School of Psychology, Birkbeck College

Course PSYC044U (Psychobiology II.) **WEEK 1**

January 25th, 2007

INTRODUCTION: INSTINCT AND LEARNING (INNATE AND ACQUIRED MECHANISMS OF COGNITION)

The bulk of this course concerns the experimental study of learning in animals, reflecting a tradition of "learning theorists" such as Pavlov, Thorndike, Hull and Skinner) who tended to assume i) that learning from experience is a crucial factor in human psychology; ii) that the basic mechanisms of learning rather simple and are not uniquely human; and iii) that important general principles of psychology could therefore be discovered from the study of animal learning. All these assumptions can of course be questioned.

1. It is now often assumed that many crucial determinants of human cognition do not depend on learning from experience, but are in some way innate, most notably the abilities required for the acquisition of language in human infants. (Pinker, 1994; Ramus, 2006)

2. Although simple basic mechanisms of learning continue to be studied, for instances in the cases of habituation and classical conditioning, there are many theories of more complicated forms of information processing, such as forms of memory and spatial inference, even within animal psychology. (e.g. see week 6 and week 9 of this course)

3. There are alternative traditions of studying natural patterns of animal behaviour in particular species in relation to their evolution and function, with the assumption that each species has its own repertoire of inherited behaviour patterns, and that new learning will be heavily constrained within these "species-specific" patterns. These alternatives will be briefly reviewed, under the headings "Ethology", "Behavioural Ecology" and "Sociobiology" (see copy of overhead at bottom of p. 7). A great deal of neurobiological research currently seeks to find the detailed genetic basis of innate behaviours in insects (Manoli & Baker, 2004; Vrontou et al., 2006) and also in vertebrates (Gahtan et al., 2005) including mammals; (Choi et al., 2005; Steele et al., 2006; Dulac & Torello, 2003; Brennan & Zufall, 2006). Some unsurprising conclusions are:

- Individual species have varied patterns of perceptual abilities, response skills and motivation, in accordance with their natural life styles.
- Species differ according to how far their behavioural repertoires depend on learning.
- In many species, even those with highly developed innate patterns of behaviour, information resulting from an individual animal's experience is an essential part of its development, in for instance, forming social attachments, acquiring spatial knowledge, and finding food.

Essay Question

"Instinct and learning are mutually exclusive factors in the control of animal behaviour". Discuss.

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	INNATE (Nativism) *Predetermined cognition and reflexes, biological constraints on learning (if any).*	**ACQUIRED** (Empiricism) *Individual **learning**, including cultural transmission, formal training, and reasoning.*
IDEAS: *Complex cognitions, or relations between large units*	Plato Chomsky (et al e.g. Piatelli-Palmarini, 1989; Pinker, 1994, 1998, 2002) Fodor (1983) Darwin, (1872) Sociobiologists (e.g. Wilson, 1975)	Aristotle Empiricist philosophers Some Behaviourists (e.g. Tolman) Anderson (1983, 1987, looking at HCI Human-Computer Interaction)
REFLEXES *Or Connections:* *Relations between small units*	Darwin, Sherrington. Ethologists, (Tinbergen, Lorenz) Sociobiologists	Most behaviourists: Watson, Pavlov, Thorndike, Skinner Traditional associationists (e.g. Wm James) Neo-Connectionists, e.g. Rumelhart and McClelland (1986)

Nativism = psychology results from what is present at birth: in the extreme there is no such thing as learning.

Very Nativist points from Piatelli-Palmarini (1989)

> "Most biologists and some cognitive scientists have independently reached the conclusion that there is no such thing as learning..... .....I agree with those who maintain that we would gain in clarity if the *scientific* use of the term were simply discontinued. .. ..
>
> "Learning" a specific language (English, Japanese, Italian, etc) is setting these parameters according to a specific set of choices and acquiring the lexicon of that language.. (p.21)

Pinker, S (1998) *How the Mind Works*. Allen Lane, London p 32
"Thoughout the book we will run into other lines of evidence that our mental organs owe their basic design to our genetic program."

