National University of Singapore

LSM1303 Animal Behaviour

Lecture 3:

Innate and Learnt Behaviours

N. Sivasothi aka Otterman

Innate behaviours & Learning

1. Stimulus & Response
2. Innate behaviour (Instinct)
3. Learning in Animals
4. Types of Learning
5. Non-associative Learning
   - Habituation
   - Sensitisation
6. Associative Learning
   - Classical conditioning
   - Operant conditioning, Shaping
   - Imprinting
   - Latent learning
   - Social learning

Description Facilitators **Readings** Weblinks Timetable Library Resources

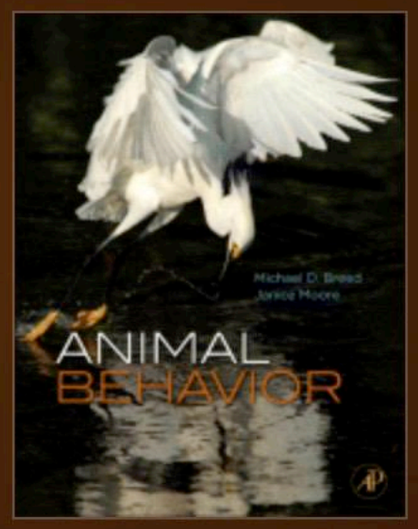
There is a book!

List the compulsory and/or supplementary textbooks and reference reading materials for your module. Provide as much details of the book as possible and contact library E-Reserves team (rbrersv@nus.edu.sg) if you would like to create readings from journal articles.

Title & Author	Edition/Year/ISBN	Publisher	Type
Animal behavior Author: Michael D. Breed, Janice Moore Website: http://www.sciencedi...	1e 2012 9780123725813	Academic Press	Compulsory This is available as an e-book, all chapters are online. You can access with your NUS Digital Library proxy.

Animal Behavior

Book • 2012



Authors:
Michael D. Breed and Janice Moore

Learning

CHAPTER OUTLINE

LSM1303 Animal Behaviour Lecture 3

1. Stimulus and Response

I. Stimulus and Response

The fundamental explanation of behavioural activity must begin with a stimulus and end with a response

- A stimulus is any change in an animal's environment
  (temperature, pressure, radiation, gravity, or the activities of other nearby organisms)
- A response is any behaviour or physiological event - internal, external

1. Stimulus and Response

Animals exhibit

i) innate responses (instinct; behaviours which "develop without example or practise" and

ii) learnt responses to stimuli

iii) or a combination of both

What influences behaviour? Not a dichotomy!

- All behaviours are influenced by
  - an animal's genetic makeup (which was selected for previously) [nature] and
  - an animal's experience from its lifetime [nurture]
  - The extent to which these influence a behaviour varies between species and activity within a species

Useful in long-lived species

What is a trait?

- A morphological characteristic of an organism
- A behavioural characteristic of an organism
- Allows an organism to survive and reproduce in its specific environment (niche)

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2. Innate behaviour

2. Innate behaviour

- Innate behaviours, shared by all members of the same species, are essentially an inheritance of *nerve pathways*.
- Selected for over evolutionary time, their primary adaptive significance is the increased survival value to the species.
- *Variation, inheritance, selection, time*

2. Innate behaviour

- These are simple behaviours, performed without thought, without observing an example or learnt, and not modified by learning; complete
  - E.g. A cockroach flees to a dark area, a fly fleeing a strike, or a cat flattening itself when it hunts, a fiddler crab waving its claw at a rival (*and many stereotypical invertebrate behaviours*)
- When a species' environment is relatively uniform or when an unambiguous message needs to be sent and received [a constant]

Innate behaviour patterns include

1. Orientations (taxes & kinesis) - e.g. phototaxis, hydrotaxis, barotaxis [moth to a flame; turtle hatchlings to stars]
2. Reflexes, e.g. eye blink reflex, patellar reflex, diving reflex
3. Instincts - complex, and include biological rhythms, territorial behaviour, courtship, mating, aggression, altruism, social hierarchies and social organization

2.1 Innate behaviour:
Orientation

Phototaxy – turtle hatchlings move towards the brightest areas, which is the moonlight over the ocean

Bernard Seah, Turtle Watch

2.1 Innate behaviour:
Orientation – the problem of light pollution

Sivasothi, N., 2006. Hawksbill turtle hatchling rescue at East Coast Park. Habitatnews. http://habitatnews.nus.edu.sg/index.php?entry=/marine/20060523-turtle_rescue.txt

2.1 Innate behaviour:

Orientation – the problem of light pollution

Wed 24 May 2006

Hawksbill turtle hatchling rescue at East Coast Park

Category : marine

23 May 2006 - NParks was alerted by a member of the public at about 9pm - about turtle hatchlings crawling inshore and getting stuck in drains! Derek Yap of NParks called me and I called others and soon a bunch of NParks staff, the members of public who originally alerted us, staff and volunteers from Raffles Museum, Nature Society (Singapore) and Blue Water Volunteers joined hands to scour the area of hatchlings.

After three hours, we managed to salvage and release 76 from the track, drains and shore. Two died and one will be preserved and deposited into the Raffles Museum's Zoological Reference Collection.

I called resident turtle expert C H Diong from NIE/NTU; he was of the opinion a nesting site was nearby; but we were unable to find it. NParks staff will try to look for it again in the morning. He also suggested we release the hatchlings the same night, but allow them to crawl down a dark beach and head into the sea. Finding a dark beach in Singapore is not easy and we settled for Changi Beach extension which was relatively near.

