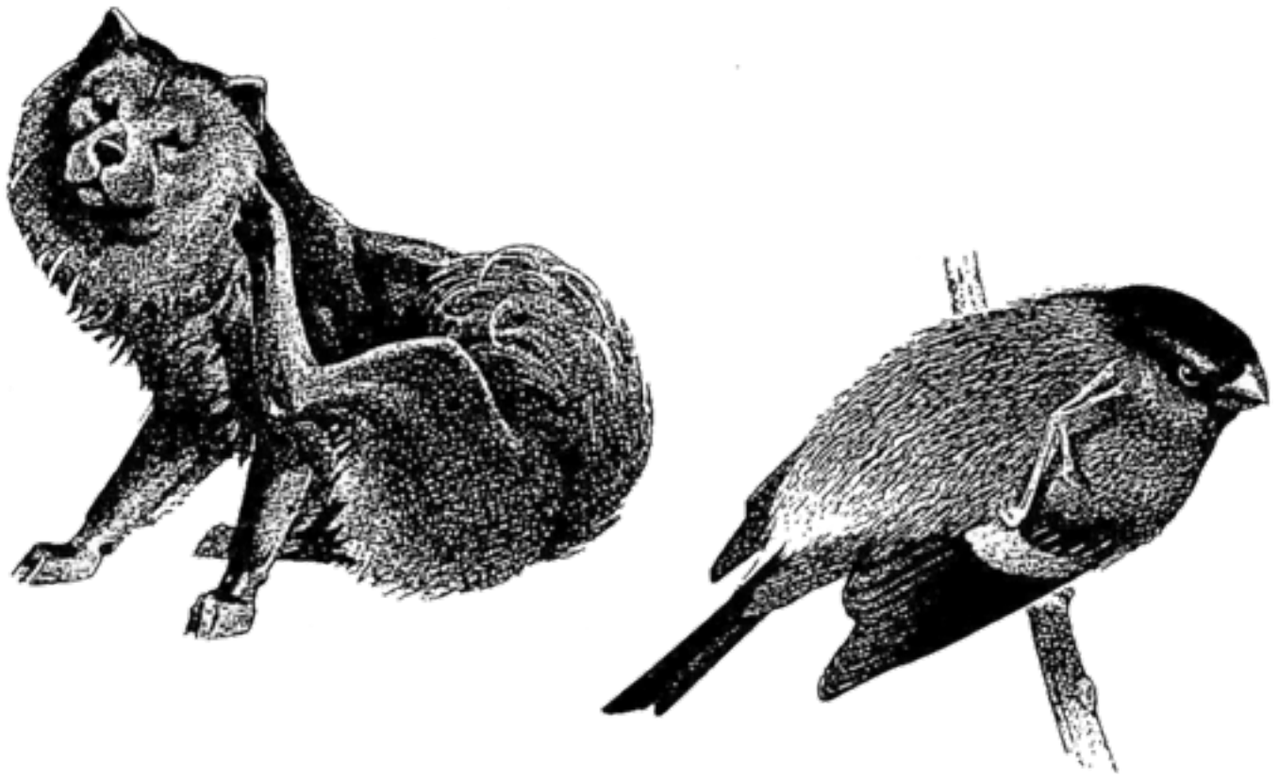


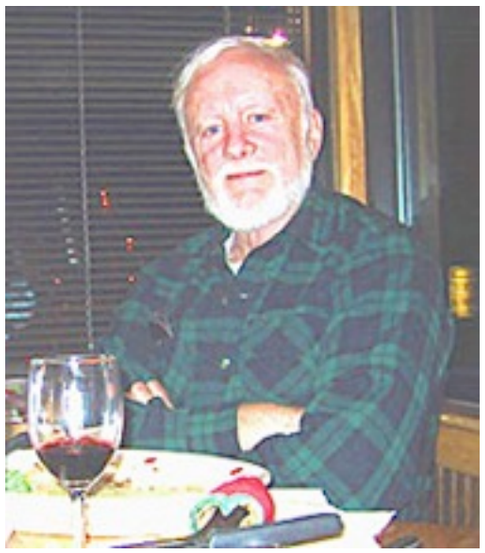


Jack Hailman

... young birds as well as in adult birds while in flight.

Burtt & Hailman, 1978





Jack Hailman

"The swallow's shift in head-scratching method associated with its shift in center of gravity relative to its locomotory systems suggests that subtle differences among species' center of gravity may explain the adaptive significance of interspecific differences in head-scratching method."

Burtt & Hailman, 1978

Hailman: Are instincts learned?

"Perhaps stereotyped behavior patterns of animals... require subtle forms of experience for development. In other words, perhaps instincts are at least partly learned."