"It's not that the claim that there is an interaction between innate structure and learning (or between heredity and environment, nature and nurture, biology and culture) is literally wrong. Rather, it falls into the category of ideas that are so bad they are not even wrong."

However,

"But if the mind has a complex innate structure, that does *not* mean that learning is unimportant." (Pinker, 1998; p. 32) and

Pinker, S. (2002) ***The Blank Slate***

p. 31. "The first bridge between biology and culture is the science of mind, cognitive science."

Empiricism = the "tabula rasa" = in the extreme psychology is *only* learning

E.g current connectionist models.

"For learning, the implications are equally profound. For if the knowledge is in the strength of the connections, learning must be a matter of finding the right connection strengths so that the right patterns of activation will be produced under the right circumstances. This is an extremely important property of this class of models, for it opens up the possibility that an information processing mechanism could learn,..... (McClelland, Rumelhart and Hinton, 1986, p.32)

"In short, if all connections in the system were modifiable by experience, the system could learn to perform any behaviour at all that such a system of units, interconnections, and effectors might ever be capable of. The question of what behaviours it actually did carry out would presumably be determined by the learning process and the patterns of inputs the system actually experienced. *In this sense, the simple PDP model is clearly consistent with a rabidly empiricist world view*."
(Rumelhart and McClelland, 1986, p.140: my italics).

"..such representation systems are not very easy to develop. Usually they are provided by our culture."(Rumelhart *et al* , 1986 PDP II; p.47)

A traditional empiricist view
".. the most important and distinctive of human traits: our ability to acquire and utilise new knowledge.. By studying the acquisition of new algorithms, we are addressing fundamental epistomological questions and analysing a quintessential human trait. .....the study of learning is central." (Anderson, 1987; pp 472-3)

Animal and Human Learning

"Learning theorists" such as Pavlov, Thorndike, Hull, Tolman and Skinner made the inference —

1. Learning is the crucial factor in human psychology;

2. the basic mechanisms of learning are not uniquely human — e.g. because they are *neural* mechanisms;

3. laws and principles underlying human psychology can be discovered by studying the basic mechanisms, which is easiest in animals.

e.g. *Pavlov (1927)*

> "the important question of the intimate mechanism by which new nervous connections are established in the hemispheres" *(p. 36)*
>
> "It is obvious that the different kinds of habits based on training, education and discipline of any sort are nothing but a long chain of conditioned reflexes" *(p. 395)*

This sort of claim is now rare, but Lieberman (2000, pp. 31-33; 1990, pp. 26-8) advances the case that:

a) in animal experimentation it is easier to control the environment and "manipulate only one independent variable at a time while holding all others constant."

b) it is also useful for some purposes to study simpler systems: "The simpler the system, the easier it is to determine its fundamental principles."

ETHOLOGY

= "the scientific study of the function and evolution of animal behaviour patterns". The term is associated with the work of TINBERGEN & LORENZ. and the concepts of INNATE RELEASING MECHANISM (IRM) and FIXED ACTION PATTERN. These related to the **immediate causation** of behaviour. Hinde (1982) refers to 4 questions about behaviour:

1. Immediate causation
2. Development
3. Function
4 Evolution.

All these questions could be asked in any biological approach to behaviour which emphasises its innate and unlearned determinants.

BEHAVIOURAL ECOLOGY

= a more recent term (cf Krebs and Davies, 1991) for work which particularly emphasises the ADAPTIVE FUNCTION of behaviour. As Hinde (1982) says, "the boundary between ethology and behavioural ecology is now impossible to define."

SOCIOBIOLOGY

= a term coined by Wilson (1975). It can be seen as a sub-division of behavioural ecology: for present purposes it is another name for work which asks biological/evolutionary questions about social behaviour, and tends to emphasise unlearned causes of behaviour.

