Lecture 3: Evolutionary Foundations of Behaviour II

Contents

Summary of "The Nature of Human Nature"

- Language
  - Stephen Pinker, MIT
    Brain must have specialized systems (predispositions) for language learning.
    There are striking similarities in grammar across cultures.
    Language simply too complex to be learned by a general learning machine.
  - William's Syndrome: strong language skills but extremely impaired visual-spatial skills. This argues for specialized circuits.
- Motherese
  - "Motherese" differs from regular speech; it is high pitched and musical - regardless of culture.
  - Infants prefer to motherese over regular speech as indicated in a preferred looking task in which the baby controls the amount of motherese or regular speech by looking at one stimuli or another.
  - The fact that motherese appears to be the same in all cultures suggests that it is an evolutionary adaptation. Perhaps loud hard sounds are reserved for warning children and getting their attention whereas soft musical sounds are reassuring.
- Natural Selection
  - Wallace and Darwin. Wallace's letter in 1858 prompted Darwin to publish the Origin of Species.
  - The "second Darwinian Evolutions" - natural selection applied to minds and behaviour - not just anatomy and physiology.
  - According to evolutionary psychologists, we have adapted specialized skills that guide our interactions with the environment.
- Mental Maps and Brain Maps
  - Antonio Damasio at the Univ. of Iowa - fMRI and PET studies showing specific, localized areas in the brain that appear to be involved in specific mental activities.
  - Frames of reference: we likely use both large and small scale maps in different frames of reference.
- Adaptations
  - US versus THEM
  - Fats, sweets, and Salts. Appetites for these foods may have been life saving in the past (due to a lack of availability) but these same

appetites are now life threatening!
    - Sexual jealousy. An adaptation to ensure the propagation of one's genes. With contraception, jealousy is less necessary to ensure that one's genes are passed on. (Is this really so?)
    - Faces. People in New Guinea who has never encountered other cultures nevertheless had similar facial expressions for pain, sadness, joy, etc.
- Human Nature
    - The concept that there is a "single" human nature may be threatening to some who believe it implies that human potential is constrained.
    - On the other hand, Stephen Pinker points out that if the mind really was a blank slate, it would be a "totalitarian's dream" because minds could then be shaped or trained for any purpose unhindered by human nature.

Evolutionary Adaptation

The Selfish Gene and Levels of Analysis

In his excellent book, the "The Selfish Gene", Richard Dawkins agues that behaviours are the result of genes trying to replicate themselves. According to this view, your own personal survival is really the survival of your genes. Propogation of genetic material is used as an explanation for a variety if social behaviours:

> An example is the alarm calls given by ground squirrels when they detect a threat. By calling out, the individual puts themselves at risk and this behaviour seems altruistic. However, research has shown that ground squirrels are more likely to give alarm calls when close relatives are nearby. Thus, by calling out the individual may be in danger but the gene itself might be better off and be passed on more effectively (because the gene is shared with the relations).

Although it is true that alarm calls in ground squirrels can be explained in terms of evolutionary theory, this does not mean that we cannot describe the behaviour as altruistic at a different level of analysis. After all, the behaviour is altruistic by definition!

As Stephen Pinker points out in his book "How the Mind Works", it is important to distinquish between our goals and our genes' goals:

> "People don't selfishly spread their genes; genes selfishly spread themselves. They do it by the way they build our brains. By making us enjoy life, health, sex, friends, and children, the genes buy a lottery ticket for representation in the next generation, with odds that are favourable in the environment in which we evolved. Our goals are subgoals of the ultimate goal of the genes, replicating themselves. But the two are different. As far as we are concerned, our goals, conscious or unconscious, are not about genes at all, but about health and lovers and children and family.
> The confusion between our goals and our genes' goals has spawned one muddle after another. A reviewer of a book about the evolution of sexuality protests that human adultery, unlike the animal equivalent, cannot be a strategy to spread the genes because adulterers take

> steps to prevent pregnancy. But whose strategy are we talking about? Sexual desire is not people's strategy to propogate their genes, It's people's strategy to obtain the pleasures of sex, and the pleasures of sex are the genes' strategy to propogate themselves." (Page 44.)

Thus, although our love of our children can be explained in terms of genetic propogation, this does not mean that it is not interesting to analyse the psychology of parental bonds, or to write and read literature dealing with family relations. These are just different, and valid, levels of analysis. (Of course, the evolutionary level of analysis is often extremely important to consider.)

The Role of Environmental Change and "Speedy Evolution"

Darwin believed that evolution is a slow and steady process. While this is often the case, we now know that evolution can - under certain conditions - occur remarkably quickly.

