Studies of Monkeys and Apes: Laboratory vs Naturalistic Studies

Monkeys and apes have a long history of being used in psychology, from the laboratory work on attachment and deprivation in rhesus monkeys (eg: Harlow 1959) to the controlled community of rhesus monkeys on the Caribbean island of Cayo Santiago (Rawlins 1979), and insight problem-solving in chimpanzees (Kohler 1925).

One major use has been in order to establish the evolutionary basis of behaviour. It is argued that if monkeys and apes show the behaviour seen in humans then that behaviour must have evolutionary benefits.

Research on monkeys and apes is based in two methods - laboratory experiments and naturalistic studies.

EXPERIMENTS IN THE LABORATORY

The use of monkeys and apes in laboratory experiments has both strengths and weaknesses (table 1), but control of variables tends to be the strongest motivator. It is much easier to study behaviour, like co-operation in controlled situations than in the natural habitat, and variables can be manipulated to establish cause and effect.

ADVANTAGES	DISADVANTAGES
- can be used where humans couldn't	- ethics of use and of inflicting pain and suffering
- greater control of variables	- ignores role of language and culture in human behaviour
- whole process of development can be observed, and several generations studied in relatively short period of time	- flexibility of humans to learn
- similar physiology among mammals	- cognitive processes, like attribution, cannot be studied
	- physiology is different in some ways

Table 1 - Main advantages and disadvantages of laboratory experiments with non-human animals.

Experiments on Animal Cognition

Number-Handling

Put simply, this is very basic mathematical ability. Work in the laboratory with one chimpanzee, Ai (eg: Kawai and Matsuzawa 2000) has shown a basic numerical ability. When numbers were shown on a screen in a random pattern, Ai was able to press the numbers in correct order for 1-2-3 (three items) (over 90% correct), four items (over 95% correct), and five items (around 90% correct) (Hauser 2005). But five numbers in order seemed to be Ai's capacity.

Hauser (2005) argued that this type of research is not completely artificial because chimpanzees in the wild use basic knowledge of numbers to decide when to fight or hide from opponents. Wilson et al (2001) played, over a loudspeaker, the call of a foreign male. When three or more males together heard this call, they called back and prepared for a fight. But with one or two males, they kept silent in response to the loudspeaker. Wrangham and Peterson (1996) reported, from observations of chimpanzee warfare, that three or more to one is "meaningful, representing the minimum number of males necessary to hold and kill an intruder" (Hauser 2005 p60).

Brannon and Terrace (quoted in Motluk 1998), working with rhesus monkeys, have found that they can understand the sequence of numbers up to nine (with 75% accuracy on tests). There is debate as to whether numerical skills can exist without language abilities.

In fact, there is the suggestion that macaque monkeys are better at simple maths than one-year-old human babies (O'Leary 1998). What the simple maths ability shows is that the monkeys are recognising individual objects, grouping them, and tagging them with a value which allows the monkeys to keep track. Other famous examples of counting monkeys include "Sheba" (male chimpanzee) trained by Sarah Boysen (Vine 2000).

Theory of Mind

"Theory of mind" is the term for an individual being able to understand the thinking behind the behaviour of another individual.

A human puts sweets in a container in front of the monkeys, then leaves the room. "Panbanisha" (bonobo chimpanzee) watched bugs substituted for sweets by another human, and knew when the first human re-entered the room, they would expect to find sweets. This is a

commonly used scenario for the "theory of mind"; ie: to take the other's perspective (Heyes 1998).

"Austin" "knows" that "Sherman" is afraid of the dark. The former will make noises at night to scare the latter if "Sherman" is being difficult (Vines 1992). These are chimpanzees.

Povinelli (quoted in Vines 1992) arranged for two humans to deliver a drink to the chimpanzees. One of the humans accidentally spilled it, while the other deliberately poured it away in front of the chimpanzees. The chimpanzees showed a preference for the first person to deliver future drinks. This is the ability to understand intentions.

