

Animal Mind: How similar are animal mental processes to ours?



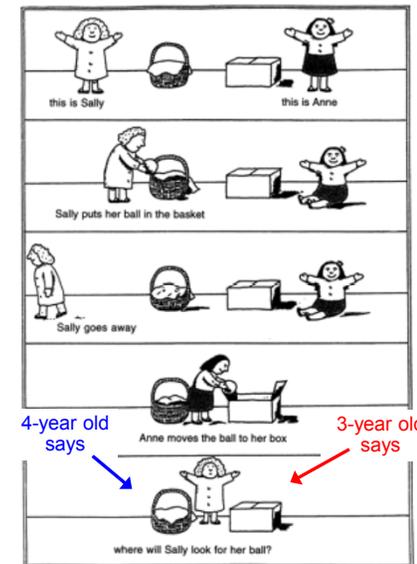
Speculations about animal mind center on one or another of these attributes:

- **intelligence**: are animals smart, do they reason problems out?
- **complex cognitive mechanisms**: do they use complex mental mechanisms such as mental maps?
- **consciousness**: what is the *content* of the animal mind, do they introspect?
- **emotion**: do animals have feelings like us: love, hate, jealousy, sadness, etc.?
- **intentionality**: do animals make plans?
- **self awareness**: are animals aware of themselves as unique individuals?
- **theory of mind**: is an animal aware that other animals have minds too?
- **communication**: can animals 'talk' with one another? with us?

Special problems with studying animal *mind* that we don't have when studying animal *behavior*

1. **Objectivity**. Can't know animal mind directly: Behavior is **observable**, mental processes are **inferred**.

2. **Anthropomorphism** (the injection of human qualities into animals). Humans are naturally inclined to assume that animals think and feel like we do.





A recurring question!

Anthropomorphism & Theory of Mind

Humans seem naturally inclined to engage in anthropomorphism. This may be because humans develop a refined *theory of mind* and routinely use it to interpret others' behavior.

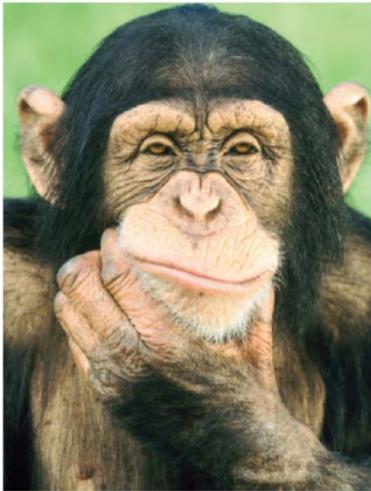
TOM = the awareness that others have minds as well as yourself. Young children act as if they are unable to distinguish between what they know and what others know. TOM develops with age.



Two points about TOM:

1. Humans instinctively apply TOM to animals (a mentalistic, anthropomorphic approach)
2. Do animals too develop TOM?

Animal Mind A little history



Historically, two approaches to the study of animal mind.

- **Mentalistic approach:** investigator tries to demonstrate that animal employs human-like mental processes in dealing with its world
- **Mechanistic approach:** investigator assumes that animal is like machine in some respect, has proposed a simple mechanical model of the underlying mental processes

Descartes (1596-1650)

- Humans and animals are machines
- Concept of the reflex arc
- ...but humans also have a soul
 - Mind/body dualism



Rembrandt's *The Anatomy Lesson* (1630)

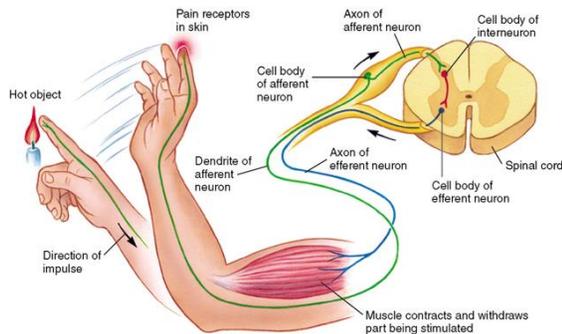


Descartes the concept of the reflex arc



“The fire has the force to move the part of the skin of the foot [at B], and by this means pull the small thread C, which you can see is attached, simultaneously opening the entrance of the pore d, e, where this small thread ends...the entrance of the pore or small passage d, e, being thus opened, the animal spirits in the concavity F enter the thread and are carried by it to the muscles that are used to withdraw the foot from the fire.”