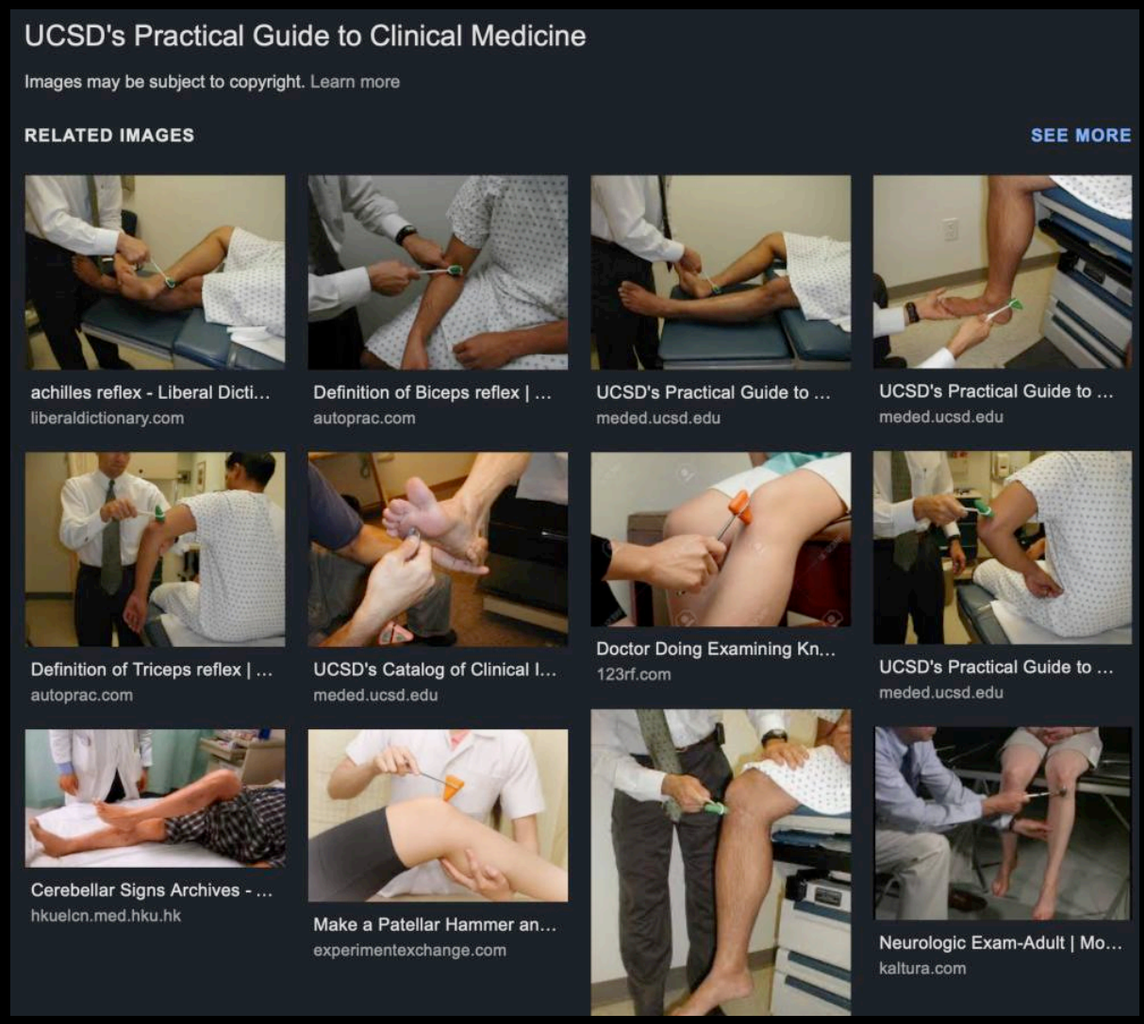
It was wonderful seeing the hatchlings swim away but we wondered if they'd make it out to sea; the light pollution from the shore disorientates this animal that would otherwise follow starlight out to sea and relative safety.

Sivasothi, N., 2006. Hawksbill turtle hatchling rescue at East Coast Park. Habitatnews. http://habitatnews.nus.edu.sg/index.php?entry=/marine/20060523-turtle_rescue.txt

2.2 Innate behaviour: Reflexes

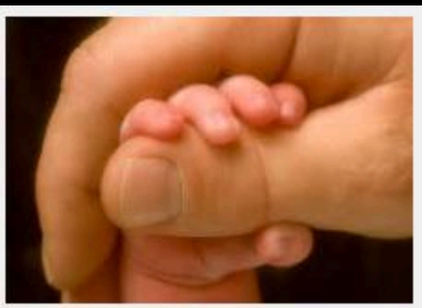
Automatic response to adequate stimulus

- Eyeblink reflex
- Patellar reflex

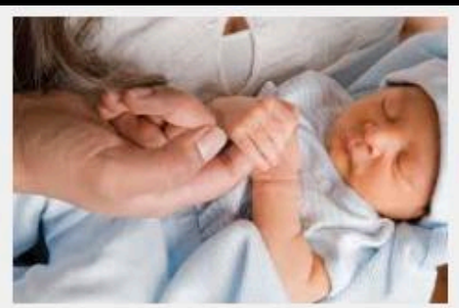


2.2 Innate behaviour: Reflexes

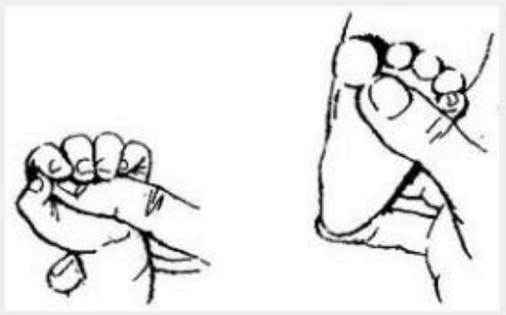
It's not personal,
it's a palmar grasp reflex!










Mammalian diving response: the diving reflex in human babies (1:40)

2.3 Innate behaviour: Action Patterns

- Action patterns are complex behaviours that are always repeated the same way by a species of animal.
- Action patterns are stereotyped, since they occur the same way each time, and through to completion.
- After repeated observations of action patterns, data can be analysed statistically and an attempt made to determine WHY a behaviour exhibited.

Niko Tinbergen

(Nobel Prize, 1973)

- Niko Tinbergen was a pioneer in the field of animal behaviour.
- He observed animals in their natural conditions, then manipulated, or varied the conditions to see how the animals responded.

2.3.1 Beewolves (*Philanthus* sp.)

Insecta: Hymenoptera: Apocrita: Apoidea: Crabronidae

- Bee-hunters are solitary, predatory wasps, which are nectar and pollen feeding, except for inseminated females who prey on bees.

- When nesting, adult females dig multiple-chambered tunnels in sandy slopes in large aggregates

- Once mated, the female will hunt for food to provide for the future larvae. Each time she leaves, *she hides the nest*.

Beewolves stock their nest with paralysed prey for their with larvae to feed on when they hatch

Action Pattern of Beewolf (Tinbergen)

- Tinbergen observed the beewolf wasp finds its nest among other nests.
- Observation when it leaves: beewolf circles their nest in an ever-widening circle before flying away to hunt.
- This behavior was performed exactly the same way each time *suggesting an action pattern.*