Lazarus (1987)- BPS "concepts of Sociobiology"

Foundation Principles

a) *Natural selection*: resources are limited: populations can grow geometrically - thus there is a struggle for existence. We know individuals vary, thus the survival of the fittest. We know variable phenotypic characters are heritable thus individuals with adaptive heritable characters produce more offspring = **natural selection.**

b) *Task of sociobiology* is discover how social behaviour has been moulded by natural selection in the past, and how is maintained in its present for by present day *selection pressures* - which are simply particular cases of natural selection.

c) *Genetic determinism?* Not necessary to assume simple relationship between genotype and behaviour. May be very many genes, and interest is in *differences* in behaviour between species or individuals, without knowing degree of genetic determinism. We do *not* have to assume that behaviour is resistant to modification by experience in order to believe that there are natural selection causes as well - e.g. imprinting in birds.

d) *Adaptation, optimisation and modelling*. A major advance is theoretical models that go beyond theories of *how* and predict quantitative values for behaviour. They all test the hypothesis that natural selection has, given certain assumptions, produced the best possible solution to a behavioural problem. Parker (1978) and the dung fly : predicts male copulation time pitting the advantage of fertilizing more eggs with current female against cost of losing opportunities with other females. predicts 41.4 mins - actual time =35.5 minutes. What if data do not fit the prediction? either optimality hypothesis thrown out (rare) or model is modified. Optimization is not a *necessary* consequence of the theory of natural selection.

e) *Evolutionary stability*. Social behaviour is "frequency dependent" - it depends on others: therfore the Evolutionarily Stable Strategy. *This is mathematical not a strategy consciously done by the animal*

Parental care and sexual behaviour special since shared genes.
Hawks and Doves.
If benefit of winning is more than cost of injury then everyone should be a hawk - this is a "pure "ESS. If other way, then hawks could invade an all-dove population but doves would still spread when too many Hawks. - Thus most social behaviour is probably a "mixed" ESS