But Povinelli and Eddy (1996) found that chimpanzees would gesture for food to experimenters who were blindfolded equally as those who were not blindfolded. Povinelli argued that reasoning about another's mental state is unique to humans.

Not everybody agreed. Hare et al (2001) tested the understanding of the other's mind in a competitive situation, which is similar to the wild, with a dominant and a subordinate chimpanzee. The experiment involved three conditions and the availability of bananas to the chimpanzees:

Condition 1 - One banana visible to both the dominant and the subordinate chimpanzee, and another banana only visible to the subordinate. The dominant usually took the first banana, and the subordinate the second;

Condition 2 - Two bananas visible to both chimpanzees, and usually the dominant chimpanzee took both;

Condition 3 - Initially no banana visible, but when the dominant chimpanzee looks away a banana is placed in the sight of the subordinate only. Subordinate chimpanzees with a theory of mind will know that only they can see the banana and so will take it. Subordinates without a theory of mind will assume that the dominant chimpanzee also knew about the banana, and leave it to them. The former is what happened.

Co-operation Experiments

Two group of monkeys have studied mainly in recent experiments on co-operation - capuchin and cotton-top tamarins.

Capuchin monkeys

The basic design of this type of experiment involves two monkeys in separate cages who can only reach the food by working together. In Chalmeau et al (1997), the monkeys had to press two levers simultaneously for the food to fall down tubes into the cages. While, in de Waal and Berger's (2000) version, the monkeys had to simultaneously pull on two iron bars attached to a food tray. In both experiments, the food could not be obtained by a single monkey.

These experiments were performed by two different teams of researchers, and they both found that the monkeys co-operated to gain the food. But the two teams interpreted the results differently.

Chalmeau et al (1) explained the co-operation as due to the chance occurrence of simultaneously pulling the levers. While de Waal and Berger (2) saw the behaviour as definite evidence of co-operation and co-ordination between the two animals. For them, this was similar to co-operative hunting seen in the wild. Noe (2006) was not convinced about this.

The problem is that the behaviour of the animals used in the experiments has to be interpreted. Human participants can be asked to describe their motives in an experiment.

Cotton-top tamarins

Hauser et al (2003) set up an experiment where one member of a pair of monkeys in separate cages could pull a tray with food towards itself only, the other animal only, or for both of them. Using a trained and an untrained monkey, the researchers were interested to see if one monkey would reciprocate the altruism of the other.

Some monkeys were trained always to be altruistic (pull the tray for the other monkey to receive food only) or non-altruistic ("defector") (only pull the tray when they themselves received food only). These were classed as stooges. How would the untrained monkey respond to the stooge when they had control of the tray? The untrained monkeys were more likely to pull the tray when paired with an altruistic than a non-altruistic stooge.

A number of variations in the basic experiment were performed, but, in all cases, the behaviour of the monkeys has to be assumed. It was felt by the researchers that the behaviour was not due to simple reinforcement. But is it possible to establish that the behaviour is altruism in the sense of human examples, like blood donation?

Furthermore, reciprocal altruism is not seen as that common in animals (Fehr and Fischbacher 2003).

Chimpanzees

The concern for the welfare of others (ie: non-kin) (known as "other-regarding preferences"; Silk et al 2005) is not evident in chimpanzees, even with familiar individuals, and at no cost to the self, despite the fact that chimpanzees in the wild do collective activities like hunting.

Silk et al (2005) had expected chimpanzees to show "other-regarding preferences". Using two groups of captive chimpanzees (in Texas and Louisiana), she and her colleagues offered individual chimpanzees the choice of food for themselves (known as 1/0) or food for themselves and another chimpanzee at the same time (known as 1/1). The choice of 1/1 did not vary whether another chimpanzee was present or not suggesting that the animals were not concerned with others (table 2).

So there is the problem of different results using different species.

Table 3 lists the problems with these types of experiments.