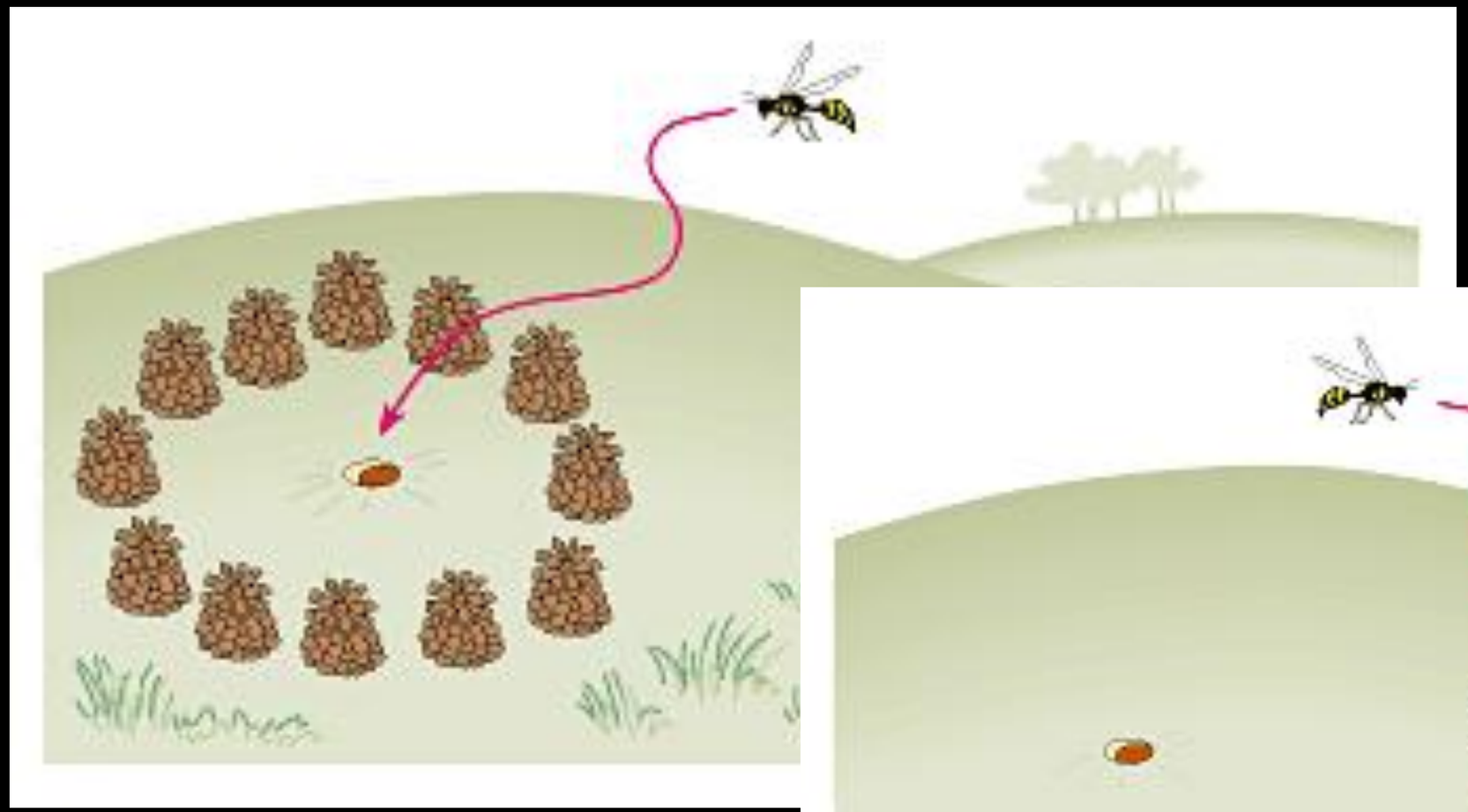
Female Beowulf locating nest, orientating to nest position and returning with prey

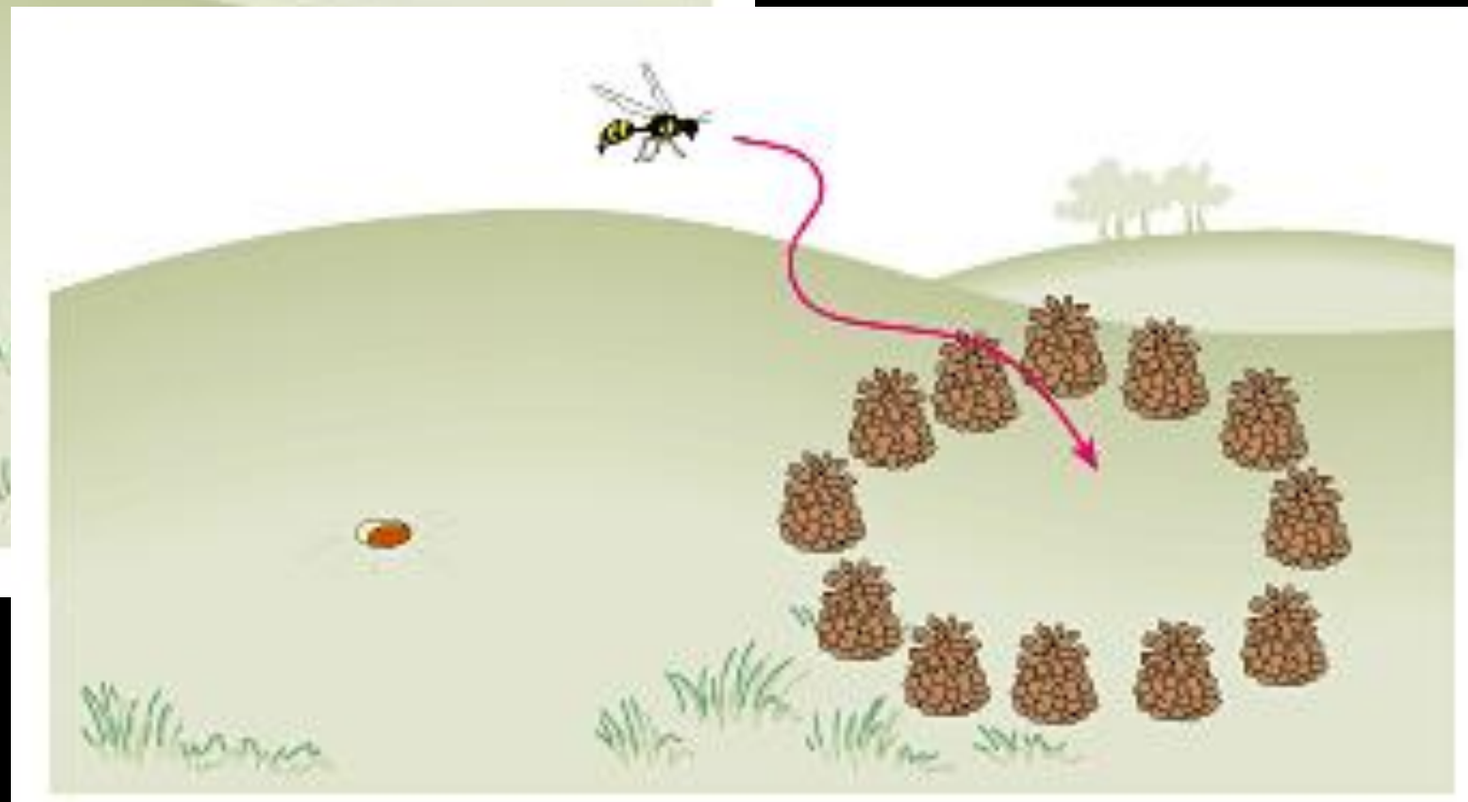
http://www.myrmecofourmis.fr/

Action Pattern of Beewolf (Tinbergen)

- Tinbergen hypothesized that beewolf wasps (*Philanthus triangulum*) learnt the position of their nest relative to surrounding visual cues.
  He performed three experiments:
  - Firstly, Tinbergen moved certain landmarks around the nests (pine cones) after the beewolf left.
  - When the beewolf returned, it was disoriented.