Modern conception of the reflex arc

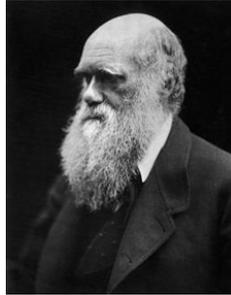


Charles Darwin (1809 -1882)

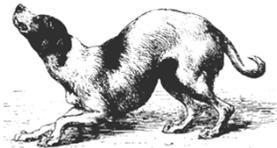


- Life a battle for limited resources
“survival of the fittest”
- Crucial elements of theory:
 - **Adaptation**
 - **Natural selection**
 - **Phylogeny** (evolutionary history) – all species are related (some more closely than others)

Charles Darwin (1809 -1882)



Mental continuity
between humans
and animals.



Descent of Man (1871)
*The Expression of the Emotions in
Man and Animals (1872)*

*"Nevertheless the difference in
mind between man and the higher
animals, great as it is, certainly is
one of degree and not of kind."*

Georges Romanes (1848 - 1894)



Applied Darwin's ideas to
study of animal behavior

Animal Intelligence (1883)

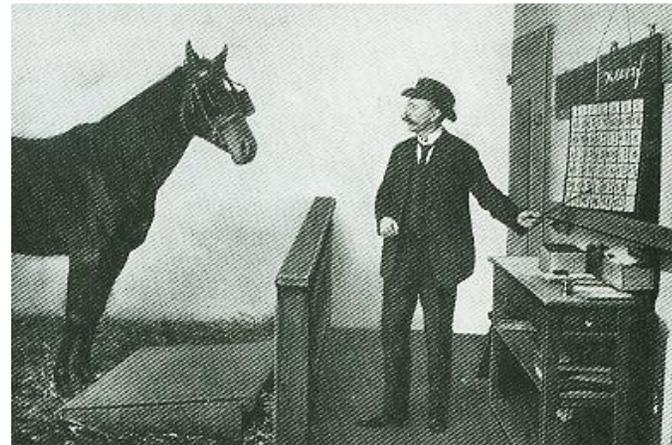
"The external indications of
mental processes which we
observe in animals are trustworthy, **so...we
are justified in inferring mental states** from
particular bodily actions".

Romanes used the **anecdotal 'method'** to
build his views on animal intelligence.

Excerpted from George Romanes' book *Animal Intelligence* (1888)

"One day, watching a small column of these ants (*Eciton hamata*), I placed a little stone on one of them to secure it. The next that approached, as soon as it discovered its situation, ran backwards in an agitated manner, and soon communicated the intelligence to the others. They rushed to the rescue; some bit at the stone and tried to move it, others seized the prisoner by the legs and tugged with such force that I thought they would be pulled off, but they persevered until they got the captive free, and covered one up with a piece of clay, leaving only the ends of its legs projecting. It was soon discovered by its fellows, which they immediately, and by biting off pieces of the clay soon liberated the prisoner. In a short time ... I confined one of these under a piece of clay. As the ants passed it, but at last one discovered it and tried to get it out, but could not. It immediately set off at a great rate ... in a short time about a dozen ants come hurrying up, evidently fully informed of the circumstances of the case, for they made directly for their imprisoned comrade and soon set him free. **I do not see how this action could be instinctive.** It was **sympathetic help**, such as Man ... shows. The excitement and ardour with which they carried on their unflinching exertions for the rescue of their comrade could not have been greater if they had been human beings".
(quote from J. Bret)

Der Kluge Hans (Clever Hans)



Pfungst, O. (1907). Das Pferd des Herrn von Osten (Der Kluge Hans).
Ein Beitrag zur experimentellen Tier- und Menschen-Psychologie

- Anthropomorphism
- needless mentalistic explanations
- lack of rigorous observation



✓ **Morgan's Canon**

✓ **Behaviorism**

Romanes' method of supporting his claims with anecdotal evidence rather than empirical tests prompted **Lloyd Morgan's Canon** (similar to much older Ockham's "Razor" or to "law of parsimony")

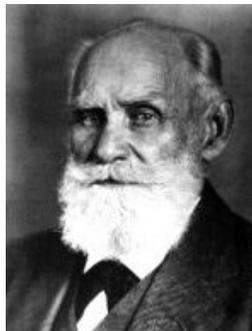
Morgan's Canon of Parsimony

"In no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale." (Morgan 1903)



C. Lloyd Morgan
(1852 – 1936)

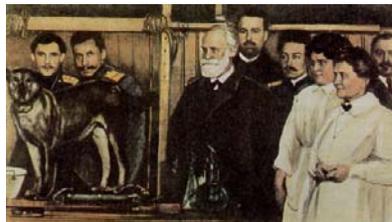
In studying the digestive system, Pavlov discovered classical conditioning.



