Link to all slides in colour (8MB file)

Overview

- There will inevitably be some overlap with nature/nurture issues (Dec 5th)
- There is also a a contrast between evolutionary or biological psychology and social constructionist or psychosocial approaches (Nov 28th)
- At least two kinds of reductionism will be illustrated: explaining behaviours as adaptations, and explaining behaviours in terms of neural circuits that control them.

Fossils versus Genomics

- There are epistemological difficulties in studying human evolution.
- The difficulties are in inferring the past course of human evolution from a limited number of fossil finds.
- But in the last 10 or 15 years technologies have become available allowing geneticists to pinpoint where and when the human genome has undergone significant changes.

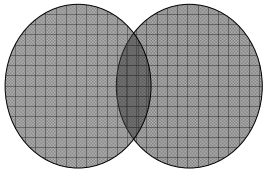
The Darwinian Theory of Evolution

- There are inherited differences between individuals
- These include random variations
- Resources are not unlimited
- Some individuals will flourish more than others and produce more offspring
- Natural selection occurs if a population changes over generations because of this

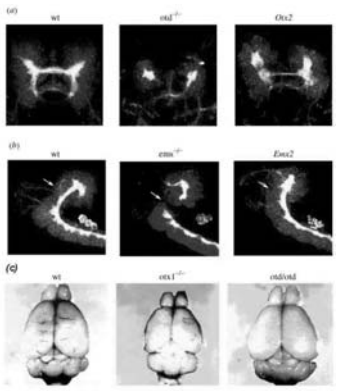
Human Uniqueness on behavioural grounds

Almost all animal behaviour is genetically pre-programmed (by evolution) to fit an ecological niche (Darwin, 1859; Tinbergen, 1951)

Almost all human behaviour involves cultural learning (Tomasello and Razoksky, 2003; Tomasello et al., 2005)



EVOLUTIONARILY CONSERVED MOLECULAR GENETIC MECHANISMS FOR PATTERNING THE EMBRYONIC BRAIN . Reichert, H., & Simeone, A. (2001)



Fly mutant restored with **human** gene

Fly mutant restored with mouse gene

Mouse mutant restored with fly gene

Tinbergen: Nobel Prize 1973

Nikolaas Tinbergen – Autobiography

I was born in The Hague, Netherlands, on 15th April 1907, the third of five children of Dirk C. Tinbergen and Jeannette van Eek. We were a happy and harmonious family. My mother was a warm, impulsive person; my father - a grammar school master in Dutch language and history - was devoted to his family, a very hard worker, and an intellectually stimulating man, full of fine, quiet humour and *joie de vivre*.

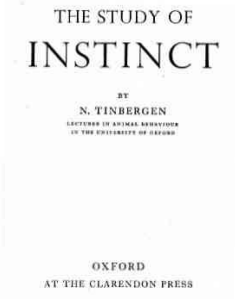
The Nobel Prize in Physiology or Medicine 1973
Press Release
Presentation Speech

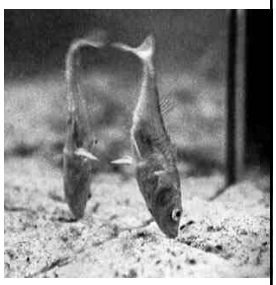
Karl von Frisch
Autobiography
Nobel Lecture

Konrad Lorenz
Autobiography
Nobel Lecture
Banquet Speech
Other Resources

Nikolaas Tinbergen
Autobiography
Nobel Lecture
Article

1951, title and frontispiece



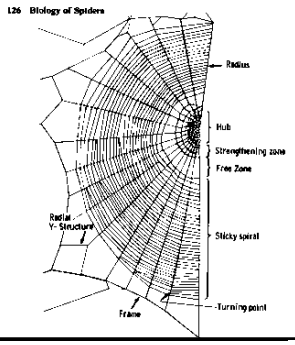


Instinct - 2

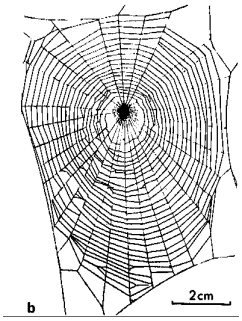
- Tinbergen (1951) stressed two key concepts
- 1. "sign stimuli" e.g. redness for sticklebacks.
- 2. The "**innate releasing mechanism**", by which particular sign stimuli release particular instinctive behaviour patterns
- He believed these concepts applied to mammals
- But the evidence is much clearer with lower vertebrates and invertebrates

E.g. Spiders

The orb web



A first attempt

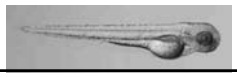


e.g. zebrafish

Gahtan, E., Tanger, P., & Baier, H. (2005). Visual prey capture in larval zebrafish is controlled by identified (four of them) reticulospinal neurons downstream of the tectum. *Journal of Neuroscience, 25*(40), 9294-9303.

