Ethological analysis of behaviour

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Ethology

- Ethos (“be”) + logia (“study”)
- Discipline that study animal behaviour

Ethologist...

- ...see the behaviour as a biological trait
- ...study the evolution of the behaviour through the natural history of the species, their development in the individual and how it is triggered

Ethologists ‘Pre-ethology’

- John Ray, XVII, UK – instinct of birds’ behaviour
  Lazzaro Spallanzani, XVIII, Italy – bats orientation by sonar
- Charles George Leroy, XVIII, France – intelligence and animals adaptability
- Douglas Spalding, XIX, UK – relation between instinct and experience
- **Charles Darwin,** XIX, UK

Behavioural traits as taxonomic characteres

Ethology vs Psychology (1960)

Traditionally:

Ethologists

- European zoologists
- Interested in the evolution of behaviour in the species
- Field work
- Studying the behaviour of several species

Comparative psychologists

- Norte-americans psychologists
- Interested in the individual behaviour
- Work in the laboratory
- Studying rats, pigeons, humans

Ethology vs Psychology nowadays

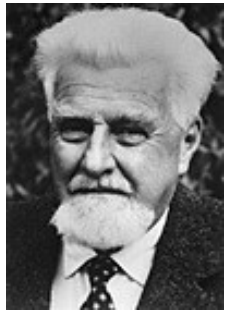
- ***Ethologists*** increasingly resort to experiments in the laboratory
- Increased perception of the biological aspects of the behaviour in the **Psychology** field

Nobel Prize 1973

(Physiology or Medicine)

Karl von Frisch

Konrad Lorenz



Niko Tinbergen

"for their discoveries concerning organization and elicitation of individual and social behaviour patterns"

"if there is one single date for the **birth of ethology**, it would be during that summer [of 1937] when [Niko Tinbergen and Konrad Lorenz] collaborated in developing theory and in studying such behavioral patterns as egg rolling in greylag geese"

Dewsbury 2003

Figure 1. Female "snow" phase *Anser caerulescens* rolling egg into nest at McConnell River, N.W.T.

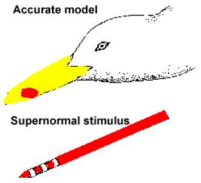
After Prevett & Prevett 1973

Fixed action pattern

(Marken, Richard S. Review of General Psychology, Vol 6(3), 2002, 260-270.)

Egg outside of the nest
- **sign stimulus or releaser**

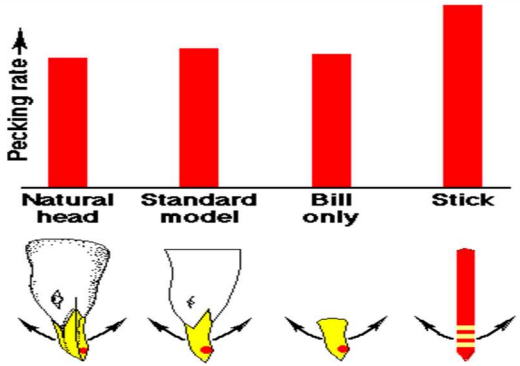
Behaviour
- **rolling the egg**



Red dot in the beak
- **sign stimulus**

Behaviour:
- **pecking the beak**

Supernormal stimuli



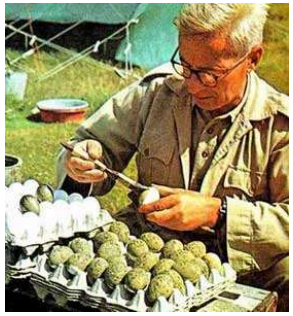
(Tinbergen and Perdeck, 1950)

(http://www.flyfishingdevon.co.uk/salmon/year1/psy128ethology_experiments/ethexpt.htm#sign_stimuli)

Sign stimulus

Niko Tinbergen

- Four questions of behaviour:
  - function
  - cause
  - ontogeny
  - behavioural evolution
- Innate mechanisms of action & fixed action pattern (com Konrad Lorenz)
- Sign stimulus or releaser