Ivan Petrovich Pavlov
(1849 - 1936)

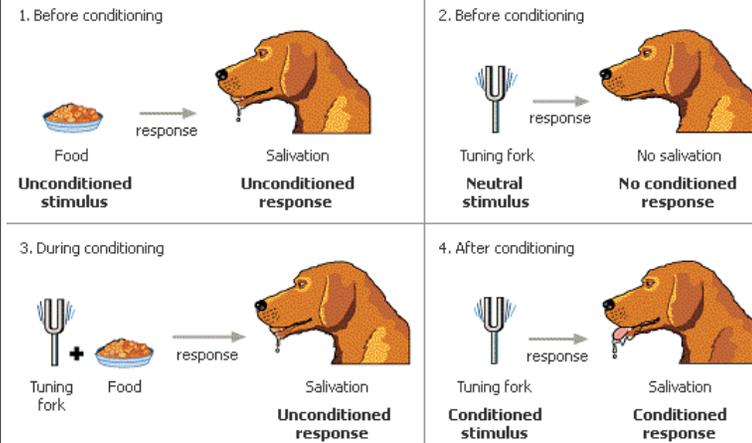


Pavlov received Nobel Prize in 1904



Pavlov(center) shown demonstrating classical conditioning to students at the Military Academy in Russia. © The Granger Collection

Classical Conditioning



Edward Thorndike (1874-1949)

Criticized Romanes' views as unscientific.

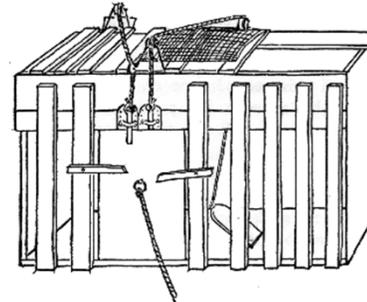
Problems with anecdotes:

1. Only a single case is studied – Does it apply to whole species?
2. Observations are often not repeated or repeatable.
3. Conditions under which observations are made are not controlled.
4. Do not know history of the animal.

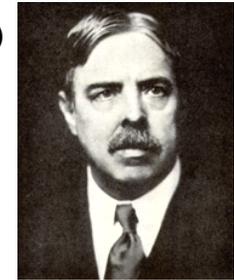
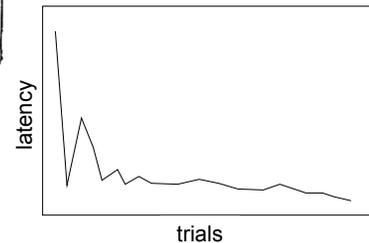


Edward Thorndike (1874-1949)

Animal Intelligence (1911)



The Puzzle Box



Edward Thorndike (1874-1949)

Law of Effect

- There is a random element in behavior (**trial & error**)
- Behaviors with pleasurable consequences are “stamped in” (**reward**)
- Those that have noxious consequences are weakened (**punishment**)
- **Instrumental conditioning**



John Watson (1878-1958)

Founder of Behaviorism

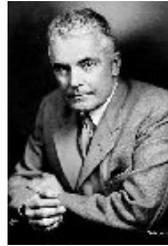
Behaviorism (1911)

- *Psychology from the Standpoint of a Behaviorist* (1919)
- Psychology “has failed signally...to establish itself as a natural science”
- Psychology should be “a purely objective experimental branch of natural science”
- “Psychology must discard all reference to consciousness”



John Watson (1878-1958)

Founder of Behaviorism



Behaviorism (1911)

- *Psychology from the Standpoint of a Behaviorist* (1919)
- “Behavior, not consciousness, [should be] the objective point of our attack.”
- **Inferring internal states is redundant and unnecessary.**
- Pavlovian and instrumental conditioning can explain much, if not all, behavior.