> e.g. study of Galapagos finches after 1-year drought -- beak size increased in response to shortage of small seeds.

While Darwin may not have appreciated that evolution can occur very quickly, he certainly understood the relationship between traits and the environment. Indeed, this is how he explained differences in traits among different groups of the same species.

Evolution and "Progress"

Evolution is not a predetermined process! There is no end-goal or plan, just a mechanism. Evolution is neither moral nor amoral! (Indeed, when people talk about "higher" and "lower" species, they are imposing their own bias - not one prescribed by evolution.)

This, of course, does not mean that humans are not moral. For from it. Again, it is a question of levels of analysis.

Evolution and Behaviour

Darwin proposed that many behaviours - not just anatomical structures and physiological mechanisms - might be explained by natural selection. In other, words he suggested that natural selection created pressures on species to exhibit certain behaviours.

Darwin thought that behaviours involved in mating, feeding, and caring for off-spring were particularly likely to be involved in natural selection.

> e.g. courtship displays precede copulation in many species. Copulation is unlikely to occur if one partner fails to respond appropriately to the displays of the other. Courtship displays provide a good example of how behaviour can influence the genetic structure of a species.

Ultimate and proximal explanations of behaviour

- Ultimate explanations are functional explanations at the level of evolution

(survival, reproduction
- Proximal explanations deal with mechanism - statements of the intermediate conditions that bring on the behaviour

Song birds example:

Ultimate explanation: Singing in the spring attracts female mates and warns away male rivals. In the course of evolution, males whose genes promoted such singing were more successful.

Proximal explanation: In the spring, increased daylight triggers testosterone release

which in turn turns on the song area in the brain, promoting singing.

Precautions Concerning Evolutionary Hypotheses

Genetic Drift. Genetic drift occurs when two populations from the same species have different inheritable characteristics just by chance. Can occur when changes in genes are not maladaptive.

The founder effect is a form a genetic drift which occurs when one group was founded by a small group of individuals with unusual genes.

Example: Achromotopsia is a genetic disorder where the retina does not have any cones and, as a result, people with achromotopsia do not have colour vision. Oliver Sacks has recently described a population of people living on a small pacific island who have a very high rate of achromotopsia. Researchers suspect that the gene may have been introduced by one Nordic migrant.

The question arises whether this genetic change involves natural selection or genetic drift. As it turns out, people on the island (or at least those with achromotopsia) see very well as night and are successful at night time fishing. Thus, there may be an advantage to having achromotopsia. On the other hand, it may be that achromotopsia is simply not maladaptive (in the case of the islanders) and simply reflects genetic drift.

Correlates of Structure. Darwin was aware of the possibility of non-adaptive side effects.

Example from Gray's Pstchology (2nd Edition):

Female spotted hyenas have a very large clitoris. The researcher Hans Kruuk proposed that this was an adaptive change important in the hyena greeting ceremony used to identify clan membership, etc. However, Stephen J. Gould has suggested that the enlarged clitoris may be a side-effect of high levels of androgens (e.g., testosterone) in the female hyena which is actually larger than the male and leads hunting and fighting with other clans. For Gould, it is the aggressive large female that deserves an ultimate explanation rather than the large clitoris.

Even though structural correlates may not be adaptive immediately, they may prove useful for some other adaptive function later on in the evolution of the species.

Changes in Adaptive Function.

Importantly, the function of a structure may change as the structure evolves. For example, wings may have evolved initially to shield and protect the nest.

Human brain is also a good example. As pointed out in the video, the brain evolved complex systems to solve specific problems. Modern humans make use of these systems to do new things such as read.

Indeed, relatively small changes in structure may lead to large changes in adaptive function. The bacterial flagellum motor, discussed in class, provides a clear example. This motor may have evolved from a bacterial syringe that has a very similar structure but a very different function.

Such changes in function provide a counter-argument to the idea of "irreducible complexity" – the notion that complex structures could not have evolved because they do not function properly when components are missing.

Ethology

The study of behaviours that are typical of a species and that result in increased reproductive success has largely been the domain of ethologists.

Definition of Ethology

> The study of animal behaviour in the natural environment which uses evolutionary adaptation as its primary explanatory principle.

Ethologists are interested in:

- identifying species-specific behaviours,
- understanding the environmental requirements for this development of such behaviors,
- understanding how evolutionary pressures contribute to behaviour.

The assumption is that if a behaviour is relatively invariant across individuals in a species, it must be genetically based.

Fixed action patterns

Fixed action patterns are motor responses to specific types of stimuli that are relatively unchangeable by experience. They are relatively invariant behaviours.