Konrad Lorenz

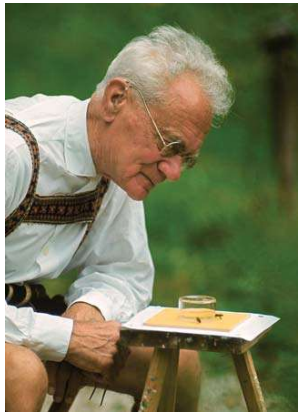
- Innate mechanisms of action & fixed action pattern (com Niko Tinbergen)
- Instinctive behaviour of birds
- ‘Imprinting’ theory

‘Imprinting’

- Ability to recognize individuals of their own species developed in young animals
- Konrad acted as geese’s mother by raising them since birth
- In adults, these geese made the court to humans

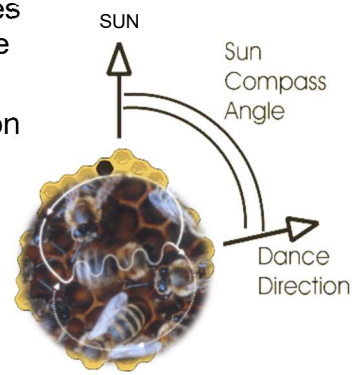
Karl von Frisch

- *Waggle dance*
- The way bees communicate the localization of a flower field.



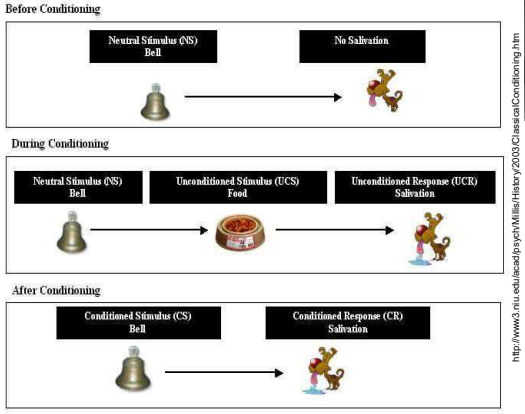
Waggle dance

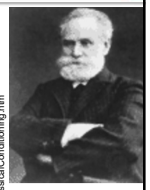
- Waggle duration: indicates the distance from the hive to the flowers.
- Waggle direction: direction of the flower field.
- Waggle angle: adjusted through the day because of the sun position



Classical conditioning

- Ivan Petrovich Pavlov (1927):

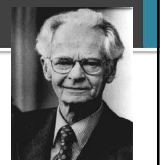


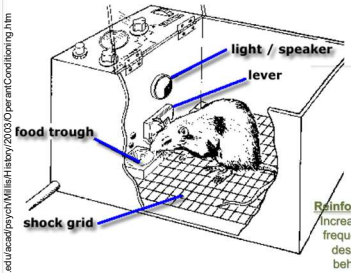


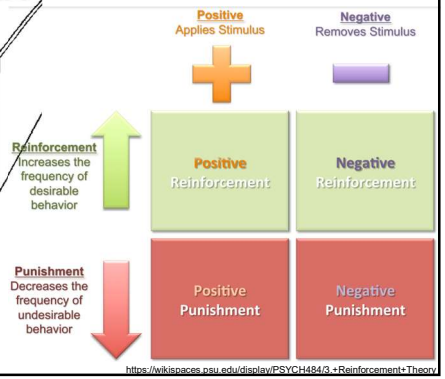
http://www3.niu.edu/acad/psych/Millis/History/2003/ClassicalConditioning.htm

Operant conditioning

- BF Skinner (1930):







http://www3.niu.edu/acad/psych/Millis/History/2003/OperantConditioning.htm

https://wikispaces.psu.edu/display/PSYCH484/3.+Reinforcement+Theory

Tinbergen's 4 questions

- **Function**: Which are the consequences of a certain behaviour (immediate and final) (ecology)?
- **Cause**: Which mechanisms are involved are regulate the behaviour (physiology)?
- **Ontogeny**: How the behaviour evolve in the individual throughout its life?
- **Evolution/ phylogeny**: How the behaviour evolve in the species?