Watson’s famous quote:

Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I’ll guarantee to take any one at random and train him to become any type of specialist I might select -- doctor, lawyer, artist, merchant-chief and, yes, even beggarman and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors. (Watson, 1930, p. 104)

Concept of Tabula Rasa (Blank Slate)

The Age of Behaviorism and Learning Theory (~1920 - 1970)

- Watson a methodological behaviorist **and** an extreme environmentalist.
 - Behaviorism – goal to rid the world of (1) mentalistic explanations, (2) instinct.
- Universal rules of learning became the Holy Grail**
- Hull – a theoretical behaviorist / learning theorist
 - Tolman – a very different kind of learning theorist
 - Guthrie – an atheoretical learning theorist
 - Skinner – an atheoretical, radical behaviorist

Clark Hull – a theoretical behaviorist

$$sEr = V \times D \times K \times J \times sHr - slr - lr - sOr - sLr$$

where sEr = excitatory potential (likelihood that animal will produce response r to stimulus s)

sHr = habit strength (derived from previous conditioning trials),

D = drive strength (determined by, e.g., hours of deprivation of food, water, etc.)

V is the stimulus intensity

K is incentive motivation (size or quality of the reinforcer),

J is the incentive based on the delay of reinforcement,

lr is reactive inhibition (i.e., fatigue) slr is conditioned inhibition (due to previous non-reinforcement of r),

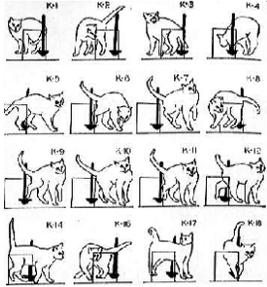
sLr is the reaction threshold (smallest reinforcement that will produce learning), and

sOr is momentary behavioral oscillation (error).



(1884 - 1952)

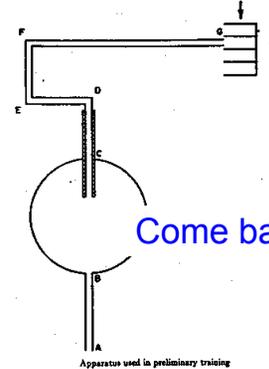
Edwin Guthrie – an **a**theoretical behaviorist



(1886 -1959)

Edward Tolman – a cognitive behaviorist

"Cognitive maps in rats and men" (1948)



Come back to later!



(1886 - 1959)

FIG. 15
 (From E. C. Tolman, R. F. Ritchie and D. Kalish, Studies in spatial learning. I. Orientation and the short-cut. *J. exp. Psychol.*, 1946, 36, p. 16.)

B. F. Skinner – a **radical** behaviorist

"We explain behavior in everyday life by using a language that came into existence long before there were philosophers or scientists of any kind. It is properly called a vernacular ... We all speak it. It is the language of newspapers, magazines, books, radio, and television. When speaking of the behavior of the individual, it [also] is the language of the behavioral scientists.... The attempt [by psychologists] to use the apparent references to an initiating mind and to convert the vernacular into the language of science [is], however, a mistake ...

There is no place in a scientific analysis of behavior for a mind or self".



1938: *The Behavior of Organisms: An Experimental Analysis*

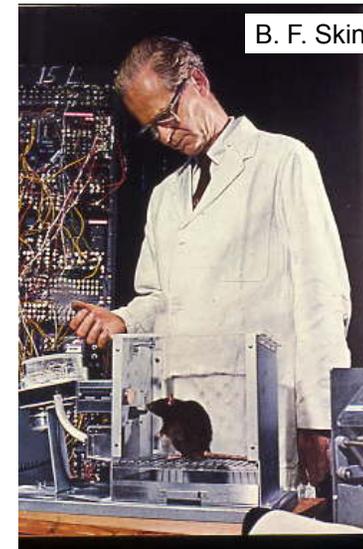
1950: Are theories of learning necessary?
Psych Review

Strict Operational Behaviorists (S.O.B.s)

Operant conditioning: behavior is voluntary and goal directed ('operates on the environment'). It is 'shaped' by its consequences – strengthened if rewarded, weakened if punished.

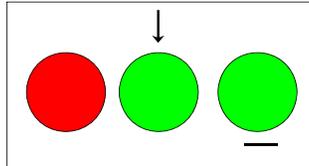
But **we do not need to** invoke mental concepts to explain behavior.

Behaviorist approach handles complex behavior, up to a point.



B. F. Skinner

Strict Operational Behaviorism



Concept Learning?

Match to Sample: Color comes up on center key, goes off, then colors on two side keys come up – pigeon's task is to pick the same color (match) that was on the center key (sample)

Concept learning? ("match the center key color")

Introduce brown
↓
chance performance!

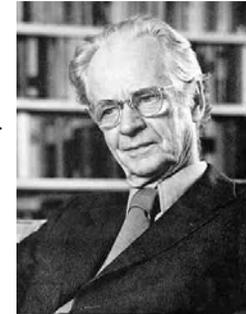
Learning very specific, *at least at first*.
Ultimately animals show generalization, 'learning to learn'.