"Many vertebrates are efficient hunters and recognize their prey by **innate neural mechanisms**. During prey capture, the internal representation of the prey's location must be constantly updated and made available to premotor neurons that convey the information to spinal motor circuits."

"Seven-day-old zebrafish oriented toward, chased, and consumed paramecia with high accuracy."



e.g. fruitfly courtship

Kimura, K. I., Ote, M., Tazawa, T., & Yamamoto, D. (2005). Fruitless specifies sexually dimorphic neural circuitry in the Drosophila brain. *Nature, 438*(7065), 229-233.

"…..we identify a subset of fru-expressing interneurons in the brain that show marked sexual dimorphism in their number and projection pattern……. Fru expression can produce a **male-specific neural circuit**,"

"Throughout the animal kingdom the **innate nature of basic behaviour routines suggests that the underlying neuronal substrates necessary for their execution are genetically determined and developmentally programmed**" Manoli & Baker (2004).

Also for mammals

Choi et al. (2005) Lhx6 delineates a pathway mediating innate reproductive behaviors from the amygdala to the hypothalamus, *Neuron, 46*(4), 647-660 (in embryonic and adult mice)

"Virtually all metazoan organisms exhibit innate reproductive and defensive behaviors that are triggered by signals sensed from conspecifics or predators. …. The stereotypical nature of these behaviors suggests that their underlying neural circuits are likely to be genetically 'hard-wired'."

"In mammals, innate reproductive and defensive behaviors are mediated by anatomically segregated connections between the amygdala and hypothalamus."

Evolutionary Psychology=Adaptations

- Williams (1966) defined an adaptation as "a characteristic that has arisen through and been shaped by natural and/or sexual selection.
- It regularly develops in members of the same species because it helped to solve problems of survival and reproduction in the evolutionary ancestry of the organism.
- Consequently it can be expected to have a genetic basis ensuring that the adaptation is passed through the generations".

Examples

- However, a few examples follow of papers firmly in the field of evolutionary psychology in recent issues of reputable journals.
- Catatonia, Anorexia Nervosa and depression are proposed as adaptations,
- there is a fairly general theory about individual decision rules interacting with group dynamics,
- a paper proposing an evolutionary account of human facial expression of pain,
- and a paper arguing that a human "innate releasing mechanism" for understanding agency is a key feature of religious concepts of the supernatural**.**

Depression

- Allen, N. B., & Badcock, P. B. T. (2006). Darwinian models of depression: A review of evolutionary accounts of mood and mood disorders**.** *Progress in Neuro-Psychopharmacology & Biological Psychiatry, 30*(5), 815-826**.**
- According to the social risk hypothesis, depression represents an adaptive response to the threat of exclusion from social relationships that, over the course of evolution, have been critical to maintaining an individual's fitness prospects
- in the ancestral environment, depression induced: (i) sensitivity to social risk/threat; (ii) signaling behaviours that elicit social support; and (iii) a reduction in risky behaviours

Kenrick and Buttner wrong

- over a period of 35 years in Sweden (1965-1999), there was **no overall over-representation of stepchildren as victims**.
- Temrin, Nordlund, & Sterner, H. (2004)
- In families with both stepchildren and children genetically related to the offender, genetic children tended to be more likely to be victims.

- **Williams, A. C. D. (2002). Facial expression of pain: An evolutionary account. *Behavioral and Brain Sciences, 25*(4), 439-+.**
- This paper proposes that human expression of pain ..,, **arises from evolved propensities**.
- The function of pain is to demand attention and prioritise escape, recovery, and healing; where others can help …, a distinct and specific facial expression of pain from infancy to old age, consistent across stimuli, and recognizable as pain by observers.
- ……..there has been skepticism about the presence or extent of pain, judgments of malingering, and sometimes the withholding of caregiving and help.
- … an evolutionary account can generate improved assessment of pain and reactions to it.