Co-operation

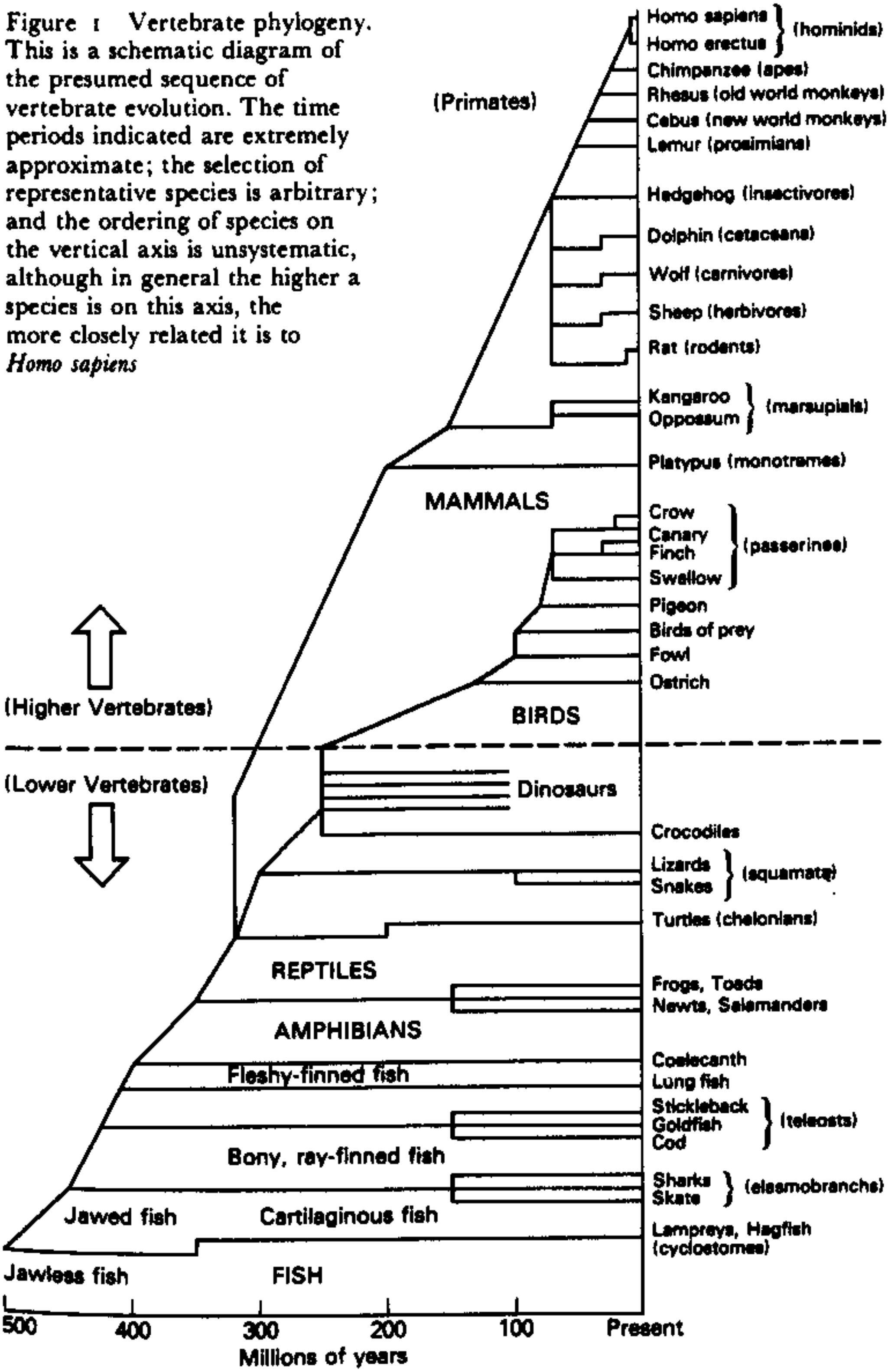
if individuals meet only once, then selfishness is best. But if meet frequently then a simple pure ESS - "*tit-for-tat"* works i.e. co-operate on first encounter then copy the other.
1. it retaliates 2. forgiving if opponent changes. 3. Never the first to defect.

see also mutual co-operation and symbiosis between species eg. cleaner fish.

Altruism and self-sacrifice

the gene-centered "Inclusive fittness" view rather than individual centred view - sibling co-operation and rivalry. discrimination of kin from non-kin is essential, - but sometimes fails e.g. the cuckoo

Figure 1 Vertebrate phylogeny. This is a schematic diagram of the presumed sequence of vertebrate evolution. The time periods indicated are extremely approximate; the selection of representative species is arbitrary; and the ordering of species on the vertical axis is unsystematic, although in general the higher a species is on this axis, the more closely related it is to *Homo sapiens*



Maynard Smith (1984)

A Qualitative Example:

Payoff To ⇓	**When Against** "HAWK"	"DOVE"
"HAWK"	– 2	+2
"DOVE"	0	+1

- These are not hawks and doves but 2 animals of the same species competing with different strategies.
- "Hawk" is aggressive and dangerous
- "Dove" is unagressive but safe.

The theory is about an "Evolutionarily Stable Strategy" (ESS) which applies to a population.

"Hawk" is not stable, because a mutant dove does better against a hawk (assuming the payoffs here) than another hawk.

Similarly "Dove" is not itself an Evolutionarily Stable Strategy because a mutant hawk would have the advantage in a population of doves.

But —

1. If all animals are either one or the other the population would evolve to 0.33 hawks and 0.67 doves.
2. Or a "mixed" ESS is stable if all animals are hawks a third of the time and doves for the other two third.
3. This could happen if animals **learn** from experienced pay-offs to be hawkish a third of the time.
4. Learning is necessary for reciprocal altruism in social groups. (the "tit-for-tat" model).