Roots of Neuroethology

The roots of neuroethology stem from the modern pioneers of the study of animal behavior: **Karl von Frisch, Konrad Lorenz, and Niko Tinbergen.**

These three pioneers shared the 1973 Nobel Prize for Physiology & Medicine for their collective contributions to the field of animal behavior.
Konrad Lorenz (1903-1989)
Austrian animal behaviorist

* An early interest in natural history, evolution & paleontology
* Medical training: comparative anatomy & embryology
* Oskar Heinroth (comparative studies of the behavior of ducks)

First to introduce the term “ethology” (from Greek word ethos meaning “manner” or “behavior”) to describe the analysis of natural behavior.

**Fixed Action Patterns:** innate responses that continue to completion without interference from external stimuli.

-- Egg Rolling in the Greylag Goose --

Konrad Lorenz (1903-1989)
Austrian animal behaviorist

* Theory of drives: psychohydraulic model
* Behavior as an inherited trait, used for taxonomy and phylogenetic analysis.

* Social imprinting in Geese
Karl von Frisch (1886-1982)
German Ethologist/Physiologist

- Comparative physiology
- Dance language of honeybees
- Hearing in fish
- Sensory biology

Niko Tinbergen (1907-1988)
British ethologist and ornithologist

- Fixed Action Patterns (along with Lorenz)
- A study of Instinct (1951)
- Herring Gull Behavior: ethogram of action patterns
- Release mechanisms that initiate fixed action patterns
- Four questions for research on behavior:
  - immediate causation
  - development
  - evolution
  - function
Niko Tinbergen (1907-1988)
British ethologist and ornithologist

Lorenz and Tinbergen considered that every species has a repertoire of stereotyped behaviors called Fixed Action Patterns (FAPs).

FAPs are elicited by a specific set of stimuli (Sign stimulus or Releaser), not a generalized stimulus - e.g., shape, color, specific-forms, not mere light

Tinbergen (1951) - courtship behavior of the male three-spined stickleback

FIXED ACTION PATTERNS

FAPs are species specific: performed by all, or nearly all members of a species.

- innate: largely unlearned (undergoes change during development; strong inherited component)
Are there any specific-specific FAPs (or “universals”) in humans?

“Eyebrow Flash”

These pictures of a Himba woman from Namibia (SW-Africa) show a rapid brow raising which coincides with raising her eyelids. Because all cultures examined show this behavior, it is suggested to be a human ‘universal’ or Fixed Action Pattern.
Predator Vigilance: “hidden” camera studies (Eibl-Eibesfeldt)

- Glancing during a meal
- Eye dart or head turn every third or fourth bite
- Predator vigilance?

Similar in other primates? YES!

Behavior Reflexes in Humans – Hand reflex in newborns

Newborns exhibit a characteristic reflex of the hand in which they firmly hold any object (but especially hair).

- Quantitative measures showed that infants apply more strength if they touch hair.

This FAP appeared in evolution among primates so that the infant can hold to the mother's hair and not fall when she moves briskly.

Given a rope, new-borns hold firmly and remain suspended by themselves.
What makes a baby smile? (innate behavior)
What is the releaser (sign stimulus)?

YES!  YES!  YES!  YES!  NO!

Conclusion: A pair of eyes releases a baby’s smile

Neural Basis for FAPs?

Tinbergen and Lorenz maintained that:
- FAP is “released” by external stimuli, but not controlled by stimulus as in a reflex
- some neural circuit must control FAP
Innate Releasing Mechanism

The neural network responsible for detecting the simple cue (sign stimulus = red dot) and activating the instinctive behavior (FAP = begging/pecking behavior) is known as:

*An Innate Releasing Mechanism*

**Sign Stimuli** = component of the environment that triggers a given instinctive behavior

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**Defining the Sensory Releaser**

Effectiveness of different visual stimuli in triggering the begging behavior of young herring gull chicks
Supernormal Stimuli:

*Incubation Behavior of the Oystercatcher*

If given a choice, the bird will prefer to incubate 5 eggs over the normal clutch of 3 eggs.