Complex behavior can be 'shaped'
Shaping by successive approximations

Gould: “Behaviorism, then, saw a difference in degree between humans and other animals, but in its ideological desire to rid the world of instinct, it considered all animals’ minds to be essentially identical. Some were simply larger than others, ours being the biggest of all. Learning looked the same from top to bottom, limited only by sensory equipment and anatomy; **universal rules of learning became the Holy Grail**. At heart, then, Behaviorism ignored (and implicitly denied) natural selection’s ability to create niche-specific minds designed to solve particular intellectual challenges”.

B. F. Skinner – a **radical** behaviorist (or a strict operational behaviorist, S.O.B.)

- 1938: *The Behavior of Organisms: An Experimental Analysis*
- 1939: The alliteration in Shakespeare's sonnets: a study in literary behavior
- 1948: *Walden Two*
- 1950: Are theories of learning necessary? *Psych Review*
- 1950: *Verbal behavior* (revised 1957)



B. F. Skinner – a **radical** behaviorist (or a strict operational behaviorist, S.O.B.)

What can be an operant?

Practically anything!

- rate of response
- timing
- pushes and pulls
- posture
- study habits
- athletic performance
- arts and crafts
- creativity
- behavioral disorders
- bad habits
- ~~language~~



Ethology

a totally different – but still mechanistic! – approach to animal behavior



Originated in Europe in the 1930s-1940s, at a time when behaviorism ruled in the U.S.

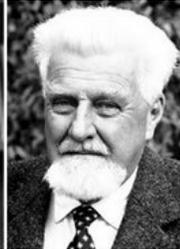
Gould: “Like behaviorists, most ethologists saw animals as machines. The two schools disagreed violently, however, on how these machines worked, and the role of evolution in learning”.

Ethology (Heyday ~ 1930-1960)

- Originated in Biology Departments in Europe.
- Focused on species-specific behavior, studied in the field (or close laboratory analogs).
- Focused on instinct rather than learning.
- On one and only one point did the ethologists agree with the behaviorists: they wanted an objective science of behavior and rejected mentalism and anthropomorphism outright.



Karl von Frisch
(1886 - 1982)



Konrad Lorenz
(1903 - 1989)



Nikolaas Tinbergen
(1907 - 1988)

Ethology (Heyday ~ 1930-1960)



The Nobel Prize in Physiology or Medicine 1973
"for their discoveries concerning organization and elicitation of individual and social behaviour patterns"

Ethology – Mechanistic Models of Instinctive Behavior

Sign Stimulus (Releaser)



Innate Release Mechanism



Fixed Action Pattern



Supernormal stimulus

Ethology – Mechanistic Models of Instinctive Behavior

Sign Stimulus (Releaser)



Innate Release Mechanism



Fixed Action Pattern

Supernormal stimulus



Ethology – Mechanistic Models of Instinctive Behavior

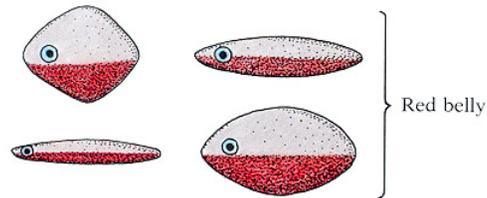
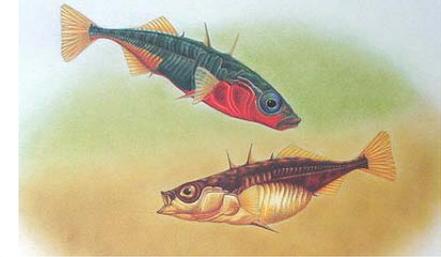