Atran, S., & Norenzayan, A. (2005). Religion's evolutionary landscape: Counterintuition, commitment, compassion, communion. ***Behavioral and Brain Sciences, 27(06), 713-730.***

- Religion is not an evolutionary adaptation per se,
- but a recurring cultural by-product of the complex evolutionary landscape
- A key feature of the supernatural agent concepts common to all religions is the triggering of an "Innate Releasing Mechanism," or "agency detector,"
- whose proper (naturally selected) domain encompasses objects relevant to hominid survival – such as predators, – but which actually extends to moving dots on computer screens, voices in wind, and faces on clouds.

Kanazawa, S. (2004). General intelligence as a domain-specific adaptation. *Psychological Review, 111(2), 512-523*

- General intelligence (g) poses a problem for evolutionary psychology's modular view of the human brain. The author …. argues that general intelligence evolved as a domain-specific adaptation for the originally limited sphere of **evolutionary novelty in the ancestral environment…**
- It has accidentally become universally important merely because we now live in an evolutionarily novel world

Human uniqueness

- The human brain is uniquely large
- It is also functionally lateralized in a way which differs from chimpanzees
- It may be metabolically enhanced Cacares et al (2003)
- It may include different physiological components (Allman et al., 2005)
- It may be organized uniquely, e.g. large frontal lobes (Deacon, 1997)

Number of neurons in the nervous system

1,000,000,000,000	• Homo sapiens (maybe 10^{14})
350,000,000,000	• Chimpanzee
100,000,000,000	• Rhesus monkey
500,000,000	• Mouse
300,000,000	• Octopus
50,000,000	• Stickleback
850,000	• Honey bee
250,000	• Fruitfly
20,000	• Sea slug
381	• Thread worm male
302	• Thread worm

Ponting and Jackson, 2005

- …….recent advances from the cloning of two human disease genes promise to make inroads in the area .. of brain size evolution.
- Microcephalin (MCPH1) and Abnormal spindle-like microcephaly associated (ASPM) are genes mutated in primary microcephaly.
- In this, the brain is of a size comparable with that of early hominids.
- It has been proposed that these genes evolved adaptively with increasing primate brain size. ….**both genes have undergone positive selection during great ape evolution.**
- the evolutionary **patterns of all four presently known primary microcephaly genes** are consistent with the hypothesis that genes regulating brain size during development might also play a role in brain evolution in primates and especially humans (Evans, 2006)

articles

Humans and great apes share a large frontal cortex

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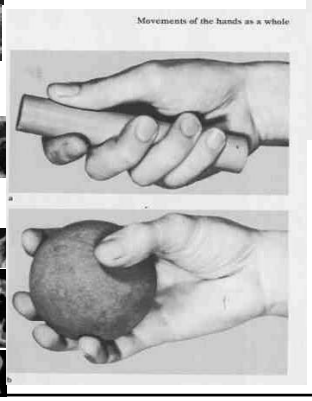
Published online: 19 February 2002, DOI: 10.1038/nn814

Some of the outstanding cognitive capabilities of humans are commonly attributed to a disproportionate enlargement of the human frontal lobe during evolution. This claim is based primarily on comparisons between the brains of humans and of other primates, to the exclusion of most great apes. We compared the relative size of the frontal cortices in living specimens of several primate species, including all extant hominoids, using magnetic resonance imaging. Human frontal cortices were not disproportionately large in comparison to those of the great apes. We suggest that the special cognitive abilities attributed to a frontal advantage may be due to differences in individual cortical areas and to a richer interconnectivity, none of which required an increase in the overall relative size of the frontal lobe during hominid evolution.

Delagnes & Roche (2005)

- Even 2.34m years ago there was a highly controlled technology for producing stone flakes following constant technical rules and resulting in high productivity.
- Their data consists of reconstructions of cobble reduction sequences --- putting the flakes back together, e.g.