CHIMPANZEES:	LOUISIANA	TEXAS
Choice of 1/1 when alone	56	48
Choice of 1/1 when another chimpanzee present	58	48

Table 2 - Average percentage choices by chimpanzees.

1. Behaviour of animals has to be interpreted by researchers
2. Use of artificial tasks
3. Problems of training monkeys for experiment
4. Whether monkeys perceive themselves as partners in the experiment (Noe 2006)
5. Problems of generalising results to human co-operative and altruistic behaviour
6. Different results from using different species of monkeys
7. General weaknesses of laboratory experiments

Table 3 - Problems with laboratory experiments on co-operation between monkeys and apes.

The use of chimpanzees in any experiments is criticised by Peter Singer of the Great Ape Project: "The fact that they clearly have some self-awareness shows that we should treat them differently... The case for granting them some basic rights is a stronger one than

might be made for mice and other animals" (quoted in Check 2005).

In September 2005, the complete sequence of the chimpanzee genome was published (The Chimpanzee Sequencing and Analysis Consortium 2005), and, for Gagneux et al (2005), this raised the concern that it was "likely to motivate many further studies of ape biology and physiology". The authors argued for very careful controls on the use of chimpanzees in scientific research generally.

While VandeBerg et al (2005) believed that "Research with chimpanzees is essential for reducing risks to human research subjects, and ultimately to human patients" (p30). Again these authors were talking about scientific research generally.

Brewer (2003) argued that, within psychology, attitudes against animal experiments are dominant among young people coming through graduate courses. For example, among psychology PhD students in the US in the mid-1990s, only 20% strongly supported animal research (compared to 50% pre-1970) (Plous 1996).

NATURALISTIC STUDIES AND CULTURE IN CHIMPANZEES

Because of the concerns about using monkeys and apes in laboratory experiments, one alternative is to study them in their natural habitat without interference. Table 4 lists the advantages and disadvantages of such studies.

ADVANTAGES	DISADVANTAGES
- natural environment observed	- lack of control or causality
- where experiment not appropriate	- difficulties of measurement
- means of identifying new problems/hypotheses	- usually relatively small sample
- where fuller picture of behaviour needed than in experiments	- some aspects of behaviour not observable
- describe chronology of behaviour	- important behaviour may be missed
	- observer bias
	- difficult to replicate
	- reactivity of participants when know being watched

Table 4 - Advantages and disadvantages of naturalistic observation studies.

Traditionally the existence of culture is seen as distinction between humans and non-humans. The dominance hierarchies of certain monkeys, like vervets, is quite sophisticated, but it is not the same as human culture.

Yet there is evidence of "enculturation" among apes reared by humans, particularly in language teaching studies. For example, "Kansi" (bonobo chimpanzee) was never directly taught "symbol language", but picked it up from the teaching of "Matata" (adopted mother) (Savage-Rumbaugh 1991). Similarly, "Washoe" (chimpanzee) was seen to teach her infant American Sign Language (ASL) (Gardner and Gardner 1980). But these are not typical situations.

However, studies have found animals showing social transmission of individual behaviours in their own habitats; eg: sweet potato washing in sea water by macaques at Koshima, Japan (Imanishi 1957). The social or cultural transmission of ideas across generations is used as a key concept of culture by biologists.

Only recently has more detailed evidence of cultural transmission been highlighted among chimpanzees.

Jane Goodall is probably best known for her painstaking observations of chimpanzees in their habitat (3). This research and that of others as part of seven long-term projects have together produced 151 years of chimpanzee observation (Whiten et al 1999).

From these projects has come observations of differences in the behaviour repertoires of chimpanzees that has been called cultural variation (Whiten et al 1999).

Whiten et al (1999) identified thirty-nine different behaviour patterns between the seven sites in Africa (4): Bossu (Guinea), Budongo (Uganda), Gombe (Tanzania), Kibale (Uganda), Mahale (2 separate projects) (Tanzania), and Tai Forest (Ivory Coast) (5) (6).