i. Pine cones were placed around the nest entrance of a bee wolf

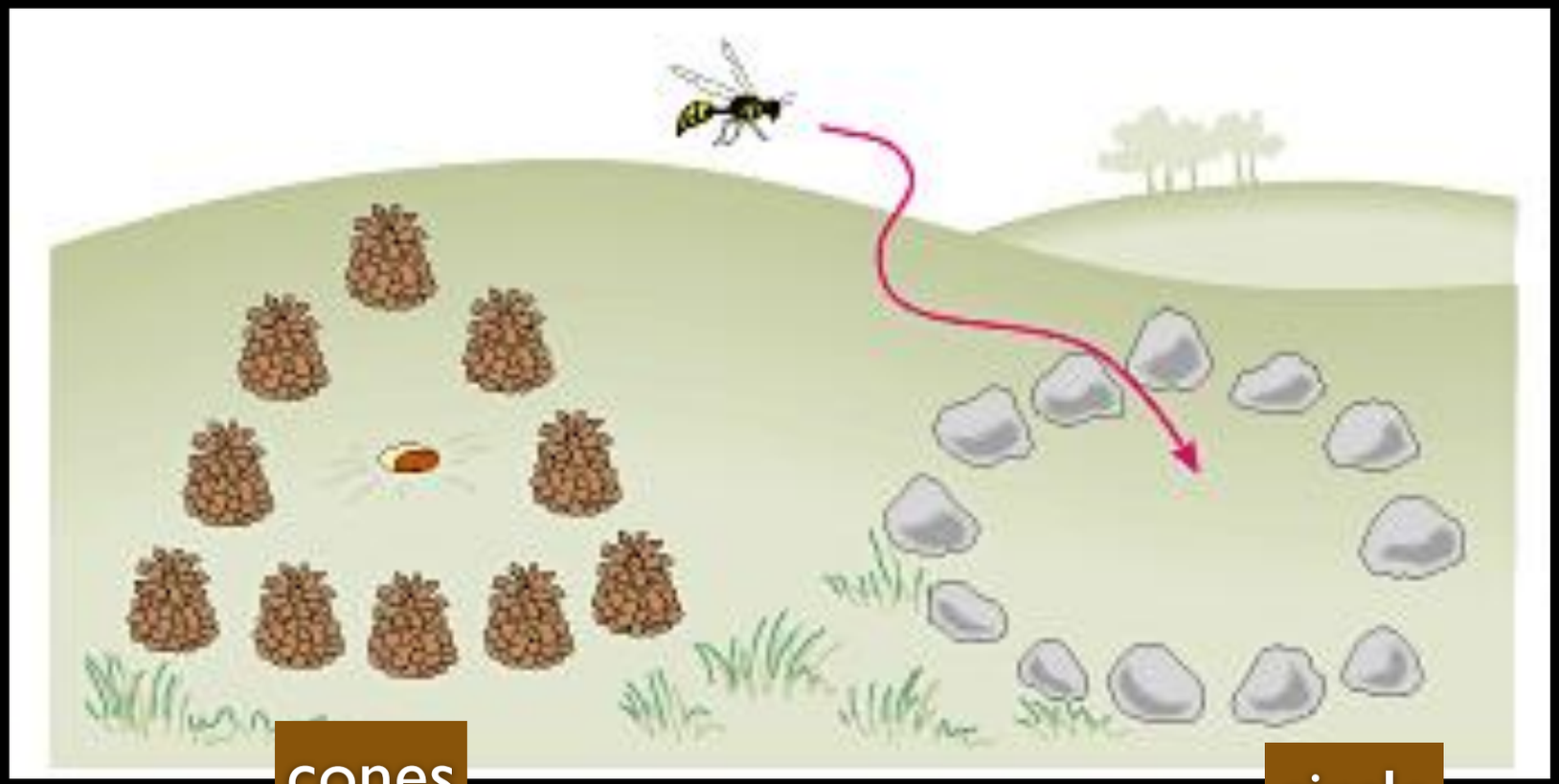




When the pine cones were shifted, the beewolf returned to cones

Action Pattern of Beewolf (Tinbergen)

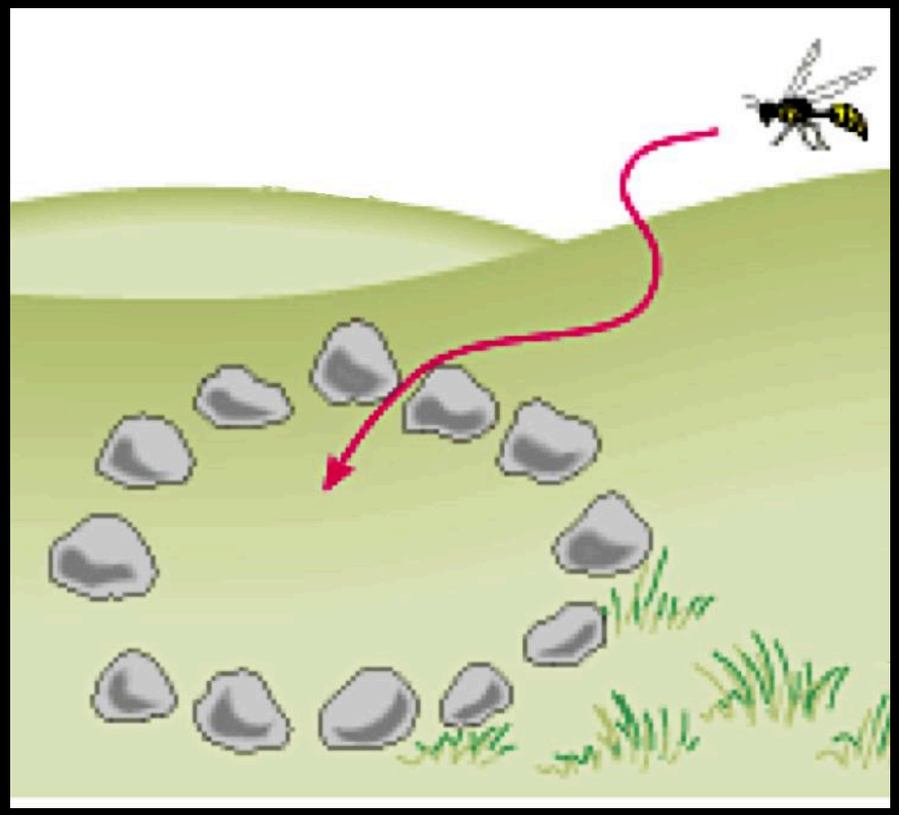
ii. Tinbergen then displaced visual cues, and this misled the wasps to land in the wrong spot.



With pine cones are arranged in a novel shape, and a set of stones are arranged in a familiar circle, the bee wolf returned to the circular stones

Action Pattern of Beewolf (Tinbergen)

iii. Thirdly he placed novel visual cues about the nest and after a few days he moved them; this again misled the wasps to land in the wrong place.



Action Pattern of Beewolf (Tinbergen)

- Tinbergen was able to conclude:
  - the beewolf commits landmarks to memory
  - to be able to find its nest upon return from hunting

Action Pattern of Beewolf (Tinbergen)

- He described the action pattern behaviour first: WHAT the organism was doing.
- Before inferring WHY it was doing it.

2.3.2 Greylag Goose (*Anser anser*)

Fixed action pattern of Greylag Goose (Tinbergen & Lorenz)

- The egg-rolling behavior of the greylag goose is a good example of an action pattern.

- Niko Tibergen and Konrad Lorentz originally observed this behavior.