Hailman, 1969

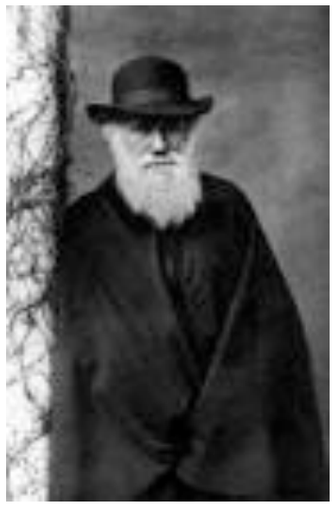
The Many Meanings of "Instinct"

1. Present at birth
2. Not learned
3. Developed before it can be used
4. Unchanged once developed
5. Shared by all members of the species
6. Organized into a distinct behavioral system
7. Served by a distinct neural module
8. Adapted during evolution
9. Individual differences attributable to genes

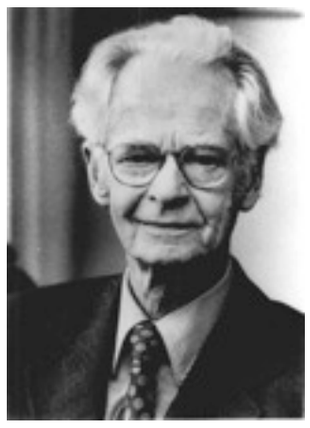
Bateson, 2002

Disputes over "instinct": A brief history

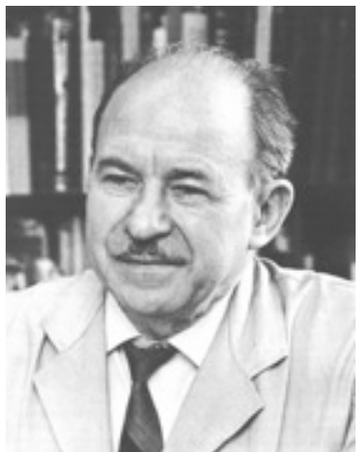
Charles Darwin



B. F. Skinner



T. C. Schneirla



"Experience"

Learned
vs. Unlearned

Genetic
vs. Epigenetic

Konrad Lorenz

Daniel Lehrman

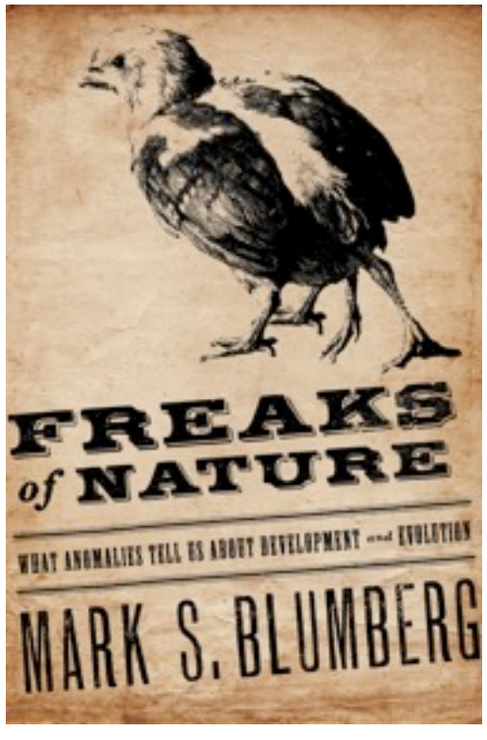
Gilbert Gottlieb, Zing-Yang Kuo

Developmental Systems Theory

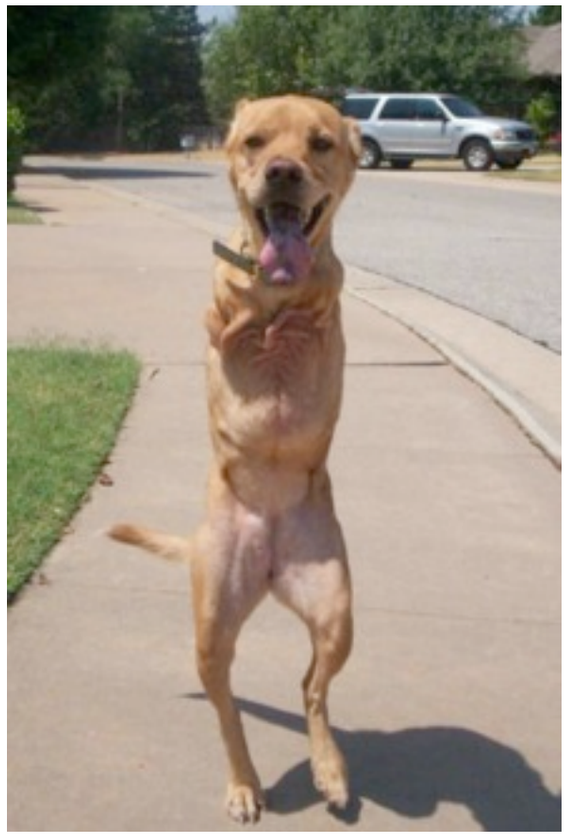
- Development as construction
- Context sensitivity and contingency
- Joint determination by multiple causes
    - Interchangeability
- Distributed control
- Extended inheritance

Oyama, Griffiths, and Gray, 2001

The developmental systems perspective presents a challenge to Lorenz's notion that behaviors and bones provide equal insight into homology and common descent.