Jack-in-the-Box
model of behavior

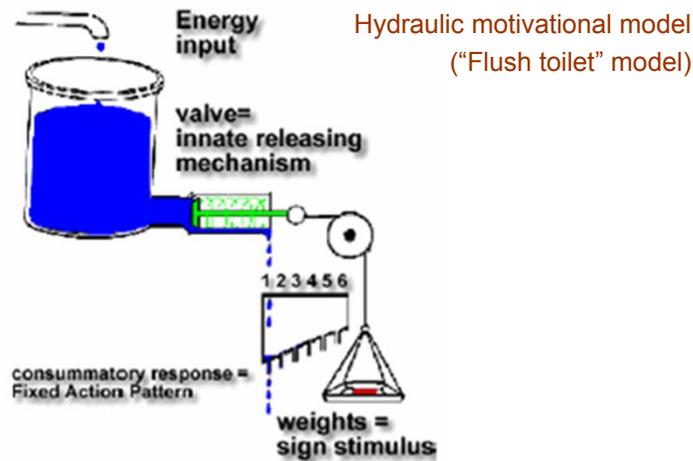


Ethology – Mechanistic Models of Instinctive Behavior

Stickleback:
Red belly as sign stimulus



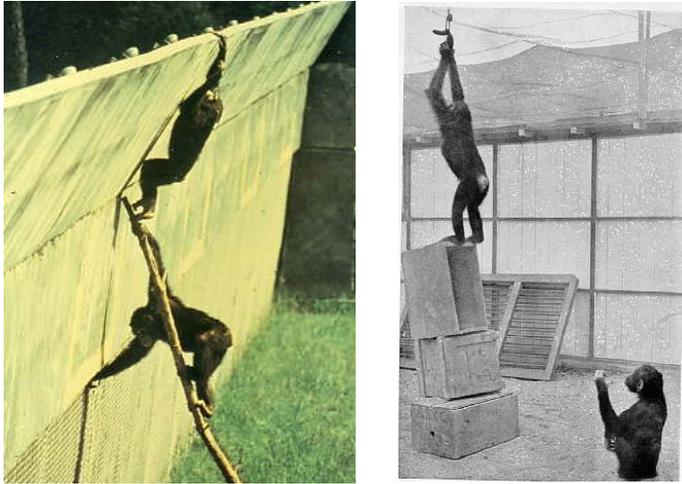
Ethology – Mechanistic Models of Instinctive Behavior



Gould: "The Behaviorist world view of animals was shaken by four telling sets of studies".
[and I would add, so was the Ethological world view]

1. Kohler – insight learning in chimps
2. Tolman – spatial maps, S-S learning, latent learning in rats
3. Garcia – 'prepared' learning
4. Olton – spatial maps in rats (radial maze)

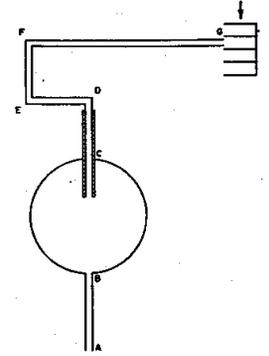
Köhler on Insight Learning



Suddenness of finding solution thought to indicate mental process of 'insight'

Edward Tolman – a cognitive behaviorist

"Cognitive maps in rats and men" (1948)



Apparatus used in preliminary training

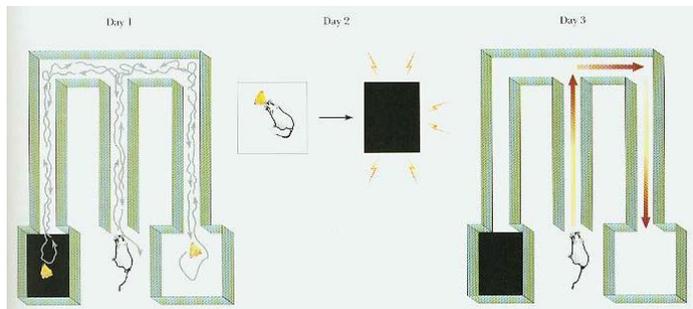
FIG. 15

(From E. C. Tolman, R. F. Ritchie and D. Kalish, Studies in spatial learning. I. Orientation and the short-cut. *J. exp. Psychol.*, 1946, 36, p. 16.)



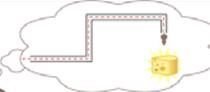
(1886 - 1959)

Tolman: Rats appear to "map" their environment
Make S-S associations, not just S-R