When offered eggs of different sizes, they prefer the supernormal egg.

Do Humans make use of supernormal stimuli???
The use of atropine by early Egyptian women to dilate eye pupils for a more attractive appearance

The enlargement of men’s shoulders in various societies to emphasize a larger appearance

Can you think of other physical attributes that are often enlarged (via plastic surgery) to increase physical attraction??
Others Innate Releasing Mechanisms in Humans?

Baby schema

Lorenz claimed that the behavior patterns of caring for young are released on an innate basis by a number of signal stimuli that characterize infants:

- Head large in proportion to the body
- Protruding large forehead in proportion to the face
- Large ears and eyes below the midline of the head
- Small nose
- Short thick extremities
- Rounded body shape
- Soft elastic body surfaces
- Round protruding cheeks

Baby schema

- Animals such as red squirrels and dormice have these characteristics that make them attractive to humans
- these animals often appear as 'loveable' characters in books for children or as soft toys.

Contrast these characteristics to that of the birds of prey (Opposite of baby schema). For example, the use of the imperial eagle on top of standards carried by soldiers in ancient Rome.
Baby schema

Some of these baby-like features can be seen in these pictures of two members of the “The Spice Girls” (one member is known as 'Baby Spice')

Psychologists have examined the relationship between facial babyness and sexual attraction, and evidence suggests:

• *Facial babyness in adult females is sexually attractive for males*
• *Attractive female prototypes show more babyness*

Question: _Are there specific neurons in the brain that respond sign stimuli??_

Answer: YES!

These neurons are known as *Feature Detectors*

*Feature detectors* = neurons that are selectively responsive to specific features of a sensory stimulus.

Example = Neural mechanisms of *feature detection* involved prey catching behavior of toad
Back to Tinbergen and Lorenz.....

Proximate Causes of Behavior

- During the 1950s & 60s, pioneering ethologists devoted more effort to understanding the proximate causes of behavior.

- *Study of Instinct* (1951) devoted a significance portion (> 5 chapters) to the development and physiological causes of selected behavior patterns.


- Tinbergen’s Instinct theory attracted great interest, in part because it went against the prevailing view of Behaviorists, exemplified by *Skinnerian conditioning theory*. The debate was often spirited [see Lehrman & Lorenz (1965)] and continued into the 1980s (nature vs nurture controversy)
Rise of Sociobiology and Behavioral Ecology (1960-70s)

- Sociobiology: the new synthesis (E.O. Wilson, 1975) offered a monumental review of social behavioral research.

- Sociobiology was proposed as the synthesis of scientific disciplines (ethology, anthropology, evolution, zoology, archaeology, and population genetics) to explain social behavior in all species by considering the application of evolutionary theory to social behavior.

Wilson made some clear statements on how the field of animal behavior would develop between 1975 and 2000 (these statements proved to be correct)......

EO Wilson’s diagrammatic representation of possible changes in the field of animal behavior from 1950 to 2000
EO Wilson’s diagrammatic representation of possible changes in the field of animal behavior from 1950 to 2000
Rise of Neuroethology

• significant advances were made only in the 1970s and 1980s

• such success was due to both the advent of new neurobiological methods and to the focus on simple and robust forms of behavior.

• subjects in neuroethology are as diverse as the animal kingdom. Neuroethologists are interested in comparative aspects of behavior and in the evolution of the nervous system. The comparative method is used in many studies.

Theodore Bullock (1915-2005)

pioneered investigations that included studies of sensory system, especially fish, neurophysiology of nerve cells, and electrical activity & evolution of the brain
Walter Heiligenberg (1938-1994)

Development of Bird Song

Peter Marler

Donald Griffin

Echolocation by Bats