Napier (1980)



Hands

by

John Napier

Visiting Professor in Primate Biology, Birkbeck College, University of London

The hand and tools: conclusion

- The consequence of evolution is that humans have domain-general potential for manual skill
- The hands can be used for anything anatomically possible
- There is no evidence for completely steretotyped movements, even for the precision grip (Wong and Whishaw, 2004)

Cultural learning and Invention

- Tomasello & Rakoczy (2003) have argued that there are two (initial) stages of uniquely human social cognition.
- The first stage is observable in one year olds, who have an understanding of other persons as intentional agents,
- This enables them to take part in pretend play, and is important as a prerequisite for shared attention and early social and linguistic learning.
- The second stage is the "Theory of Mind" belief-desire psychology which normally starts around 4 years of age, but which is dependent on several years of linguistic communication.
- These early stages of uniquely human social cognition enable the **cultural "ratchet"** of social and technological innovation (Tomasello et al., 2005)

Understanding and sharing intentions

Tomasello et al., 2005

- a species-unique motivation to share emotions, experience, and activities with other persons.. Leading to ..
- "species-unique forms of cultural cognition and evolution"

Reading

- As last week for nature/nurture
- Any of the papers quoted.
- Or a debate initiated by Lickliter, R., & Honeycutt, H. (2003). Developmental dynamics: Toward a biologically plausible evolutionary psychology. *Psychological Bulletin, 129*(6), 819-835.
- Or take a brief look at one of the books on human evolution listed in the handout.

Conclusions

- Evolutionary theory is essential for many areas of animal behaviour, and rapid advances in molecular genetics may impinge on knowledge of the physiological underpinnings of human capacities
- But a crucial outcome of human evolution was a fairly open aptitude for cultural and technological invention
- The human brain may not be equivalent to a blank slate, but it has large areas of free space for cultural and historical changes — the blank parts may be the most important.

Evolution, Psychology, Evolutionary Psychology and Human Uniqueness

I will begin by looking at issues in the study of animal behaviour, where arguably the theory of evolution has relevance. There is a strong case that in the animal kingdom as a whole, including most non-human vertebrates, species-specific behaviours are the result of Darwinian selection (Tinbergen, 1951; Choi et al., 2005; Manoli et al., 2005)

"Evolutionary Psychology" is based on the claim that the details of human psychology are strongly determined by the details of human evolution. The evidence for these claims is often extremely weak, but I will look at a few recent examples (e.g. Williams, 2002, Gusinger, 2003; Allen & Badcock, 2006; Rhodes, 2006.)

I will also look briefly at the evidence concerning the course of human evolution. It is extremely difficult to be certain about the facts of human evolution, but there is general agreement that: the common ancestor of modern humans and modern chimpanzees occurred about 5 or 6 million years ago; bi-pedalism preceded brain expansion and tool use, and probably goes back 3.5 or 4 million years; early tool use goes back at least 2 million years and extensive tool use was typical of homo erectus for more than a million years before the oldest ("archaic") fossils of homo sapiens are found; the use of fire by homo erectus was also well-established; during the 5 million years since the common ancestor of humans and chimpanzees brain size in the human line has increased, from little more than modern chimpanzee size (which is about 350 cc) in the first bipedal hominids, to 2-3 times this size in homo erectus to and 3-4 times as big a chimpanzee brain in modern humans. (e.g. Bradshaw, 1997)

There is thus little doubt that the human species has an evolutionary history involving hunter-gatherer ancestors. However it does not necessarily follow that "The human brain is a set of computational machines, each of which was designed by natural selection to solve adaptive problems faced by our hunter–gatherer ancestors." (Duchaine et al., 2001). An alternative view is that the human brain is adapted to share emotions and experiences with others (Tomasello et al., 2005) which means that human psychology is determined more by cultural learning than by built-in stone-age preferences. An example is that 4 million years of bi-pedalism means that human arms and hands are capable of an enormous range of learned manipulative skills, rather than being restricted to fixed sequences of muscle movements (for an experimental example, see Wong and Whishaw, 2004).

Although new fossil evidence of human evolution is still useful (e.g. Alemseged et al., 2006) it is increasingly the case that information from molecular genetics is applied to evolutionary issues. In particular, genes putatively associated with in increase in human brain size (Ponting and Jackson, 2005; Evans et al., 2005, 2006) and also human brain lateralization (Sun and Watson, 2006) have been identified, but other comparisons between the human and chimpanzee genome (Ennard et al., 2002; Pollard et al., 2006; Prabhakar et al., 2006) and the potential to compare the modern human with the Neanderthal genome (Green et al., 2006) suggest that a detailed psychobiological account of uniquely human mental capacities may eventually become available.

Books on Human Evolution (alternatives)

Bradshaw, J. L. (1997). *Human Evolution: A Neuropsychological Perspective*. Hove: Psychology Press. BK lib 599.935BRA.

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