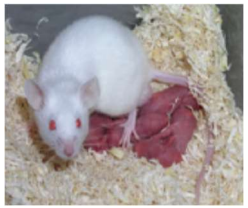
Nest building in rodents

- **Function**

- Shelter to them and to the pups
- To create a microclimate

Nest building in rodents

- **Cause**



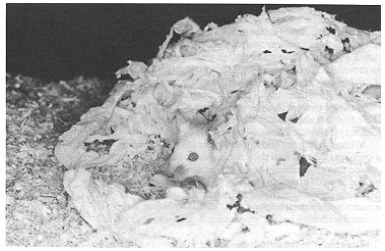
- Hormones related with pregnancy (prolactin, progesterone)
- Humidity and/or temperature
- Predators

Nest building in rodents

- **Ontogeny**
- Behaviour increased during reproduction in females
- Older animals behaved similarly to young adults
- Size of the nest is related with parental fitness: bigger nests are positively correlated with bigger animals and more pups

Nest building in rodents

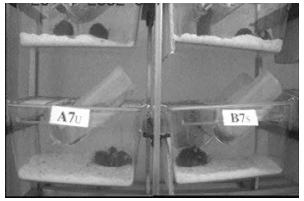
- Phylogeny



Standard housing in laboratory

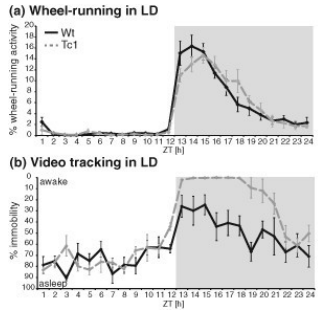
Considerations:

- economic
- ergonomic
- health
- ethological?



Mus musculus domesticus natural history

- Nocturnal

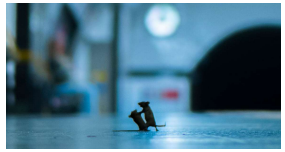


Heise, I et al. (2015). *Genes, Brain and Behavior*, *14*(2), 209-216.

Mus musculus domesticus natural history

- Territorial (2-20000m^2)
- Social animals
- Hierarchy: one dominant and others subordinates (importance of scent marks)

- Normal dominance behaviour: mitigated by escape or appeasement
- Escape can be as simply to move out of the sight of the dominant mice.

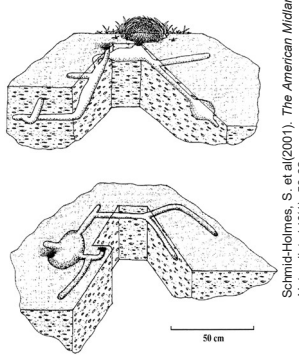


Mus musculus domesticus natural history

- Digging
- Nest building (both genders)
- Burrow systems

- Sites for nesting females and their litters, for communal nests during winter months, for male to live in the summer months, to store food

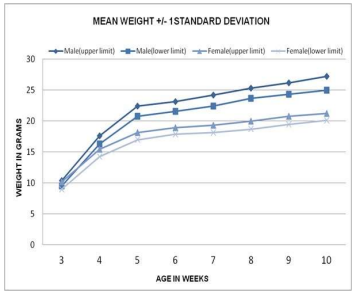
- Developed orientation



Schmid-Holmes, S. et al(2001). *The American Midland Naturalist*, *146*(1), 53-62.