The differences in behaviours between the sites were classed as culture where it appeared that the behaviour had been learnt by chimpanzees at that particular site. For example, eight behaviour patterns were seen as unique to Tai Forest chimpanzees and three to chimpanzees at Gombe. Table 5 gives some examples of behaviours.

"Each local chimpanzee community has a unique array of specific traditions, representing a 'package' that can be described as its local culture.." (Whiten 2005 p53).

Frans de Waal (2002) argued that these behaviours along with "Machiavellian intelligence" (8), empathy, and looking after non-genetic orphans are signs of culture.

Since Whiten et al (1999) other behaviour patterns have been added. For example, McGrew et al (2001) noted differences in "grooming handclasp" between the two

BEHAVIOUR	EXAMPLES
Cracking nuts	Hit with wood (hammer) against wood (anvil), or stone hammer on wood anvil, or stone hammer on stone anvil
Fishing for insects	Put stick into termite mound and pull out with insects on, wipe stick with hand and place insects in mouth, or put stick directly into mouth (7)
Grooming	Pick off parasite and squash in hand, or squash on skin
Gaining attention	Knock knuckles loudly, or slap branches, or bend branches nosily

Table 5 - Examples of behaviour differences between sites.

projects at Mahale, and between Mahale and Gombe (100 km away), where the behaviour is absent. This is the holding of one hand outstretched while grooming with the other.

A similar project with orangutans has identified nineteen clear behaviour patterns between sites (van Schaik et al 2003).

In terms of evolution, Whiten (2005) proposed:

> A working hypothesis is thus that in the ancestors of the great ape clade, there occurred a distinctive step towards reliance on a relatively rich cultural repertoire that incorporates both technological and social elements (p53).

Allsopp and Brewer (2002), talking about modelling of human cognition, pointed out that culture is more complex than just the intergenerational transmission of behaviours. It includes values, beliefs, customs, rules, and regulations. Culture influences all behaviour if a social constructionist or sociological position is taken.

After the observations of different chimpanzee cultures, researchers have tried experiments to see how the chimpanzees learn the cultural repertoire. These include moving a chimpanzee with a particular behaviour (eg: cracking nuts) to another site to see who copies who (eg: Nielsen et al 2005).

This research has led to the main question currently being answered - why is chimpanzee culture so limited, or put another way, why has human culture developed so much more?

CONCLUSIONS

The use of animals in science generally is highly controversial, including, at the extreme, letter bombs sent to researchers (Koenig 1999). In psychology, particularly with experiments which do not cause the animals pain, the response is not so strong. However, it always has to be asked how useful such experiments, like the co-operation ones discussed above, really are to understanding human psychology.

It may be better to follow the recommendations of the "3Rs", proposed originally by William Russell and Rex Burch in 1959 (Langley 2003):

i) Replacement of animals experiments by other methods;
ii) Reduction in the numbers of animals used;
iii) Refinement of experiments to cause less pain and distress.

Organisations, like The Dr.Hadwen Trust for Humane Research (9), are actively involved in funding alternatives to animal research in science (eg: test-tube studies of immune cells rather than in animals).

FOOTNOTES

1. Also Visalberghi et al (2000).

2. Also Mendres and de Waal (2000); de Waal and Davis (2003).

3. Goodall's years of observing Gombe Stream Reserve's Kasakela and Mitumba chimpanzee communities (on the eastern shore of Lake Tanganyika) produced some surprising findings (eg: van Lawick-Goodall 1965; Goodall 1968; van Lawick-Goodall 1974). The first remarkable observation was in 1960 when "David Greybeard" showed evidence of tool-use by using a grass blade to get termites from their nest (Goodall 1964). More disturbingly, warfare and cannabalism were also observed (Goodall 1978).

Similar long-term observations of gorillas were made by Dian Fossey (Fossey 1980).

4. Details of Bossu (Matsuzawa 2002); Budongo (Reynolds 2005); Gombe (Goodall 1986); Mahale (Nishida 1990).

5. Whiten et al (2001) added observations from chimpanzees at Lope (Gabon).

6. Overall known as Collaborative Chimpanzee Cultures

Project (CCCP) (Whiten 2005).