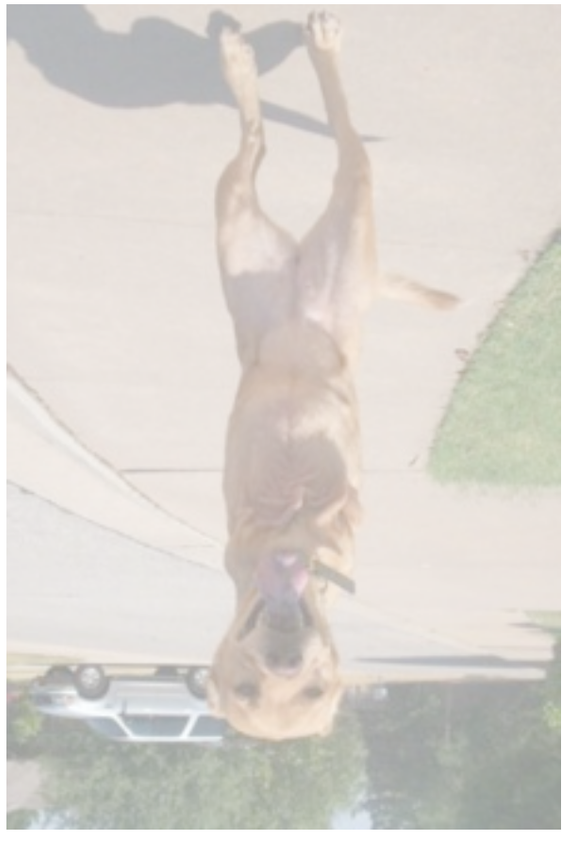


Lorenz's ethological perspective engenders a false belief in the predetermination of complex behaviors in part because it focuses exclusively on species-typical behaviors in typically formed adult animals. As a consequence, developmental plasticity is easily overlooked.