Fixed action pattern of Greylag Goose (Tinbergen & Lorenz)

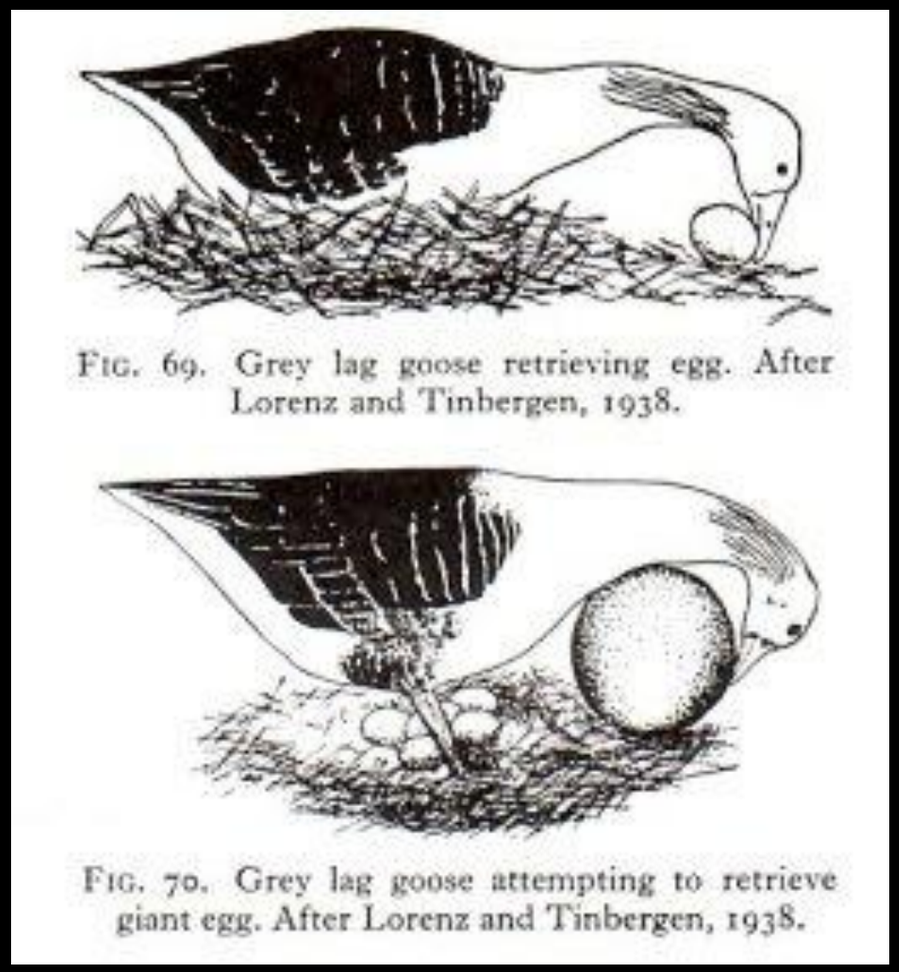


FIG. 69. Grey lag goose retrieving egg. After Lorenz and Tinbergen, 1938.

FIG. 70. Grey lag goose attempting to retrieve giant egg. After Lorenz and Tinbergen, 1938.

- The goose will roll an egg that is outside the nest back into the nest in the same manner every time.
- This will happen with any round object placed outside the nest.
- Every time this action pattern is initiated, it is carried through to completion.

Fixed action pattern of Greylag Goose (Tinbergen & Lorenz)

- Every time this action pattern is initiated, it is carried through to completion.

What is the evolutionary value?

- Variation
- Inheritance
- Selection
- Time

2.3.3 Interactive FAP in Herring Gulls (*Larus argentatus*)

Tinbergen, N. & A. C. Perdeck, 1950. On the stimulus situation releasing the begging response in the newly hatched herring gull chick (*Larus argentatus argentatus* Pont.). *Behaviour*, 3 (1): 1-39.

- Seabird nesting colonies, which nest on cliffs and ground
- Adults take turns to fly out to sea
- Return to feed chicks

2.3.3 Interactive FAP in Herring Gulls

- Fixed Action Patterns,
  shared by all members of the same species,
  are triggered by a key stimulus (KS).
- The key stimulus (KS) triggers an innate releasing mechanism (IRM),
- IRM produces a definite, constant response, a fixed action pattern (FAP)

2.3.3 Interactive FAP in Herring Gulls

- Innate Releasing Mechanism (IRM) can be any visual, hormonal, neural or muscular mechanism that results in the FAP (int/ext)
- Once started, FAP cannot be stopped until the entire action sequence is completed.
- KS ➡ IRM ➡ FAP

How do chicks get fed?

- Do chicks exhibit a behaviour, and when?
- Do adults exhibit a behaviour, and when?

An adult seagull feeding its young

2.3.3 Interactive FAP in Herring Gulls

- Herring gull chicks
  - Adults have a red spot on their beak
    - Chicks instinctually peck at this spot
- The red spot is the Key Stimulus, and it triggers the pecking FAP in the chick
  - The pecking in turn triggers regurgitation by the parent to feed the chick

2.3.3 Interactive FAP in Herring Gulls

- What is happening?

The pecking FAP is the KS for the parent to regurgitate food, which is it's FAP and is the result of an IRM

- This is an interactive FAP sequence
  - KS (red spot) → IRM → FAP (pecking by chick)
  - KS (pecking) → IRM → FAP (regurgitation by adult)

2.3.4 Other examples of Fixed Action Patterns

- Trickery, Code-breaking
- Best example: Brood parasitism
- Asian Koel

Crows feeding koel chick

Dr Suhel Quader's lab at NCBS, India

2.4 Complex responses to stimuli
The three-spined stickleback (*Gasterosteus aculeatus*)
More experiments by Tinbergen!

Don Loarie @ Flickr

2.4 Complex responses to stimuli

The three-spined stickleback (*Gasterosteus aculeatus*)

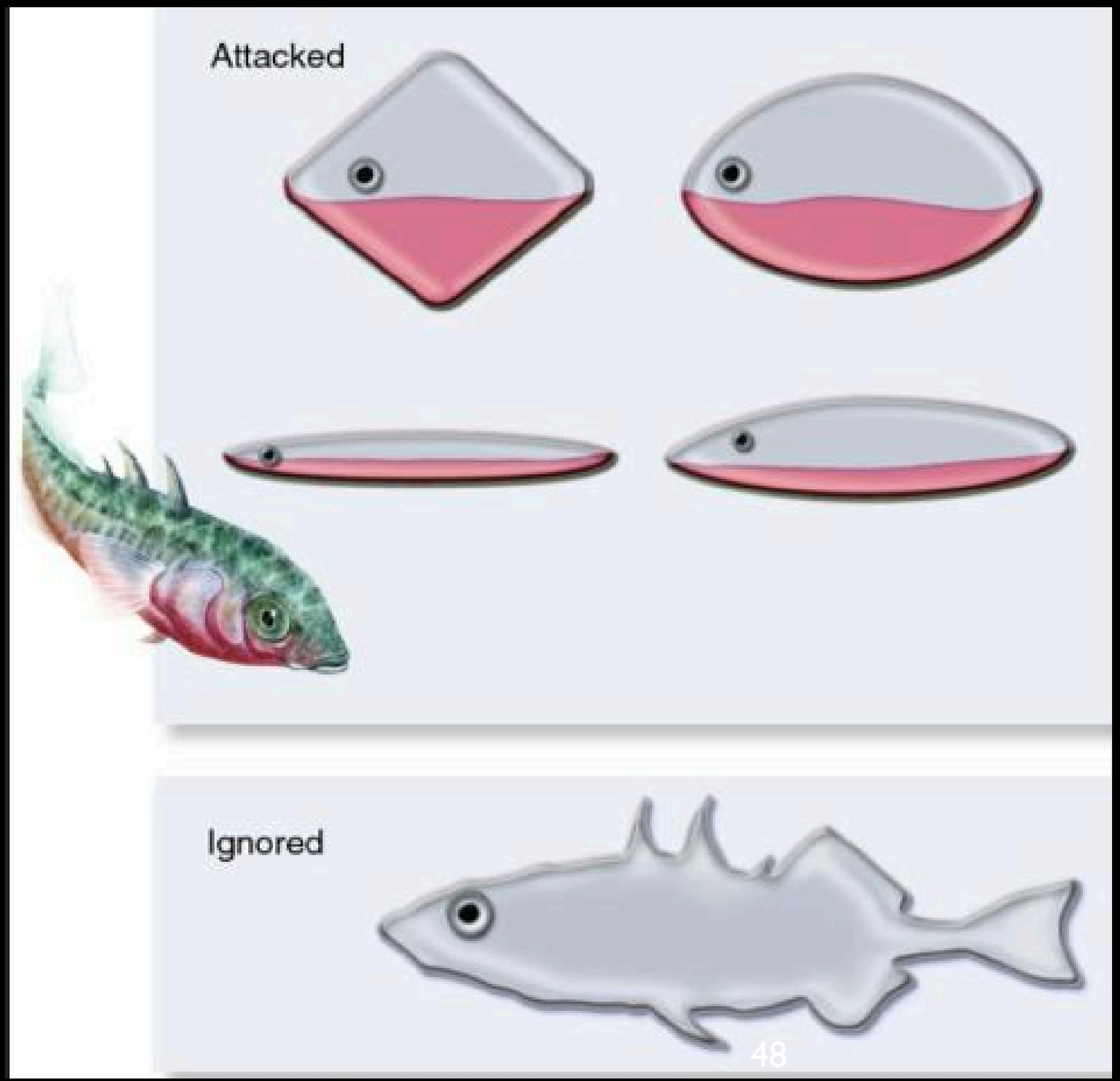
- Freshwater or brackish water species north of 30˚
- Territorial males build a nest in hours, courts females with a zig-zag dance
- Red colour from carotenoids in diet (ability of male?)
- Attract females, chase away males

