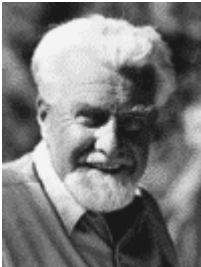


Konrad Lorenz, Classical Ethology, and Imprinting

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Lorenz, Konrad
Vienna, Austria. 1903-1989

Austrian zoologist, founder of modern ethology, the study of animal behaviour by means of comparative zoological methods. His ideas contributed to an understanding of how behavioral patterns may be traced to an evolutionary past, and he was also known for his work on the roots of aggression. He shared the Nobel Prize for Physiology or Medicine in 1973 with the animal behaviourists Karl von Frisch and Nikolaas Tinbergen.

Lorenz was the son of an orthopedic surgeon. He showed an interest in animals at an early age, and he kept animals of various species--fish, birds, monkeys, dogs, cats, and rabbits--many of which he brought home from his boyhood excursions. While still young, he provided nursing care for sick animals from the nearby Schönbrunner Zoo. He also kept detailed records of bird behaviour in the form of diaries.

In 1922, after graduating from secondary school, he followed his father's wishes that he study medicine and spent two semesters at Columbia University, in New York City. He then returned to Vienna to study.

During his medical studies Lorenz continued to make detailed observations of animal behaviour; a diary about a jackdaw that he kept was published in 1927 in the prestigious *Journal für Ornithologie*. He received the M.D. degree at the University of Vienna in 1928 and was awarded the Ph.D. degree in zoology in 1933. Encouraged by the positive response to his scientific work, Lorenz established colonies of birds, such as the jackdaw and greylag goose, published a series of research papers on his observations of them, and soon gained an international reputation.

In 1935 Lorenz described learning behaviour in young ducklings and goslings. He observed that at a certain critical stage soon after hatching, they learn to follow real or foster parents. The process, which is called imprinting, involves visual and auditory stimuli from the parent object; these elicit a following response in the young that affects their subsequent adult behaviour. Lorenz demonstrated the phenomenon by appearing before newly hatched mallard ducklings and imitating a mother duck's quacking sounds, upon which the young birds regarded him as their mother and followed him accordingly.

In 1936 the German Society for Animal Psychology was founded. The following year Lorenz became coeditor in chief of the new *Zeitschrift für Tierpsychologie*, which became a leading journal for ethology. Also in 1937, he was appointed lecturer in comparative anatomy and animal psychology at the University of Vienna. From 1940 to 1942 he was professor and head of the department of general psychology at the Albertus University at Königsberg, Germany (now Kaliningrad, Russia).

From 1942 to 1944 he served as a physician in the German army and was captured as a prisoner of war in the Soviet Union. He was returned to Austria in 1948 and headed the Institute of Comparative Ethology at Altenberg from 1949 to 1951. In 1950 he established a comparative ethology department in the Max Planck Institute of Buldern, Westphalia, becoming codirector of the Institute in 1954. From 1961 to 1973 he served as director of the Max Planck Institute for Behaviour Physiology, in Seewiesen. In 1973 Lorenz, together with Frisch and Tinbergen, was awarded the Nobel Prize for Physiology or Medicine for their discoveries concerning animal behavioral patterns. In the same year, Lorenz became director of the department of animal sociology at the Institute for Comparative Ethology of the Austrian Academy of Sciences in Altenberg.

Lorenz's early scientific contributions dealt with the nature of instinctive behavioral acts, particularly how such acts come about and the source of nervous energy for their performance. He also investigated how behaviour may result from two or more basic drives that are activated simultaneously in an animal. Working with Tinbergen of The Netherlands, Lorenz showed that different forms of behaviour are harmonized in a single action sequence.

Lorenz's concepts advanced the modern scientific understanding of how behavioral patterns evolve in a species, particularly with respect to the role played by ecological factors and the adaptive value of behaviour for species survival. He proposed that animal species are genetically constructed so as to learn specific kinds of information that are important for the survival of the species. His ideas have also cast light on how behavioral patterns develop and mature during the life of an individual organism.

In the latter part of his career, Lorenz applied his ideas to the behaviour of humans as members of a social species, an application with controversial philosophical and sociological implications. In a popular book, *Das sogenannte Böse* (1963; *On Aggression*), he argued that fighting and warlike behaviour in man have an inborn basis but can be environmentally modified by the proper understanding and provision for the basic instinctual needs of human beings. Fighting in lower animals has a positive survival function, he observed, such as the dispersion of competitors and the maintenance of territory. Warlike tendencies in humans may likewise be ritualized into socially useful behaviour patterns. In another work, *Die Rückseite des Spiegels: Versuch einer Naturgeschichte menschlichen Erkennens* (1973; *Behind the Mirror: A Search for a Natural History of Human Knowledge*), Lorenz examined the nature of human thought and intelligence and attributed the problems of modern civilization largely to the limitations his study revealed.