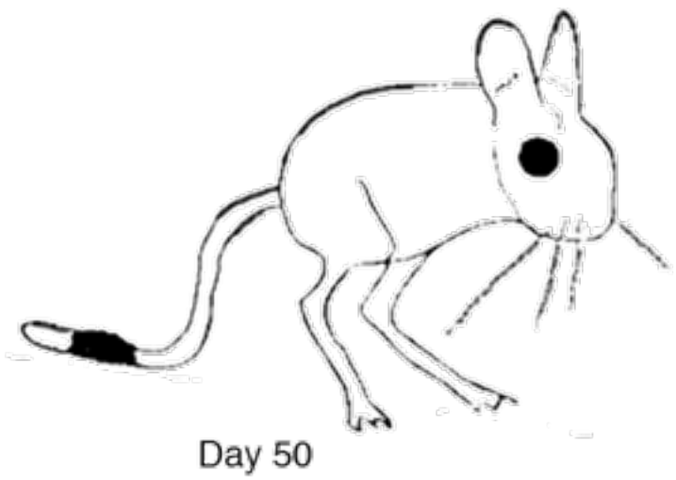



THE AMAZING JOHNNY ECK
1911-1991


1991-1961
THE AMAZING JOHNNY ECK

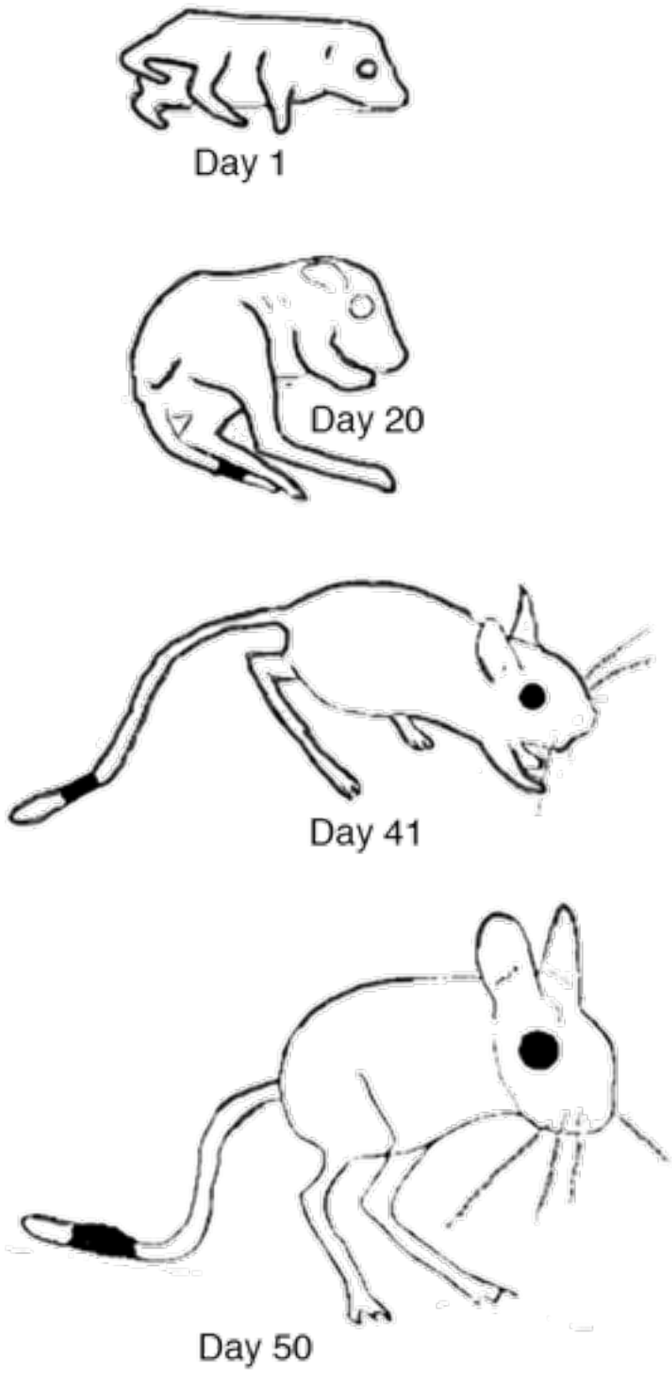


Function follows form in an anomalous species



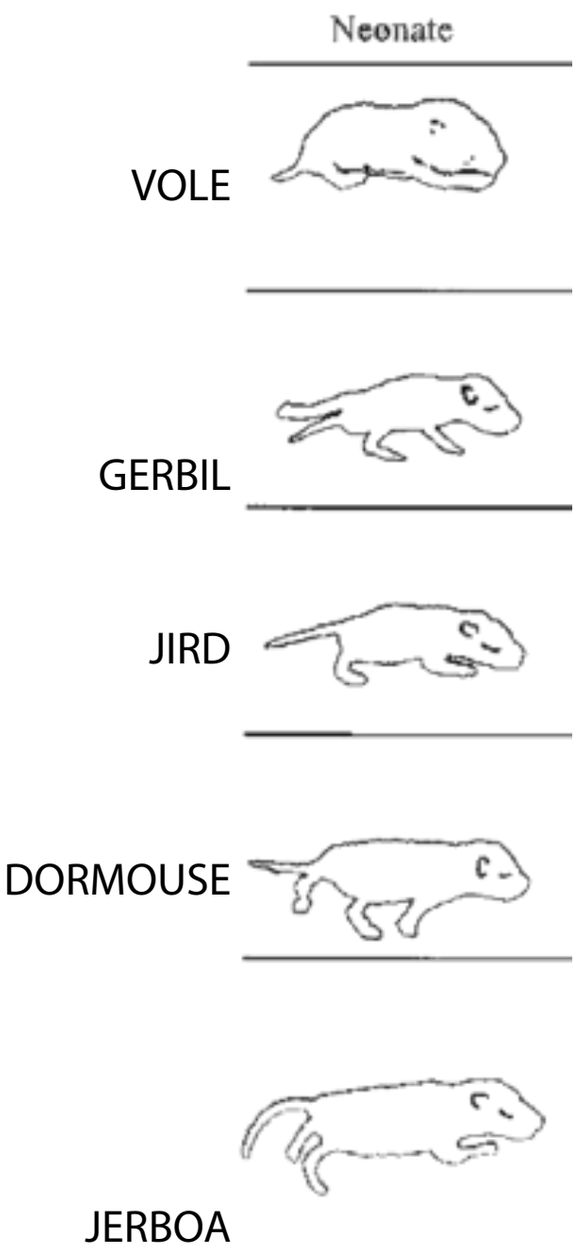
Eilam, *Developmental Psychobiology*, 1997

