

Fish Behavior

- Fish are more intelligent than they appear.
- In many areas, such as memory, their cognitive powers match or exceed those of 'higher' vertebrates including non-human primates.
- Fish hold the records for the relative brain weights of vertebrates. Most vertebrate species have similar brain-to-body weight ratios.

- Action or re-action to stimuli
- Happens in the brain (non-motor) and can be manifested through muscular response, but often involves both
- There can be a temporal component to the actual behavior (learning, e.g. feed training)
- Short-term trigger for behavior
- Long-term evolutionary significance/adaptation
- Animals behave in ways that maximize their fitness

Fixed Action Patterns

Fixed Action Patterns

- stereotypical innate behavior.
- The organism will carry it out almost no matter what, even if it doesn't seem appropriate.
- These are all part of a category of behaviors very important to survival and/or fitness.

Fixed Action Patterns

Male three spined stickleback: attacks other males with red bellies – attacks anything red



Innate behavior

- Brood parasitism (Cichlid/catfish)
- Ability to confront novel stimuli, learn about them and adjust behavior is indicative of intelligence and self awareness.
- Intelligence involves brain development, parental investment or training

Learning

- Change in behavior based on experience

Maturation is behavior change based largely on ability due to development (eg. Use of tool)

paradise fish which avoid places where they have experienced a single attack by a predator and continue to do so for many months

- Habituation

Loss of responsiveness due to repetition

- Imprinting

Learning in a critical time period (tightly correlated with innate behavior)

Conditioning: Pavlov

Associating a stimulus with punishment or reward (can also be trial and error) (visual experiments)

Associative learning/conditioning

- Associating one stimulus with another
- Pavlov: classical conditioning. Associating an arbitrary stimulus with reward or punishment
- Operant conditioning: learning through trial and error. BF Skinner's experiments. This has formed the basis for much animal training.
- Classical and operant conditioning often work together

- Rainbow trout can be trained to press a bar to get food, and they remember this three months after last seeing the bar.
- Red Sea clownfish can recognize their mate 30 days after it was experimentally removed from the home anemone.
- Channel catfish can remember the human voice call announcing food five years after last hearing that call

- Goldfish remember the colour of a tube dispensing food one year after the last tube presentation.
- Sockeye salmon still react to a light signal that precedes food arrival up to eight months since the last reinforcement.
- Some common rudd and European chub could remember the person who trained them to feed from the hand, even after a 6-month break.
- Crimson-spotted rainbowfish can learn how to escape from a trawl by swimming through a small hole in the center and they remember this technique 11 months later.

Cognition

- **Consciousness and awareness**
- **The connection between nervous system function and behavior**
- **Spatial orientation and mapping**
 - Migration: Piloting, orientation (directional headings), navigation (relative location)
 - The role of learning in migration

Reproductive behavior

- Sexual selection
 - Courtship
 - Female choice
 - Male aggression

Mating strategies

- Promiscuous
- Monogamous
- Polygamous: polygynous, polyandrous

Fish Behaviors

- Migration
- Shoaling
- Feeding
- Aggression
- Resting
- Communication

Migration

- **Spatial orientation and mapping**
 - Migration: Piloting, orientation (directional headings), navigation (relative location)
 - The role of learning in migration
 - (magnetite, light, etc.)
 - Fish orient themselves using landmarks and may use mental maps based on multiple landmarks or symbols.
 - Fish behaviour in mazes reveals that they possess spatial memory and visual discrimination.

Fish Migration

- Fish migrations are usually round-trip
 - Reasons for migration
 - Food gathering
 - Temperature adjustment
 - Breeding

Timing of migrations

- Annual
- Daily
- generational

Classification of Fish Migration

- Diadromous – Travel between sea & fresh water
 - Anadromous – most of life at sea, breed in fresh water
 - Catadromous – most of life in fresh water, breed at sea
 - Amphidromous – migrate between water types at some stage other than breeding
- Potamodromous – Migrate within a fresh water system
- Ocenodromous – Migrate to different regions of the ocean

Reasons for Migrations

- Take advantage of different habitats
 - Feeding
 - Protection
 - Avoid adverse conditions
 - Meet requirements for reproduction

Orientation During Migration

- Orientation to gradients of temperature, salinity, and chemicals
- Orientation by the sun
- Orientation to geomagnetic and geoelectric fields

Disadvantages of Migrations

- Expenditure of energy
 - Most must store energy before migration
- Risk from predation

Adjustments Required Due to Migrations

- Adjusting physiologically to new water conditions
 - Temperature
 - Light
 - Water chemistry
- Many migratory species are now rapidly declining due to changes caused by man

Social behaviour

- Solitary
- Shoal - any group of fishes that remains together for social reasons
- School - a polarized, synchronized shoal (has coordinated, directed movements)