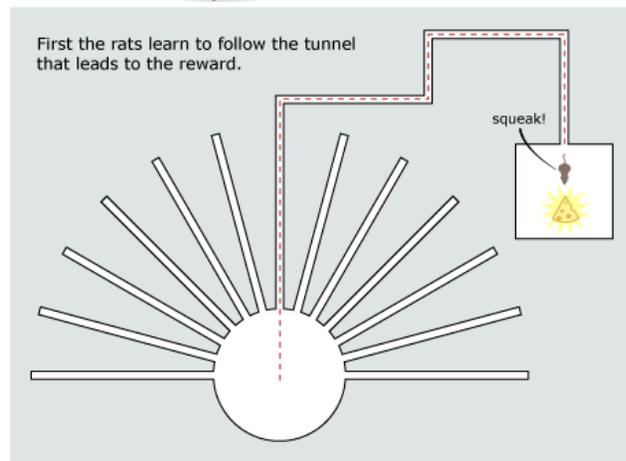


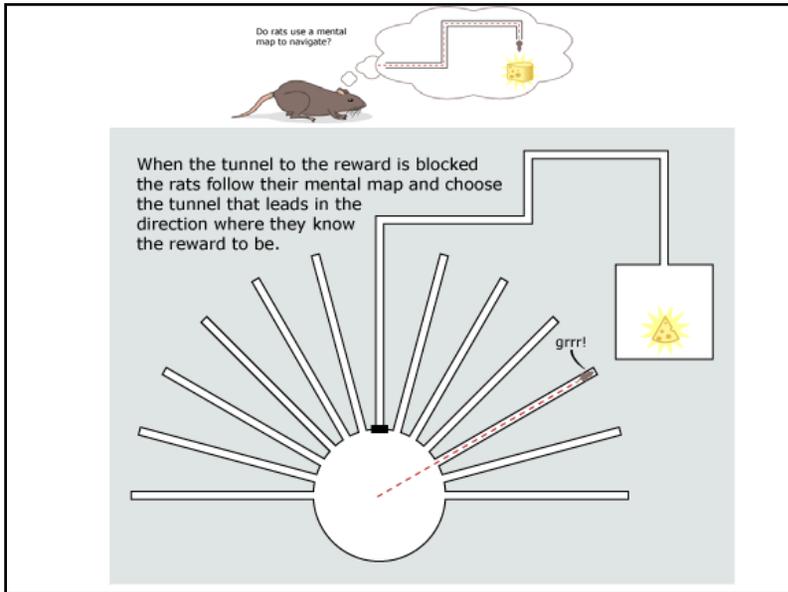
Also, Latent Learning (learning without reward)

Do rats use a mental map to navigate?



First the rats learn to follow the tunnel that leads to the reward.





Edward Tolman – a cognitive behaviorist

“When in the last quarter of the twentieth century animal psychologists took a cue from the success of human cognitive psychology, and began to renew the study of animal cognition, many of them turned to Tolman's ideas and to his maze techniques. Of the three great figures of animal psychology of the middle twentieth century, Tolman, Hull and Skinner, it can reasonably be claimed that it is Tolman's legacy that is currently the liveliest, certainly in terms of academic research.” [Wikipedia](#)

(1886 - 1959)

Flies in the Ointment: Constraints on Learning

John Garcia 1917 - 2012 (Garcia 1976)

Flies in the Ointment: Constraints on Learning

One example (Garcia 1976)

Flies in the Ointment: Constraints on Learning

Keller Breland & Marian Breland (1961) *The Misbehavior of organisms*. *American Psychologist*, 16, 681-684.

THE MISBEHAVIOR OF ORGANISMS

KELLER BRELAND AND MARIAN BRELAND
Animal Behavior Enterprises, Hot Springs, Arkansas

THERE seems to be a continuing realization by psychologists that perhaps the white rat cannot reveal everything there is to know about behavior. Among the voices raised on this topic, Beach (1950) has emphasized the necessity of widening the range of species subjected to experimental techniques and conditions. However, psychologists as a whole do not seem to be heeding these admonitions, as Whalen (1961) has pointed out.

under nonlaboratory conditions throughout a considerable segment of the phylogenetic scale.

When we began this work, it was our aim to see if the science would work beyond the laboratory, to determine if animal psychology could stand on its own feet as an engineering discipline. These aims have been realized. We have controlled a wide range of animal behavior and have made use of the great popular appeal of animals to make it an economically feasible project. Conditioned be-

1960s: The rise of behavioral ecology (aka sociobiology) and human cognitive psychology and the decline of behaviorism and ethology

W. D. Hamilton (1964) papers on inclusive fitness

George Williams (1966) *Adaptation and Natural Selection*

Robert Trivers (1970-1976) series of classic papers

E. O. Wilson (1975): *Sociobiology*

Noam Chomsky (1959) review of Skinner's *Verbal Behavior*

Ulric Neisser (1967): *Cognitive Psychology*

Behavioral Ecology

What is its stance on animal mind?