Function follows form in an anomalous species



Eilam, *Developmental Psychobiology*, 1997

Function follows form across rodent species



Eilam, *Journal of Experimental Biology*, 1997

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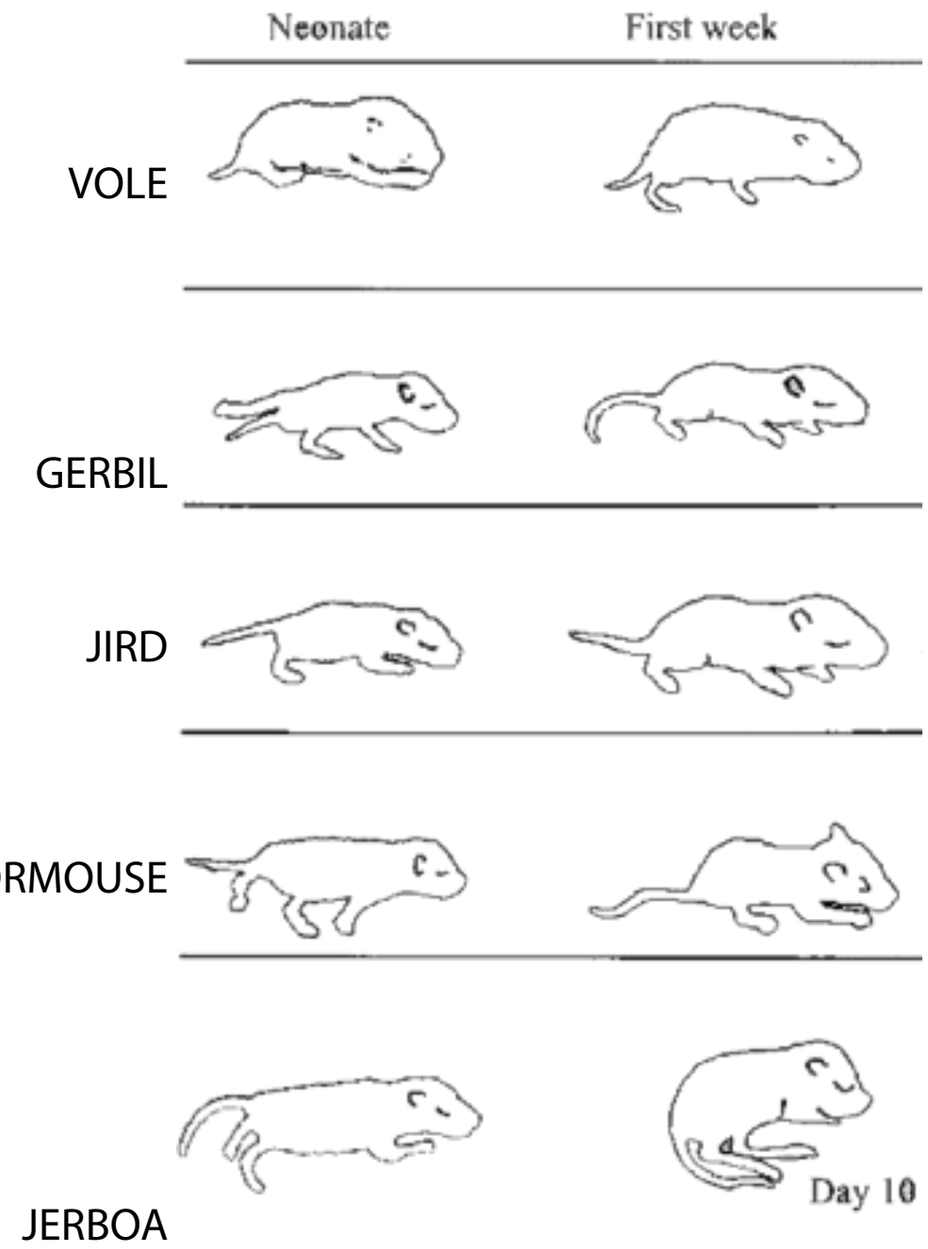