Functions of Schooling Behavior

- Hydrodynamic efficiency
- Reduced predation risk
- Feeding
- Reproduction

Functions of Schooling Behavior

- Hydrodynamic efficiency
 - individuals obtain reduction in drag by following in “slip-stream” of neighbors
 - limited evidence in support of this

Functions of Schooling Behavior

- Reduced predation risk
 - creates patchy distribution of prey - large areas with no prey
 - once school is found, individual risk of being captured is reduced by dilution
 - confusion of prey by protean displays, encirclement, other behaviors

Functions of Schooling Behavior

- Feeding
 - increases effective search space for the individual (more eyes, separated by greater distance)
 - coordinated movements to help break up schools of prey - analogous to pack behavior in wolves - by tunas, jacks

Functions of Schooling Behavior

- Reproduction
 - increases likelihood of finding a mate
 - facilitates coordination of preparedness (behavioral and pheromonal cues)
 - facilitates arriving at right spawning site at right time

Fish Behavior & Communication

- Shoaling
 - A social grouping of fish
 - Occurs throughout life in about 25% of fish species
 - Half of all fish shoal at some time
- Benefits of Shoaling
 - Gives a predator many moving targets
 - Confuses predators
 - Increases chances at the individual level
 - Increases food finding ability
 - Keeps potential mates in close proximity

Fish Behavior & Communication

- Pods
 - Tightly grouped school
 - Move as a single unit (including making quick turns)
 - Makes the school appear like one large organism
 - Protection from predators

Liabilities of Grouping Behavior

- Increased likelihood of disease & parasite transmission
 - Becoming more conspicuous to some predators
 - Harvested more easily by man

Feeding Behavior

- Morphology is often a key to feeding behavior – many fish have specialized habits
 - Actual feeding may depend on what is available
- Optimal foraging – Take whatever is closest, as long as it is suitable food
 - Highest quality of food for the least amount of effort

Optimal Foraging

- All else being equal, take the largest prey
- Don't choose prey that takes more energy than it provides
- Be in a habitat that provides the type of food you are looking for

Risk Sensitive Foraging

- Foraging is sometimes restricted because of
undo risk
 - It does not make sense to look for prey
where you will become the prey
 - Must balance energy gain possibility with
risk of obtaining the energy

Finding Food

- Visual detection
 - Diurnal feeders
 - Means being in the open in bright light
- Olfaction
 - Common in bottom dwelling species
- Taste

Aggressive Behavior

- Direct charges
 - Often includes biting
 - Ritualistic displays
 - Modified swimming
 - Flaring gill covers
 - Color changes
 - Threatening movements

Reasons for Aggressive Behavior

- Defense of territory
 - Usually connected with reproduction
 - Sometimes to keep food source
 - Defense of brood
 - Repelling competitors for mates

Resting Behavior

- Inactive state
 - Some fish spend a large part of the day not doing anything
 - Many species change color patterns
 - Most fish rest on or near the substrate
 - Many fish have a specified time of day when resting takes place
 - Some fish never rest (Sleep swimming?)
 - Must keep moving (sharks)

Communication

- Visual signals
 - Auditory signals
 - Chemical signals
 - Electric signals

Signals

- Visual Signals
 - Most important communication signal
 - Large variety of signals
 - Different species use different “languages”
 - Some cues are recognized between species

How visual signals are produced

- Types of coloring
 - Pigments
 - Colored compounds
 - Located in chromatophores
 - In mostly in skin, but also in eyes & organs
 - Controlled by hormones & nerves
 - Structural colors
 - Reflection of light

Kinds of Pigments in Fish

- Carotenoid pigments
 - Bright reds & yellow
 - Green when they overly blue structural color
- Melanins
 - Dark red, brown, black
- Purines (guanine)
 - Colorless crystals responsible for some structural colors

Purpose of Color Patterns

- Thermoregulation
 - Probably not very significant
 - Intraspecific communication
 - Evasion of predators

Common Color Patterns

- Red coloration
- Poster colors
- Disruptive colors
- Countershading
- Eye ornamentation
- Lateral stripes
- Polychromatism

Auditory Signals

- Most fish produce sounds
 - Uses for sound
 - Courtship singing
 - Territorial defense
 - Signaling shoal



Sound Production

- Stridulation
 - Rubbing hard surfaces together
 - Low frequency sounds
 - Vibration of swimbladder
 - Can give loud croaking
 - Incidental to other activities



Chemical Signals

- Pheromones released into the water
 - Reproductive cues
 - Recognition
- Schreckstoff = fear scents
 - Predator avoidance
 - Produced in epidermal cells



Electrical Signals

- Muscle contractions give off a weak
 - Some fish have electric producing organs
 - Used to locate prey or conspecifics



Behavior in Aquarium

- Loss of Appetite
- Difficulty Swimming
- Hovering Near Tank Surface
- Fish Swimming Quickly
- Fighting Among Tank Mates
- Rearranging Tank Objects
- Fin Nipping
- Fish Are Hiding