2.4 Complex responses to stimuli
The three-spined stickleback (*Gasterosteus aculeatus*)

- KS = red belly
  - Males defend territories by attacking invading males.
  - Males position themselves vertically to assume an aggressive posture, displaying their bright red bellies to their opponents.

2.4 Complex responses to stimuli

The three-spined stickleback (*Gasterosteus aculeatus*)



Unrealistic models with key stimuli

Realistic model *without* key stimuli

2.4 Responses to stimuli by the three-spined stickleback (*Gasterosteus aculeatus*)

Tomohiro Masada, So Ishida, Michiko Sato, Junko Anso & Mikiko Sadamasa, 07 Jul 2005. FIlmed in the laboratory of 'Honganshozu Itoyo no Sato', Itoyo-town, Ono, Fukui, Japan. Friends of Fukui City Museum of Natural History

2.4 Complex responses to stimuli

The three-spined stickleback (*Gasterosteus aculeatus*)

- KS (red belly) → FAP (aggression in males)
- Males were reacting to the colour
  Thus the shape and size were not important

2.4 Complex responses to stimuli

The three-spined stickleback (*Gasterosteus aculeatus*)

- KS2 (red belly) ➡ attraction (female)
- Female sticklebacks are stimulated by swollen, red belly and the zigzag dance of the male
- to lay her eggs in the male's nest

2.4 Responses to stimuli by the three-spined stickleback (*Gasterosteus aculeatus*)

Tomohiro Masada, So Ishida, Michiko Sato, Junko Anso & Mikiko Sadamasa, 07 Jul 2005. FIlmed in the laboratory of 'Honganshozu Itoyo no Sato', Itoyo-town, Ono, Fukui, Japan. Friends of Fukui City Museum of Natural History

FAPs may not be isolated events

- One animal's FAP may be another animal's KS, i.e. Interactive FAP sequences such as courtship displays, honeybee dance
- Laboratory experiments try to isolate and study individual stimuli
- In nature, individuals interact with conspecifics (others of its kind), neighbouring species, which interact with yet other species.
- These behaviours function in a continuous and complex web of behaviour.

What else is innate?

- Fixed action patterns - stereotypical actions
- Feeding behaviours - hunting, food preference (to varying degree)
- Defensive behaviours - in response to predators (to a varying degree in inverterbrates)
- Reproductive behaviours - mating, parental care (to varying degree)

Mumuration of Common starlings
(*Sturnus vulgaris*), filmed by Dylan Winter (3:54)

BBC Earth (2015): March of the Red Crabs
Lands of the Monsoon (4:02)

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3. Types of Learning in Animals

Instinct and Learning

- Instinctive or innate behaviour
  - predictable, regular stimuli
  - allows rapid response with an unmodified instinctive behaviour

- Learned behaviour
  - adaptive, animal can respond to unpredictable changes in its environment
  - increases an animal's behavioural choices as a result of experience but needs time

Behaviour of Animals

- Behaviours range from instinctive (pre-determined, innate) to learned; and a combination
- We examine learning now

Behaviour of Animals

Innate behaviour

- Learnt behaviours
  - are not inherited, i. e. not present at birth; only acquired through observation and experience;

[vs inherited]

  - are absent in animals raised in isolation (extrinsic);

[vs intrinsic]

  - are changeable (permutable);

[vs stereotypic]

  - are adaptable (suitable to changing conditions)

[vs inflexible]

  - developed by experience

[vs consumate (not changed)]

Learning in Animals

- Learning may take place at any age.
- Information to be learned can come from:
  - other animals,
  - an animal's personal experience,
  - observations of its environment.
- Animals living in constantly changing environments thrive if they are able to respond to change.

What is learning?

- Learning is a process in which an animal benefits from experience so that its subsequent behaviour is better suited to environmental conditions
- Adaptive change in individual behaviour as a result of experience
- Usually resulting in the expansion of the behavioural repertoire of an animal as a new skill or association is acquired.

Types of learning

- Non-associative Learning
  - Stimuli *without* association with reinforcement, either positive or negative
- Associative Learning
  - Stimuli *with* association with a positive or negative reinforcement

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4. Non-associative Learning

4. Non-associative learning

- Non-associative Learning
  - Stimuli *without* association of a positive or negative reinforcement
  - 4.1 Habituation
  - 4.2 Sensitisation

4 Habituation

- Repeated stimulus, but no reward/ punishment, neutral
- Animal learns *not to respond* to a particular stimulus
- Simplest form of learning
- Used in studies to neutralise observer appearance before data collection
  *horse whisperers (introduce stimuli below escape threshold of an animal)

Habituation of snail (*Aplysia* sp.)

http://www.youtube.com/watch?v=ilSouTb9pag

4 Habituation

4.1 Habituation

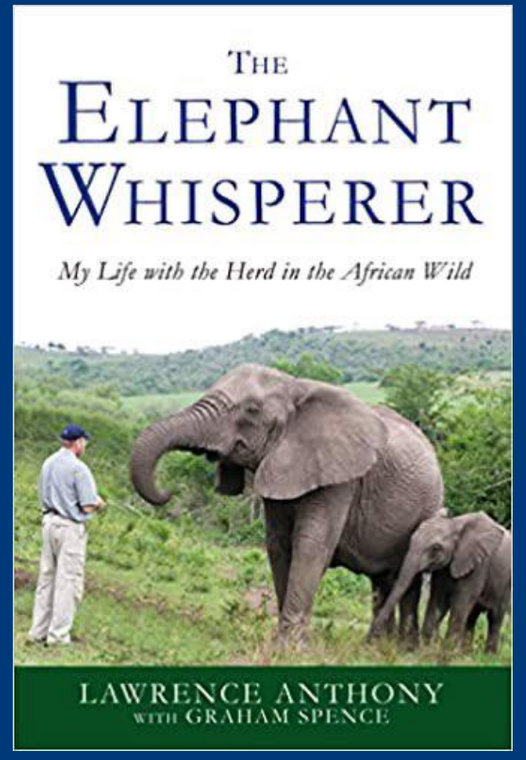
- What is the adaptive value of habituation?
  - In terms of improving fitness?
    - E.g. a balance between feeding and survival in fiddler crabs in an area of disturbance
  - helps young animals understand neutral elements in the environment, e.g. movements due to wind, wave action, etc
  - "dear enemy effect"