Imprinting

The young of many species are born relatively helpless: in songbirds, rats, cats, dogs, and primates, the hatchling or newborn infant is wholly dependent on its parents. These are altricial species. In other species, such as domestic fowl, ducks, geese, ungulates, and guinea pigs, the hatchling or newborn is at a more advanced stage of development. These are precocial species, and their young are capable, among other things, of walking independently within a few minutes or hours of birth, and therefore of wandering away from their parents. Since mammals are dependent on their mothers for nourishment, and even birds are still dependent on parental guidance and protection, it is important that the precocial infant not get lost in this way. The phenomenon of filial imprinting ensures that, in normal circumstances, the precocial infant forms an attachment to its mother and never moves too far away.

Although imprinting was first studied by the Englishman Douglas Spalding in the 19th century, Konrad Lorenz is usually, and rightly, credited with having been the first not only to experiment on the phenomenon but also to study its wider implications. Lorenz found that a young duckling or gosling learns to follow the first conspicuous, moving object it sees within the first few days after hatching. In natural circumstances, this object would be the mother bird; but Lorenz discovered that he himself could serve as an adequate substitute, and that a young bird is apparently equally ready to follow a model of another species or a bright red ball. Lorenz also found that such imprinting affected not only the following response of the infant but also many aspects of the young bird's later behaviour, including its sexual preferences as an adult.

Imprinting, like song learning, involves a sensitive period during which the young animal must be exposed to a model, and the learning that occurs at this time may not affect behaviour until some later date. In other words, one can distinguish between a process of perceptual or observational learning, when the young animal is learning to identify the defining characteristics of the other animal or object to which it is exposed, and the way in which this observational learning later affects behaviour. In the case of song learning, observation establishes a template that the bird then learns to match. In the case of imprinting, observation establishes, in Lorenz' phrase, a model of a companion, to which the animal subsequently directs a variety of patterns of social behaviour.

With imprinting, as with song acquisition, one can ask why learning should be necessary at all. Would it not be safer to ensure that the young chick or lamb innately recognized its mother? There are, in fact, genetic constraints on the range of stimuli to which most precocial animals will imprint. A model of a Burmese jungle fowl (the species whose domestication produced domestic chickens) serves as a more effective imprinting object for a young chick than does a red ball; there is even evidence that imprinting in the latter case involves different neural circuits from those involved in imprinting to more natural stimuli. Nonetheless, it is clear that the innate constraints are not very tight and that a great deal of learning normally occurs. The most plausible explanation, as in the case of

song learning, is that imprinting involves some measure of individual identification. Lorenz argued that one of the unique characteristics of imprinting was that it involved learning the characteristics of an entire species. It is true that imprinting results in the animal directing its social and mating behaviour toward other members of its own species, and not necessarily toward the particular individuals to which it was exposed when imprinting occurred. But learning usually involves some generalization to other instances, and there does not seem to be anything peculiar to imprinting here. The primary function of imprinting, however, is to enable the young animal to recognize its own mother from among the other adults of its species. This no doubt is particularly important in the case of such animals as sheep, which live in large flocks. Only learning could produce this result.

There is also an important element of individual recognition in at least some cases of imprinting's effects on sexual behaviour. Experiments with Japanese quail have shown that their sexual preferences as adults are influenced by the precise individuals to whom they are exposed at an earlier age. Their preferred mate is one like, but not too like, the individuals on whom they imprinted. The preference for some similarity presumably ensures that they attempt to mate with members of their own species. The preference for some difference is almost certainly a mechanism for reducing inbreeding, since young birds will normally imprint on their own immediate relatives.

The difference between imprinting and song learning lies in the consequences of observational learning. The effect of imprinting is the formation of various forms of social attachment. But what mechanism causes the young chick or duckling to follow its mother? Lorenz thought that imprinting was unrewarded, yet the tendency of a young bird to follow an object on which it has been imprinted in the laboratory can be enhanced by rewarding the bird with food. Rewards also occur outside the laboratory: the mother hen not only scratches up food for her young chicks, she also provides a source of warmth and comfort. Moreover, following is also rewarded by a reduction in anxiety. As chicks develop over the first few days of life, they show increasing fear of unfamiliar objects; they allay this anxiety by avoiding novel objects and approaching a familiar one. This latter object must be one to which they have already been exposed--in other words, one on which they have imprinted. Imprinting works because newly hatched birds do not show any fear of unfamiliar objects, perhaps because something can be unfamiliar only by contrast with something else that is familiar. On the contrary, the newly hatched birds are attracted toward salient objects, particularly ones that move. Once, however, a particular object has been established as familiar and its features identified, different objects will be discriminated from it. These will be perceived as relatively unfamiliar, and hence they will provoke anxiety and the attempt to get as close as possible to the more familiar object. The imprinting of the young bird on one object necessarily closes down the possibility of its imprinting on others, as these will always be relatively less familiar. Thus, there is normally a relatively restricted period in the first few hours or days of life during which imprinting can occur. The only way to prolong this period is to confine the newly hatched bird to a dark box where it is exposed to no stimuli; prevented from imprinting during this period of confinement, the bird imprints on the first salient object it sees after emerging.