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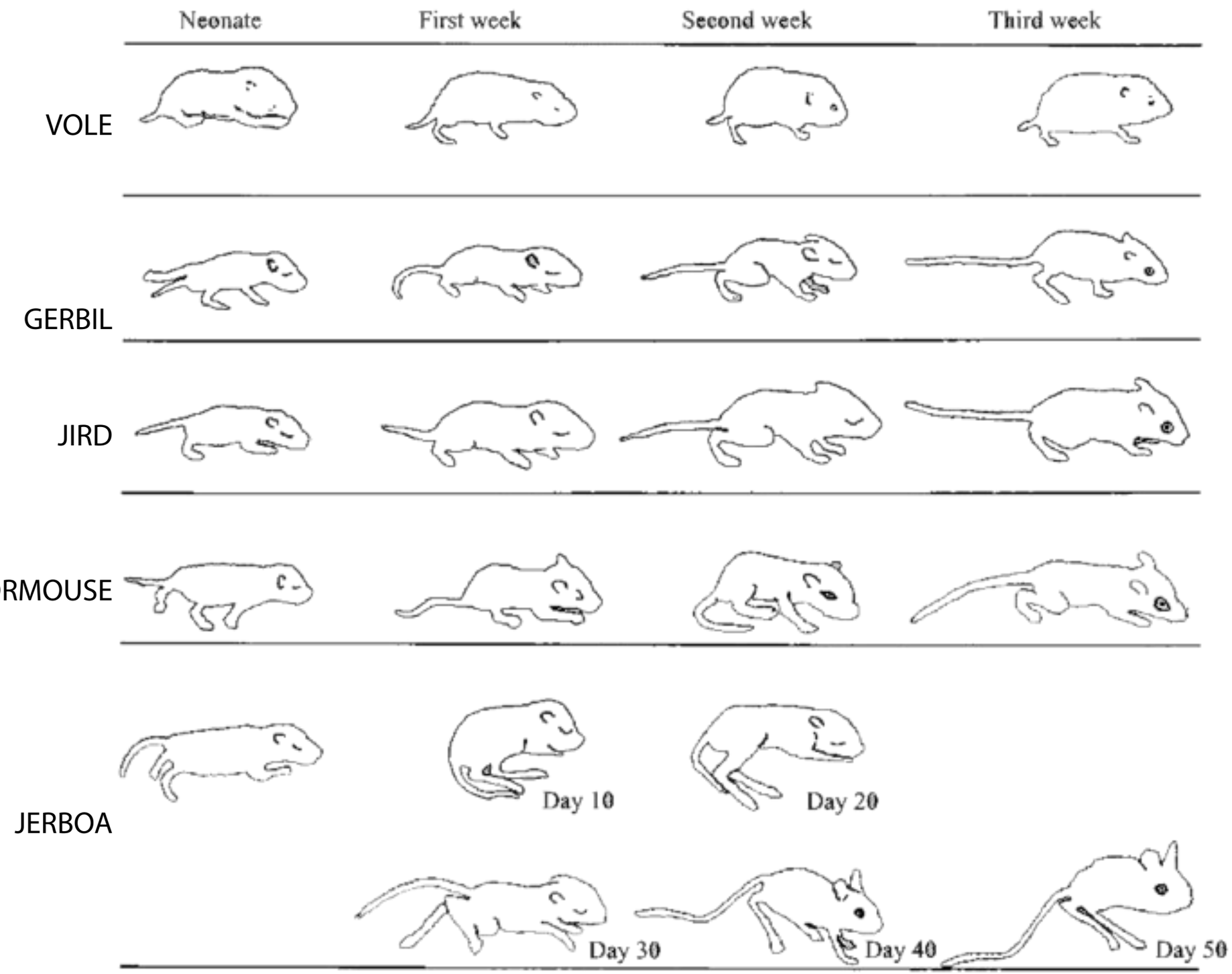


punt
walk
trot...

