Evolution and Epigenetics

Seminar: Social, Cognitive and Affective Neuroscience
Speaker: Wolf-R. Brockhaus

The history of evolutionary theory

- ~ 1800: Lamarck
- 1859: Darwin's "On the Origin of Species"
- late 19th and early 20th centuries: neo-Darwinian and neo-Lamarckian theories
- today: Modern Synthesis

Lamarck's evolutionary theory

- first modern systematic evolutionary theory
- principles:
  - use and disuse
  - inheritance of acquired traits
- adaptation to external conditions can be inherited

Darwin's „laws“ of biology

- growth with reproduction
- inheritance
- variability
- struggle for life
- natural selection
- divergence of character
- extinction

Weismann's „Neo-Darwinism“

- natural selection got an exclusive role
- sharp distinction between cells of the soma and germline cells
- variation only through accidental or environmentally induced alterations in the germline determinants

Modern Synthesis

- transmission of germline genes
- natural selection plays an important role
- variation is the consequence of the many random combinations
- new alleles arise only through accidental mutations

Some new findings

- allelic difference in a single gene can lead to many character differences
- often a variation in a single gene makes no difference to the phenotype
- DNA can be changed during development
- RNA can also act as hereditary material
- idea that all DNA changes arise through random mistakes is wrong

Conclusions

- development of traits and trait variations in terms of single genes and single-gene variations is inappropriate
- cellular and intercellular networks

Epigenetic Inheritance

- inheritance of phenotypic variations that do not stem from differences in DNA sequence
- includes
  - cellular inheritance
  - body-to-body information transfer
- epigenetic information that a cell receives depends on the conditions that ancestral cells have experienced
- may do for plants what learnt behaviors and their transmission do for animals

Transmission through socially mediated learning

- body-to-body substance transmission is the outcome of how parents behave
- can have long-term, transgenerational effects that can sometimes lead to traditions
- depends on the nature of the information and the experiences of the receiving animal

Symbol-based Information Transmission

- symbolic systems extend the potential for transmitting information
- lead to a requirement for learning
- central to
  - generation of cultural entities
  - transmissibility
  - selective retention or elimination

Interactions between genetic, epigenetic, behavioral, and symbolic variations

- not only do genetic changes affect epigenetic variations, but epigenetic variations affect DNA sequences
- natural selection will favor the most well-adjusted phenotypes and the genes underlying them
- genetic assimilation can occur not only with environmentally induced changes in form, but also with persistent changes in behavior

Modifications of the original Modern Synthesis

- genome has turned out to be far more flexible and responsive
- some transmissible cellular variations are the result of spontaneous or induced epigenetic changes
- behaviorally transmitted information plays a significant role in evolution
- symbolic culture has powerful evolutionary effects

Literature

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