They are "fixed" because they are genetically based. They provide the animal with some advantage for survival or reproduction.

Fixed actions patterns result from "releasing" or "sign" stimuli.

> e.g., egg-retrieving behaviours in geese. Goose sitting on nest shows a specific motor response if it sees an egg outside the nest - reaches out neck to retrieve the egg. It will do this over and over again - there is no reduction in the response. The retrieving behaviour is the fixed action pattern. The sign stimulus is the sight of the egg.

All Geese show this response even though they've never seen another goose do it

. Thus, it appear to be an innate response. The egg retrieving behaviour is highly adaptive - it increases the likelihood of survival of the offspring

Nico Tingbergen (1951, 1952) - one of the founders of ethology - studied Stickleback fish. During the mating season, the male sticklebacks belly turns red. He builds a nest and fights off other males.

The male stickleback performs a zig-zag dance (a fixed action pattern) when it sees the swollen belly of another female stickleback (or a lump of clay!). The swollen belly is the releasing or sign stimulus. The male stickleback also attacks when it see the red belly of another male stickleback.

Much of the work of the early ethologists concerned the nature of the releasing stimulus. It turns out that there are specific aspects of the stimulus that are important for releasing the fixed action pattern and that you can evoke very strong responses from the animal by "capitalizing" on the important aspect of the releasing stimulus.

Example is the gull chick who pecks at the beak of its parent to get regurgitated food. The key aspect of the stimulus is contrast and one can produce "supernormal stimuli" by exaggerating this feature.

Imprinting

Although species-specific behaviours are assumed to be innate (i.e., genetically-based), they can be somewhat modifiable.

An example of an instinctive behaviour that shows modifiability is imprinting. Imprinting is a response shown in the young of many birds. Specifically it is shown in species where the young are capable of walking shortly after hatching. These birds exhibit a following response to the first object they see moving in their environment.

Usually this object is their mother. They will continue to follow their mother about and will follow no other bird or object. This, of course, is a highly adaptive response which aids survival.

Konrad Lorenz demonstrated imprinting in the Graylag goose. He hatched eggs in an incubator and only allowed the geese to see himself after hatching. The geese became imprinted on Lorenz. The response is somewhat modifiable, but innate.

Some birds will also imprint on a moving soccer ball or even a rubber boot. However, chicks will tend to choose a stuffed goose over a soccer ball if both are available.

A key point here is that the genes does not code a female goose but something more general - any moving object - that will usually be the mom.

Ritualization

Lorenz went on to ask about he evolutionary origins of fixed action patterns (that have a communicative function) and argued that these patterns are built up from basic motor patterns involved in preening, feeding, flying.

The process through which basic habits become become communicative actions was called ritualization by Darwin.

Highly Probable Environmental Events

In the case of imprinting, the genes take advantage of highly probable environmental events. This stresses the intimate relationship between genes and the environment.

The research Stephen Emlen studied Indigo buntings - a song bird that migrates at night. He knew that they oriented to stars because, during the migratory seasons, they become restless when exposed, iu their cages, to the night sky and stars.

When they could see the North star, Polaris, they moved south and north depending on the season. Other stars without Polaris lead to random movement. Makes sense because Polaris is fixed in its position relative to the earth. Is this behaviour learned?

Emlen carried out an experiment to find out. Three groups of birds were exposed to controled skys in a planatarium:

- Group 1 - not exposed to stars during summer months
- Group 2 - "true" sky
- Group 3 - altered sky with another star fixed.

Emlen found that Groups 2 and 3 moved relative to the star that was fixed over the summer. The advantage of using the fixed star is that the best star changes over thousands of years!

Again, the genetic code is general and interacts with the environment to produce solutions. As we can see, this adaptive generality can be an advantage.

Earlier I mentioned that geese will exhibit the egg retrieving behaviour even if they have never before seen it performed by another goose. However, some species-specific behaviours do require environmental interactions. The white-crowned sparrow, a song bird, will develop the ability to sing - an innate ability - only if they hear the song during their first summer after hatching. (Marler, 1970) They also develop different accents in different regions.

Tracing the evolution of species-specific behaviours

Behaviours evolve and change and one way to trace the evolution of behaviours is to compare across current species.

- **homologies**: similarity between species due to a common ancestry.
- **analogies**: convergent evolution (similar solutions)

Example: flying. Similarities among insects, birds, and mammals are analogies whereas similarities among species within these groups are homologies.

Must use homologies to trace evolution of behaviour. Example of bumble bees and honey bees - gradation of simple to complex combs may reflect evolutionary pathway.

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