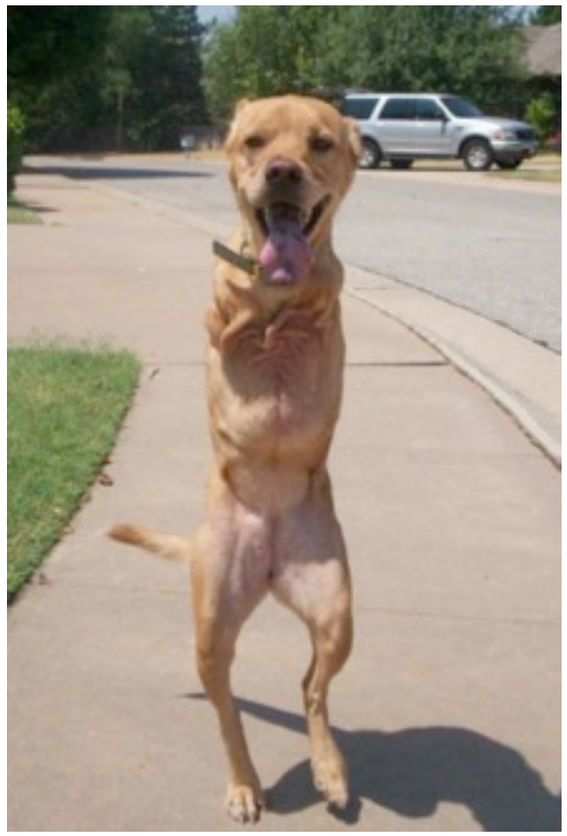
...bound

...bound

...gallup

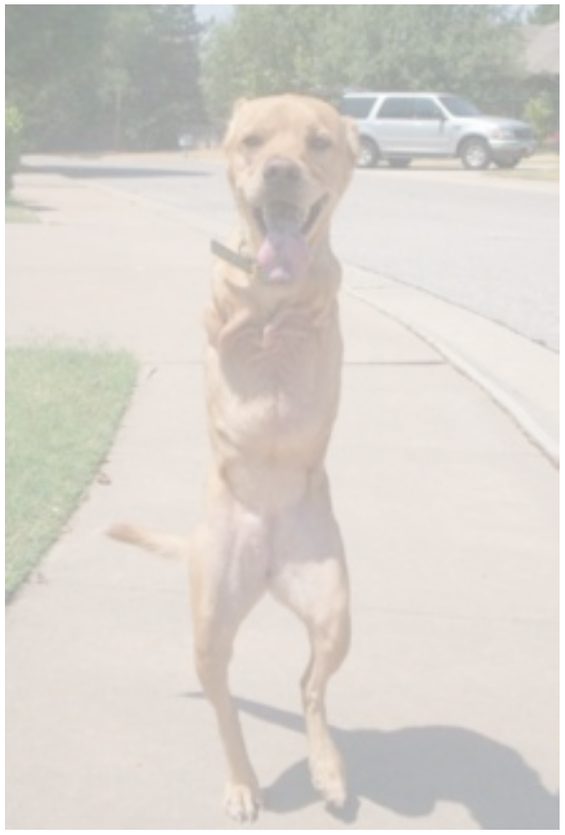
...bipedal walk

Eilam, *Journal of Experimental Biology*, 1997




THE AMAZING JOHNNY ECK
1911-1991

Faith, the two-legged dog



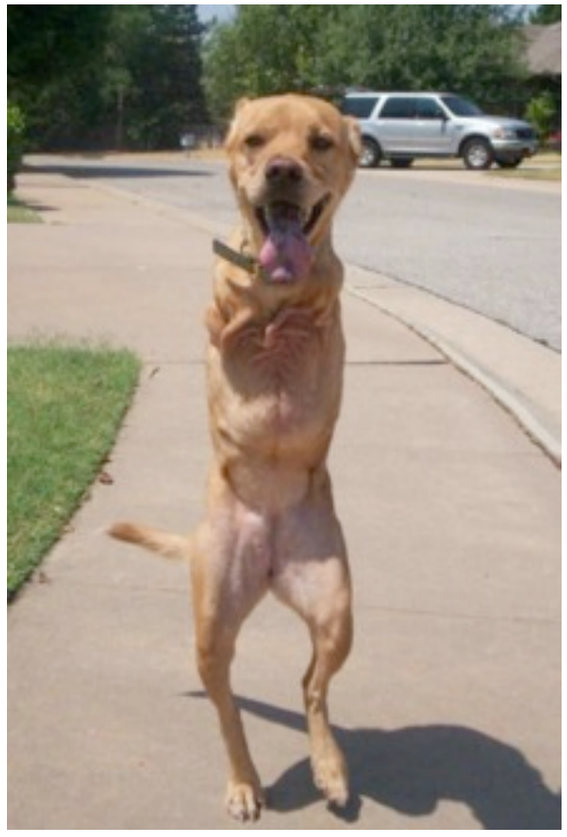

THE AMAZING JOHNNY ECK
1911-1991

Courtesy of the Mütter Museum

Johnny Eck, the “half-boy” (Freaks, 1932)

Whither instinct?

bipedal instinct?

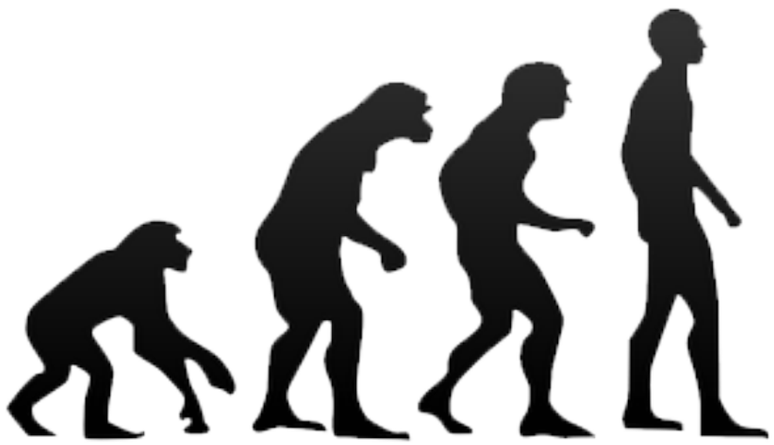


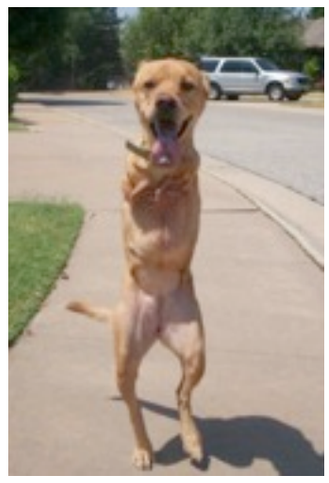
bipedal instinct?

hand-walking instinct?

In all three cases—only one of which represents a species-typical behavior—it is clear that morphology shapes and guides behavior.