Optimal foraging as an example

Shall I hunt for partridge?
Or mice? Or both?
some of each?
Decisions, decisions...



$$E = T_s(\lambda_1 E_1 + \lambda_2 E_2)$$

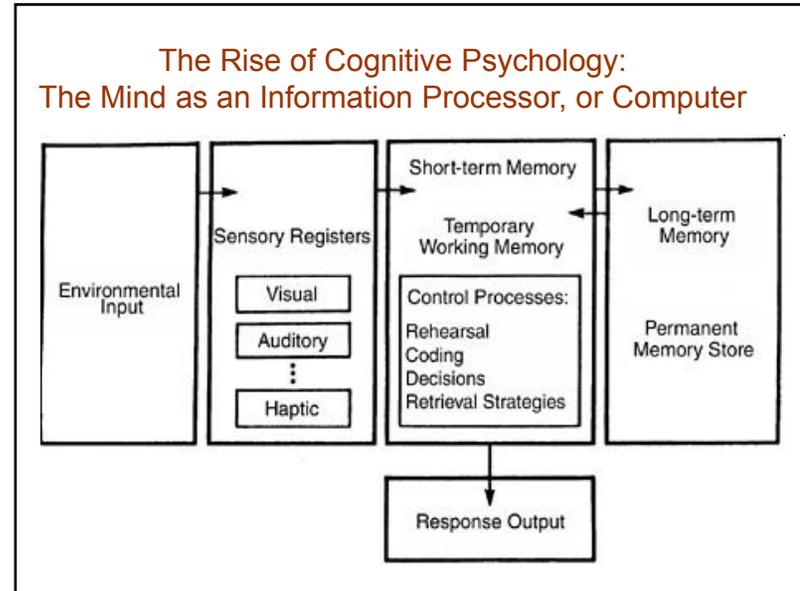
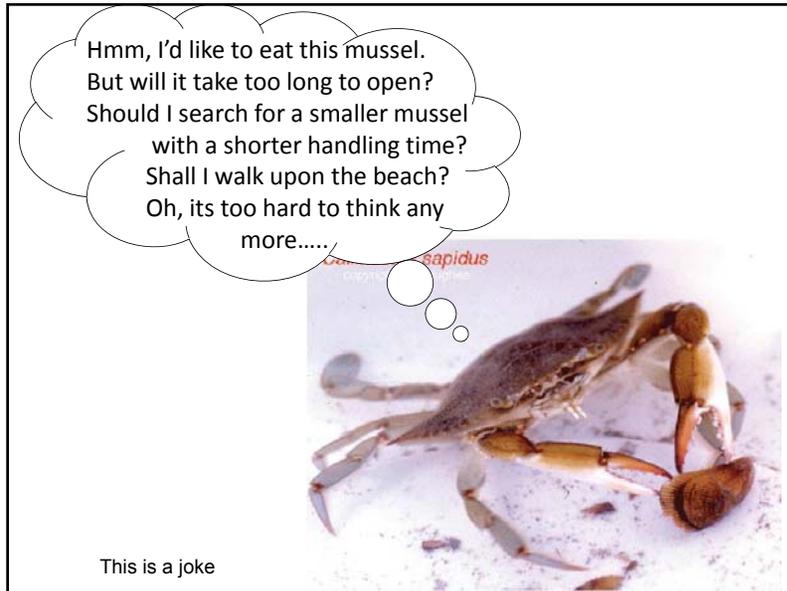
$$T = T_s + T_s(\lambda_1 h_1 + \lambda_2 h_2)$$

$$E/T = \frac{\lambda_1 E_1 + \lambda_2 E_2}{1 + \lambda_1 h_1 + \lambda_2 h_2}$$



In truth the behavioral ecologist doesn't really care about what the animal is thinking. He just assumes that some proximate mechanism has been designed (shaped) by natural selection that comes close to the optimal solution (though some interest in 'rule of thumb' solutions).





- So where does that take us?
1. **Strict Operational Behaviorists** didn't 'believe' in mind (didn't consider mentalistic concepts useful).
 2. **Ethologists** had an alternative mechanistic conception of what goes on inside the animal's head (didn't consider mentalistic concepts useful).
 3. **Behavioral Ecologists** didn't believe that mentalistic concepts are useful – any proximate mechanism will do. **Agnostic** on the issue.
 4. **Cognitive Psychologists** took the computer as their model (no consciousness, no intentions, no emotions, no mess). **Agnostic** on the issue.

Donald Griffin (1976): "The Question of Animal Awareness: Evolutionary continuity of mental experiences."

"A thin but deeply subversive volume" (Gould)

"For more than 60 years (1915 - 2003) this topic had been off limits, and most of us had forgotten that there even was such a question"

Griffin considered his book an attack on behaviorists **and** ethologists (who banned minds) **and** behavioral ecologists (who ignored minds) **and** cognitive psychologists (who preferred computer analogies).