7. Recently, Sanz et al (2004) observed chimpanzees at Goualougo Triangle (Republic of Congo) combining two sticks.

8. A term for "social intelligence", but alos the use of theory of mind to benefit the self over others.

9. The Dr.Hadwen Trust for Humane Research, 84A Tilehouse St, Hitchin, Hertfordshire, SG5 2DY, UK.

REFERENCES

Allsopp, D & Brewer, K (2002) Human cognition and cognitive science: A review of the limitations of modelling human cognition using computer technology - part 5: Sociological and cultural factors, Orsett Psychological Review, 5, March, 12-18

Brewer, K (2003) Psychologists are becoming less interested in studying animals, Orsett Psychological Review, 11, September, 22-23

Chalmeau, R; Visalberghi, E & Gallo, A (1997) Capuchin monkeys, Cebus apella, fail to understand a cooperative task, Animal Behaviour, 54, 1215-1225

Check, E (2005) Peter Singer: Rights and wrongs, Nature, 1/9, p21

Fehr, E & Fischbacher, U (2003) The nature of human altruism, Nature, 425, 785-791

Fossey, D (1980) Gorillas in the Mist, Basingstoke: Macmillan

Gagneux, P; Moore, J & Varki, A (2005) The ethics of research on great apes, Nature, 1/9, 27-29

Gardner, B.T & Gardner, R.A (1980) Two comparative psychologists look at language acquisition. In Nelson, K (ed) Children's Language vol 2, New York: Gardner Press

Goodall, J.S (1964) Tool-using and aimed throwing in a community of free-living chimpanzees, Nature, 201, 1264-1266

Goodall, J.S (1968) The behaviour of free-living chimpanzees in Gombe Stream Reserve, Animal Behaviour Monographs, 1, 161-311

Goodall, J.S (1978) Chimpanzee killings: Is it the man in them? Science News, 113, 276

Goodall, J.S (1986) The Chimpanzees of Gombe: Patterns of Behaviour, Cambridge, MA: Harvard University Press

Hare, B; Call, J & Tomasello, M (2001) Do chimpanzees know what conspecifics know? Animal Behaviour, 61, 139-151

Harlow, H.F (1959) Love in infant monkeys, Scientific American, 200, 6, 68-74

Hauser, M.D (2005) Our chimpanzee mind, Nature, 1/9, 60-63

Hauser, M.D; Chen, M.K; Chen, F & Chuang, E (2003) Give unto others: Genetically unrelated cotton-top tamarin monkeys preferentially give food to those who altruistically give food back, Proceedings of the Royal Society of London, Series B, 270, 2363-2370

Heyes, C (1998) Theory of mind in non-human primates, Brain and Behavioural Sciences, 21, 101-148

Imanishi, K (1957) Identification: A process of enculturation in the subhuman society of Macaca fuscata, Primates, 1, 1-29

Kawai, N & Matsuzawa, T (2000) Numerical memory span in a chimpanzee, Nature, 403, 39-40

Koenig, R (1999) European researchers grapple with animal rights, Science, 4/6, 1604-1606

Kohler, W (1925) The Mentality of Apes, New York: Harcourt Brace Jovanovich

Langley, G (2002) Editorial, Alternative News, 80, p1

Matsuzawa, T (2002) (ed) Chimpanzees of Bossou and Nimba 1976-2001, Kyoto, Japan: Primate Research Institute, Kyoto University

McGrew, W.C; Marchant, L.F; Scott, S.E & Tutin, C.E.G (2001) Intergroup differences in social custom in wild chimpanzees: The grooming handclasp of the Mahala mountains, Current Anthropology, 42, 148-153

Mendres, K.A & de Waal, F.B.M (2000) Capuchins do cooperate: The advantage of an intuitive task, Animal Behaviour, 60, 523-529