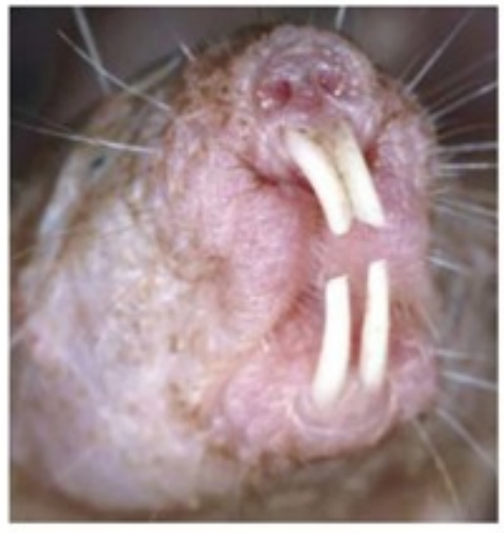
Locomotion is ancient, universal, and of critical functional importance. If head-scratching is instinctive, certainly locomotion would be. Nonetheless, like head-scratching, locomotion is exceedingly plastic in response to morphological change.





Morphology shapes the brain of “natural freaks”

Blind Mole Rat



Ratunculus

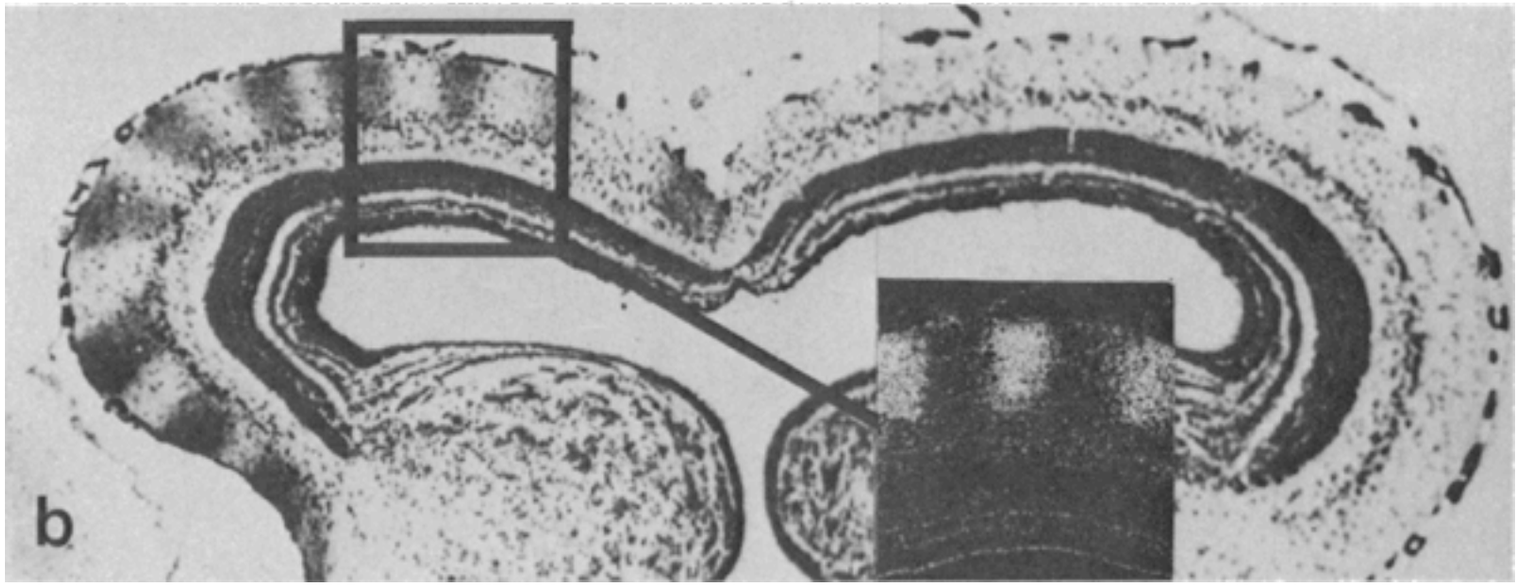
Star-Nosed Mole

Molunculus

Morphology shapes the brain of “unnatural freaks”

Constantine-Paton & Law, *Science*, 1978

Morphology shapes the brain of “unnatural freaks”



Constantine-Paton & Law, *Science*, 1978

If we are to create a successful science of behavioral homology, we should exercise caution when using the term ‘instinct.’ And we will also need to be very clear about what it is about an instinct that we are trying to identify as homologous.

The herding instinct

The herding instinct?

- Style (e.g., gathering, driving)
- Approach (e.g., runs wide or close)
- Eye (loose, medium, strong)
- Wearing
- Bark (e.g., works silently, sustained barking)
- Temperament (e.g., easily distracted, apprehensive)
- Interest (e.g., sustained, no interest)
- Power (e.g., excessive force)
- Grouping of stock
- Balancing stock with handler
- Responsiveness to training
- Stock evaluation (e.g., cooperative, controllable)

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The herding system

To the extent that morphology shapes the brain and behavior, the once seemingly rock-solid foundation for behavioral homology based on instinct that Lorenz provided now seems shaky.

We should be seeking insight into the epigenetic *processes* that shape bodies and brains and, ultimately, the development of complex behaviors. It may be in those processes that a science of behavioral homology can be found.