Grades of association

- Wild state, natural
- Tame = an individual who has undergone behavioural modification (wild but accepts interaction) – difficult with adults, easier if hand-rearing infants

Degree of interaction varies

- Domesticated = a genetically modified species (degree varies with species and individual)
- Feral = a domestic species which was not socialised and embraced a wild environment;
  e.g. cats, dogs or goats become feral if not socialised when young



Horse training

- Wild horses are tamed
- Horses are bred
- Human environments have many alarming stimuli
- Adapting to human-dominant environments quickly requires habituation

4.2 Sensitisation

- Instances in which after repeated or traumatic presentations of the stimulus, there is increased responsiveness.

- Sensitisation can over-ride habituation

- E.g. a police horse involved in a road traffic accident may become sensitised to motor vehicles
- The mere sound or sight of vehicles may trigger a flight response

Masters of Problem Solving
BBC: Honey Badger Houdini
(Honey Badgers, Masters of Mayhem, 4:12)

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5. Associative Learning

5. Associative learning

- Stimuli *with* association with a positive or negative reinforcement
  - 5.1 Classical conditioning
  - 5.2 Operant conditioning, Shaping
  - 5.3 Imprinting
  - 5.4 Latent learning
  - 5.5 Social learning

An animal learns to associate an event with a result

5.1 Classical conditioning

- The famous "Pavlov's dog" experiment
  - Rang bell when providing food, salivate
  - Rang bell produced salivation

The association of events over which the animal has no control

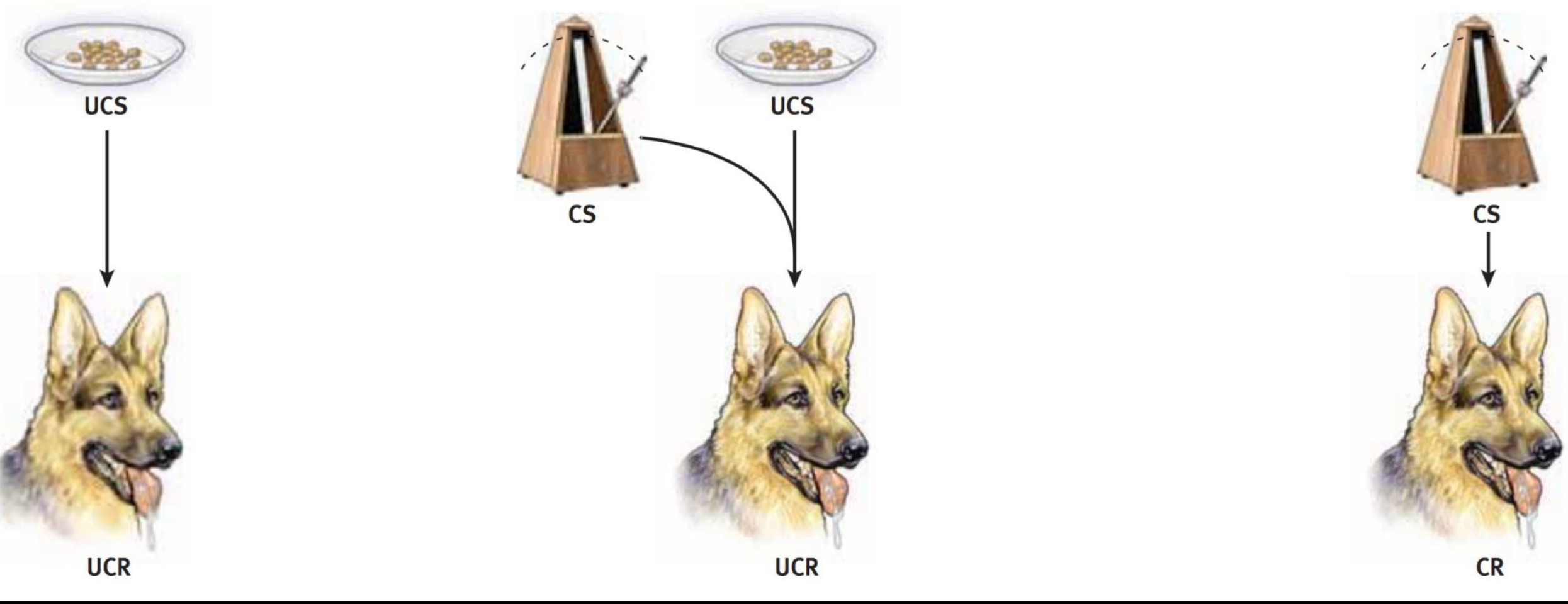
5.1 Classical conditioning

- Unconditioned stimulus (US) = food
- Unconditioned response (UR) = salivation
- US => UR

5.1 Classical conditioning

- Introduce:
  Conditioned Stimulus (CS) - bell
- Associated with
  Unconditioned stimulus (Arrival of food)
- Result in Conditioned Response (CR) - anticipatory salivation
    - CS => CR = conditioned reflex

Classical conditioning



Pavlov's Discovery of Classical Conditioning
BBC Motion Gallery (3:08)


WATCH WHAT I CAN MAKE PAVLOV DO. AS SOON AS I DROOL, HE'LL SMILE AND WRITE IN HIS LITTLE BOOK.
©2003 Stivers

5.1 Classical conditioning

- Important
  - Order of presentation: Conditioned Stimulus (bell) introduced before food Unconditioned Stimulus (US)
  - Time of stimuli close together
- Face before food!

5.1 Classical conditioning

- Adaptive value of classical conditioning?
  - i. e. how does it increase fitness?
    - Avoid certain noxious foods, anticipatory preparation for rival or mate presence,

5.1 Classical conditioning

- Not innate
- Humans
- decondition anxiety
- manage stress (perception of incidents), l.e. self-training

5.2 Operant conditioning

- A type of associative learning
- Frequency of a behaviour is increased because it is reinforced (+ve, reward or -ve, punishment)
- (B. F.) Skinner box - a hungry animal learns to press a lever, resulting in the provision of a reinforcer (food)
- The animal learns a conditioned response to obtain food (an unconditioned response).