Motluk, A (1998) Natural order, New Scientist, 31/10, p20

Nielsen, M; Collier-Baker, E; Davis, J.M & Suddendorf, T (2005) Imitation recognition in a captive chimpanzee (Pan troglodytes), Animal Cognition, 8, 31-36

Nishida, T (1990) The Chimpanzees of the Mahale Mountains: Sexual and Life History Strategies, Tokyo: Tokyo University Press

Noe, R (2006) Cooperation experiments: Coordination through communication versus acting apart together, Animal Behaviour, 71, 1-18

O'Leary, H (1998) It all adds up, New Scientist, 7/3, 43-45

Plous, S (1996) Attitudes toward the use of animals in psychology, research and education, American Psychologist, November, 1167-1180

Povinelli, D & Eddy, T (1996) What young chimpanzees know about seeing, Monographs of the Society for Research in Child Development, 247, 1-147

Rawlins, R (1979) Forty years of rhesus research, New Scientist, 82, 105-110

Reynolds, V (2005) The Chimpanzees of the Bondongo Forest: Ecology, Behaviour and Conservation, Oxford: Oxford University Press

Sanz, C; Morgan, D & Glick, S (2004) New insights into chimpanzees, tools and termites from the Congo Basin, American Naturalist, 164, 567-581

Savage-Rumbaugh, E.S (1991) Language learning in the bonobo: how and why they learn. In Krasnegor, N.A; Rumbaugh, D.M; Schiefelbusch, R.L & Studdert-Kennedy, M (eds) Biological and Behavioural Determinants of Language Development, Hillsdale, NJ: Lawrence Erlbaum

Silk, J.B et al (2005) Chimpanzees are indifferent to the welfare of unrelated group members, Nature, 437, 1357-1359

The Chimpanzee Sequencing and Analysis Consortium (2005) Initial sequence of the chimpanzee genome and comparison with the human genome, Nature, 1/9

VandeBerg, J.L; Zola, S.M; Fritz, J; Lee, R.D; Rowell, T.J & Satterfield, W.C (2005) A unique biomedical resource at risk, Nature, 1/9, 30-32

van Lawick-Goodall, J.S (1965) New discoveries among wild chimpanzees, National Geographic, 128, 802-831

van Lawick-Goodall, J.S (1974) In the Shadow of Man, London: Collins

van Schaik, C.P et al (2003) Orangutan cultures and the evolution of material culture, Science, 299, 102-105

Vines, G (1992) Why chimps are no chumps, Guardian, 29/5

Vines, G (2000) Are chimps chumps? New Scientist, 14/10, 38-42

Visalberghi, E; Quarantotti, B.P & Tranchida, F (2000) Solving a cooperative task without taking into account the partner's behaviour: The case of capuchin monkeys (Cebus apella), Journal of Comparative Psychology, 114, 297-301

de Waal, F.B.M (2002) speaking on The Cultured Ape, BBC Television

de Waal, F.B.M & Berger, M.L (2000) Payment for labour in monkeys, Nature, 404, 563

de Waal, F.B.M & Davis, J.M (2003) Capuchin cognitive ecology: Cooperation based on projected returns, Neuropsychologia, 41, 221-228

Whiten, A (2005) The second inheritance system of chimpanzees and humans, Nature, 1/9, 52-55

Whiten, A; Goodall, J.S; McGrew, W.C; Nishida, T; Reynolds, V; Sugiyama, Y; Tutin, C.E.G; Wrangham, R.W & Boesch, C (1999) Cultures in chimpanzees, Nature, 17/6, 682-685

Whiten, A et al (2001) Charting cultural variation in chimpanzees, Behaviour, 138, 1489-1525

Wilson, M.L; Hauser, M.D & Wrangham, R.W (2001) Does participation in cooperative intergroup conflict depend on numerical assessment, range location, or rank of wild chimpanzees? Animal Behaviour, 61, 1201-1213

Wrangham, R.W & Peterson, D (1996) Demonic Males, New York: Houghton Mifflin