Mus musculus domesticus natural history

- Omnivour diet: cereals, grass, seeds, plant parts, insects, worms
- Growth curve



Black 6

CD-1

Mus musculus domesticus natural history

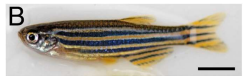
- Sexual maturity around 5-6 weeks
- Gestation period of ~21 days
- In optimal conditions may reproduce all year, otherwise the reproduction occur mainly in the warm weather

Photograph: Katsuhiko Hayashi

Mus musculus domesticus natural history

- Olfactory sense: the most developed sense
- Audition: in our frequency range but also ultrasounds
- Poor vision
- Tactil receptors: head, wiskers, paws and tail
- Taste: cannot vomit, so they learn by observation and may exibit neophobia

Danio rerio / zebrafish natural history



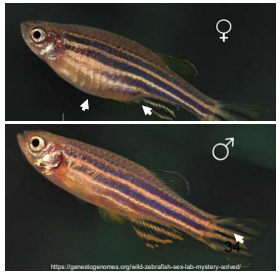
- Cyprinidae family
- Asian origin, tropical freshwater diurnal specie
- Less than 5 cm length
- Pigmentation can vary with background, water quality and health status

- Lives in shallow, clear, slow-moving water
- Preference for silt-bottom and vegetation
- Swim through all the water column

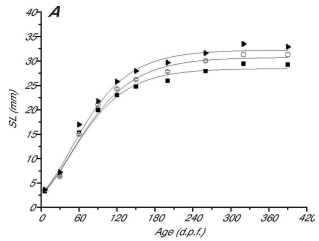
http://www.seriouslyfish.com/species/danio-rerio/

Biology

- Life span: 2-3 years in nature
- Mainly feed on allochtonous materials that fell in water, aquatic insect larvae, crustacea, zooplankton and phytoplancton
- Sexual dimorphism
- Sexual maturity at ~3 months

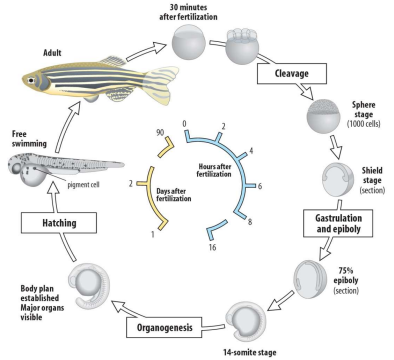


- Growth curves



Amaral I P G , and Johnston I A J Exp Biol 2012;215:3895-3904

Life cycle

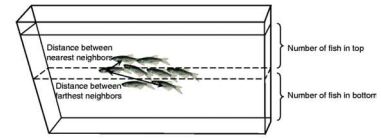


http://www.mun.ca/biology/desmid/brian/BIOL3530/DEVO_03/ch03f09.jpg

Zebrafish behaviours in nature

- Highly social animals
- Group sizes vary with environmental parameters (space, water velocity)
- Shoaling behaviour (depends on environmental conditions)
- Formation of dominance hierarchies and social status: the case of pairs of fish that show exaggerated behavioural indicators of stress

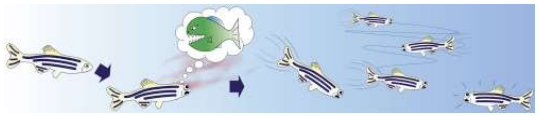
Pham, M., et al. (2012). In *Zebrafish protocols for neurobehavioral research* (pp. 231-246). Humana Press, Totowa, NJ.



Zebrafish behaviours in nature

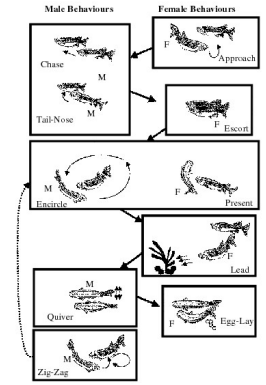
- Anti-predatory response behaviour in zebrafish related to the alarm substance:
- increase shoal cohesion and aggression
- decreased feeding rate
- freezing or erratic swimming

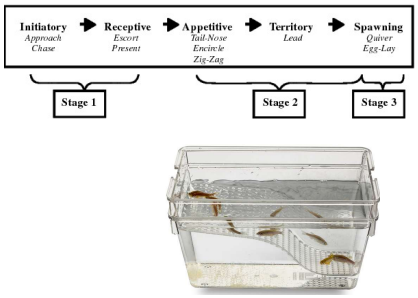
- Exploratory behaviour is crucial to gather information about their environment, to forage food and to reproduce



Volz, S. N., et al. (2020). *Chemosphere, 241*, 124963.