Skinner on Operant Conditioning

Develop individuals through positive reinforcement

Shaping

- Gradual training by reinforcement
- E.g. having a dog jump through a hoop; fine-tune rewards to higher standard.
  - reinforcement of progressive approximations towards a target behaviour

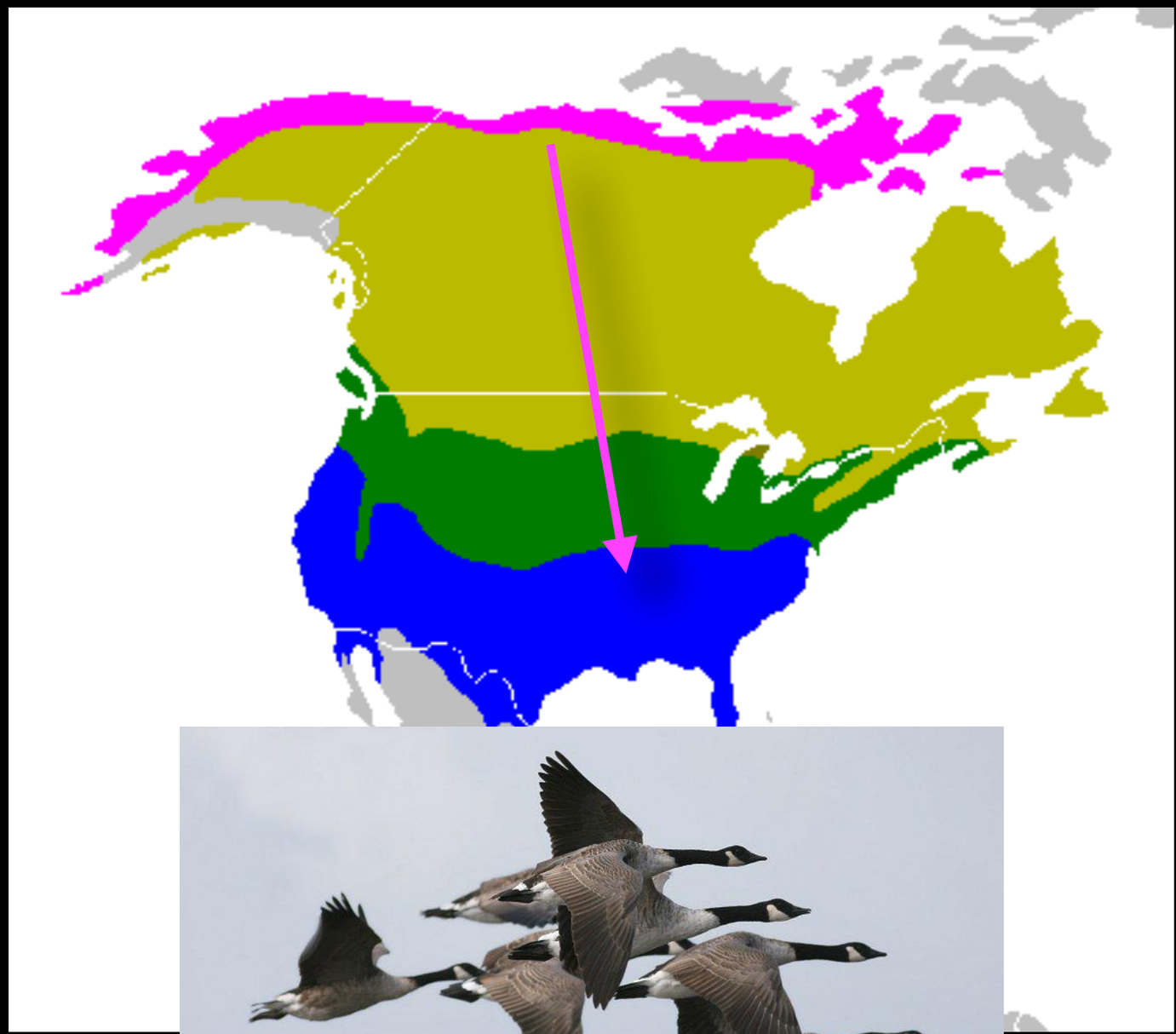
Albuquerque BioPark

5.3 Imprinting

- Filial imprinting - a young animal acquires several of its behavioral characteristics from its parent.
- Konrad Lorenz showed that incubator-hatched geese would imprint on the first suitable moving stimulus they saw within a "critical period" 13–16 hours after hatching.
  E.g. they imprinted on Lorenz's wading boots
- In one experiment, they followed a box placed on a model train in circles around the track.

5.3 Imprinting

- Filial imprinting has been used to teach orphaned Canadian goose how to migrate!



PBS: Microlight pilot Christian Moullec and his hand-reared barnacle geese (1:09)

PBS: Microlight pilot Christian Moullec and his hand-reared barnacle geese (2:49)

5.4 Latent learning

- Animal appears to learn without *immediate* obvious reward
- Familiarity with terrain
  - resident mice able to avoid predators better
- At the point of acquisition, the behaviour had no apparent value. Not all behavioural activities are directed to satisfying a need or obtaining an immediate reward.

"Phototrap Model 33 Kit",
Naturefriend magazine

Screech owl

Deer mice resident

Deer mice, transient

Screech owl hunts Deer mice

- Two mice exposed simultaneously (2-30 min): One resident, one transient - how long before capture by the owl?

TABLE 1.—*The experimental design and results.*

Exp. Test Unit	Mice familiar with environment: Number voles available	Predator hours per vole eaten	Toe-clipped voles eaten	Non-clipped voles eaten	Mice unfamiliar with environment: Number voles available	Predator hours per vole eaten	Toe-clipped voles eaten	Non-clipped voles eaten
1	10	38	4	3	10	5	3	2
2	10	10	2	3	10	4	3	4
3	7	24	0	3	10	14	2	3
4	10	43	4	1	10	10	2	3
5	8	24	4	1	10	6	5	3

In 20 confrontations:
Owls captured 2 residents and 11 transients
And caught transients faster

What about play?

- What is the adaptive value of play?
  - Social play - wrestling, ambush of conspecifics
  - Exercise play - hanging, running, climbing
    - Object oriented play - manipulate an object
- No immediate adaptive value
- Practise adult activities with low consequences of failure

Module akan datang IDM

5.5 Social Learning

- Information provided to other animals
- Individuals actively share information through specific signals
  - *Stimulus enhancement* - rats learn dietary preferences from smelling breath
  - *Location enhancement* - animals follow each other to foraging patches

5.5 Social Learning

- *Observational conditioning*
  - Animals learn from watching conspecifics
  - Wild rhesus monkeys learn to fear and avoid snakes *unlike their lab-reared counterparts*
  - Lab-reared monkeys could socially learn to be afraid of snakes.

5.5 Social Learning

- *Goal-learning emulation*
  - Not a complete copy (imitation), e.g. chimpanzees attempt to retrieve fruit after watching observer remove bolts in a box.
  - They approach right position but without bolt removal.
  - Children able to imitate exactly, and adopted the false steps as well.

5.5 Social Learning

- *Imitation*
  - Observer copies exactly what demonstrator does.
  - Budgies watching videos, learnt to remove a stopper from a food box

5.5 Social Learning

- What is the adaptive value of social learning?
  - How does it increase fitness?
    - More efficient (time and energy) to learn, less dangerous
    - Eating novel food in rats, dogs

5.5 Social Learning

- Traditions
  - Learned behaviour, spread through a group, stable over time
  - Blue tits and milk bottles in the UK (1950's)
  - Behaviour passed on the population

Culture: Macaques in Japan (BBC, 3:10)

Innate behaviours & Learning

1. Stimulus & Response
2. Innate behaviour (Instinct)

   Learning in Animals
3. Non-associative Learning
   i. Habituation
   ii. Sensitisation
4. Associative Learning
   i. Classical conditioning
   ii. Operant conditioning, Shaping
   iii. Imprinting
   iv. Latent learning
   v. Social learning