Mating behaviour





Darrow, K. O. & Harris, W. A. (2004). *Zebrafish, 1*(1), 40-45.

Breeding behaviour is influenced by group density and available space.

Housing ethological considerations

- Natural history
- Animals “work” to obtain food
- Freedom of choice (ex.: tube, plant)
- To give animals the chance to perform natural behaviours (ex.: nest material, pebbles?)

↓

Privation effects

Preference tests

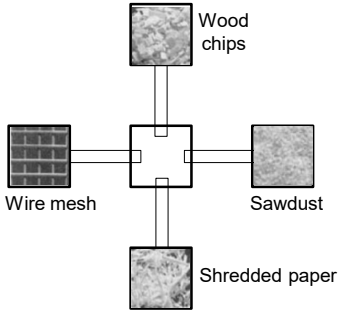
Consumer-demand studies

Preference study

- To offer to the animal several alternatives at the same time and to measure the time spend in each of the alternatives

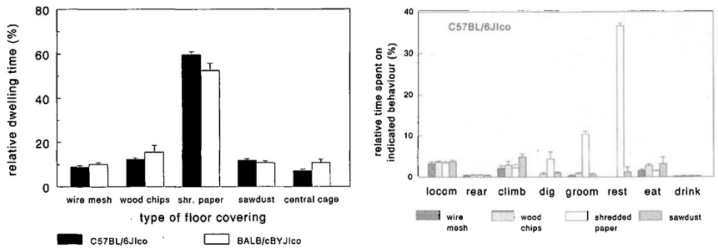
- Ex.: bedding material

- General behaviour
- Time



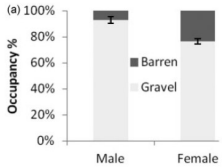
Blom et al., Lab Anim. 1996 Jul;30(3):234-44.

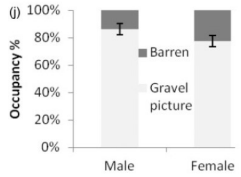
Preference study



- Cage with shredded paper had less feaces and urine

Preference study

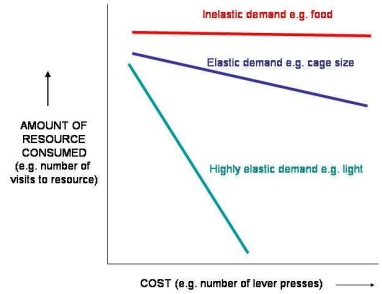




Schroeder et al, Laboratory Animals 2014, Vol. 48(4) 328–337

Consumer-demand studies

The more an individual is willing to pay for an resource, the more motivated one is to get it



Consumer-demand studies

Ex. costs

- Operant
  - To overcome a barrier/ heavy door
  - To press a lever
  - Touch/ poke a light
  - Running wheel
- Natural aversion
  - Water
  - Air
  - Predator odour
  - Alarm cue
- Homeostasis alteration
  - Temperature
  - Humidity
  - Light/ photoperiod

Results

- Mice prefer cages with shelters and nest material (van de Weerd et al 1998; Heizmann et al 1998)
- Rodents work to access several resources as nest material (Roper 1973; 1975), running wheel and additional space (Sherwin 1998, 2004), and even to get a structured cage (Lewejohann & Sachser 1999)

Photo: Emily Patterson-Kane

Behavioural phenotipage

- There is no kits to perform behavioural tests!
- The laboratory animal is NOT a test tube
- Know the animal used as you know your target gene
- Knowledge required came from ethology, experimental psychology and behavioural pharmacology