

# Konrad Lorenz

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## Life and Scientific Career

Born on 7 November 1903, Lorenz was the second and last child of Emma Lorenz and Dr. Adolf Lorenz, a distinguished and wealthy orthopedic surgeon. Growing up in comfortable surroundings at the family home in the village of Altenberg, on the outskirts of Vienna, the young Lorenz was allowed to pursue his enthusiasms as an animal lover. His interest in animals and evolution as an adolescent led him to think of becoming a zoologist or paleontologist, but his father wanted him to be a physician instead. After one semester of premedical studies at Columbia University, Lorenz enrolled in 1923 as a medical student in the Second Anatomical Institute of the University of Vienna. There he came under the influence of the distinguished comparative anatomist Ferdinand Hochstetter, who taught him how comparative anatomists use physical structures to reconstruct evolutionary lineages (Figure 1).

Lorenz's receipt of his doctorate of medicine in 1928 seems to have satisfied his father's desire that he receive a medical education. With his MD in hand, he enrolled at the University of Vienna's Zoological Institute, receiving his PhD in zoology in 1933 for a study of bird flight and wing form. In the meantime, he had continued to raise birds and observe their behavior, and his observations had brought him to the attention of Germany's leading ornithologists, Erwin Stresemann and Oskar Heinroth. They, along with Hochstetter and the psychologist, Karl Bühler, at the University of Vienna, encouraged Lorenz to pursue a career combining zoology and animal psychology. His talents in this regard were displayed in a series of papers he published on bird behavior, culminating in his path-breaking '*Kumpan*,' monograph of 1935, entitled 'Der Kumpan in der Umwelt des Vogels: der Artgenosse als auslösendes Moment sozialer Verhaltensweisen' ('The Companion in the Bird's World: Fellow Members of the Species as Releasers of Social Behavior').

Lorenz's rise in scientific visibility was not followed immediately, however, by gainful academic employment. As of 1937, his only position was that of *Dozent* (unpaid lecturer) in Bühler's Psychological Institute. By then, he had already been married for a decade (to Margarethe Gebhardt, his child sweetheart), and he had two children (Thomas, b. 1928; Agnes, b. 1930) (a third child, Dagmar, would be born in 1941). He and his family lived with his parents in Altenberg. He came to fear that his chances for professional advancement in Catholic Austria were slim,

given his Protestant background and his firmly held belief that human behavior should be understood in the context of biological evolution. This contributed to his enthusiasm in March 1938 for the *Anschluss*, the incorporation of Austria into Germany. He expected that his chances of scientific support would be greater under the Third Reich than they had been under the Austrian clerico-fascists. His greatest hope was that the Kaiser Wilhelm Gesellschaft (KWG), Germany's primary organization for supporting scientific research, would establish an institute for him in Altenberg.

Not hesitant about signaling his enthusiasm for the new regime, Lorenz in May 1938 applied for membership in the Nazi Party. In July 1938, at a joint meeting of the German societies for psychology and animal psychology, and then over the next several years in other papers and addresses, he argued that animal behavior studies could shed light on matters of racial hygiene. Breakdowns in the innate social behavior patterns of domesticated animals, he claimed, were strictly analogous to the 'signs of decay' in civilized man. He expressed support for Nazi race purity laws. In addition, in an article in 1940, he argued that Darwinism, properly understood, led not to communism or socialism but instead to National Socialism.

A Kaiser Wilhelm Institute never materialized for Lorenz. The KWG Senate reviewed favorably the idea of providing him with an institute, but the funds for it were not forthcoming. In 1940, he was named Professor of Psychology at the University of Königsberg. This professorship traced back to Immanuel Kant. The post inspired him to develop his philosophical interests and recast Kant's categorical imperative in an evolutionary context. His time at Königsberg was brief, however. He was drafted into the military in 1941, serving successively as a psychologist, psychiatrist, and then troop physician. In June 1944, the Russians captured him on the eastern front. He spent the next three and a half years in Russian prisoner-of-war camps. He did not return to Austria until February 1948.

Back in Austria, Lorenz found himself once again without an academic position. The Austrian Academy of Sciences provided him with modest support for his research station at the family home in Altenberg, where he and his family continued to live (both of his parents were now deceased). He wrote his popular book *King Solomon's Ring* (published originally in German in 1949)



**Figure 1** Konrad Lorenz lecturing student research assistants about the principles of ethology during observations of hand-raised geese at the Max-Planck-Institut für Verhaltensphysiologie in Seewiesen in 1971. Photo by Jane Packard.

as a means of making money. In 1950, he appeared to be the top choice to replace Karl von Frisch for the professorship of zoology at the University of Graz (Frisch was returning to his earlier post at Munich), but political and ideological considerations scuttled his candidacy. This would not be the last time that allegations of earlier Nazi sympathies on his part caused him difficulties. Concluding that he had no chance of ever getting a professorial appointment in Austria, he appealed to colleagues in Britain to find a position for him there. As they went about this task, Lorenz's friend, the German behavioral physiologist, Erich von Holst, persuaded the Max Planck Gesellschaft (MPG) (the KWG's successor) to work to keep Lorenz in Germany. The MPG quickly set up an institute for Lorenz in Buldern, Westphalia, under the auspices of Holst's Max Planck Institute for Marine Biology in Wilhelmshaven. Lorenz gladly took up the new post. In 1956, the MPG established for him and Holst a new Max Planck Institute for Behavioral Physiology in Seewiesen, near Starnberg, in Bavaria. Lorenz remained there until his retirement in 1973. He then returned home to Austria and Altenberg, where he continued his researches. In the course of his long career, he received many honors, including the 1973 Nobel Prize. He died on 27 February 1989.

### Lifelong Scientific Practices

Lorenz prided himself on being an animal lover. The scientific value of being an animal lover, he liked to explain, was that without the love of an animal, one would never have the patience to watch it long enough

to become familiar with its entire set of behaviors. His own favored method of research was to raise wild birds in a state of semicaptivity and observe them over the course of months and even years, thereby allowing himself to come to know the whole of a bird's normal behavior patterns. This also permitted him to witness rare but instructive behavioral events that a field observer might never see, as for example when an instinct 'misfired' in a situation where the proper stimuli for releasing it were not present. In addition, by raising different species side by side, he was able to make comparative observations that again would not have been possible for a field observer. On the other hand, he never developed the keen ecological sense of a field biologist. Nor did he develop strong skills as an experimenter. He credited himself with an intuitive understanding of animals, on the basis of his years of close observation of how animals behaved.

Given his predilection for raising animals, it is not surprising that Lorenz developed a special admiration for two of his predecessors in particular, the American biologist Charles Otis Whitman (1842–1910) and the German ornithologist Oskar Heinroth (1871–1945), both of whom raised birds and observed their behavior closely. Lorenz portrayed these two scientists, with some exaggeration, as animal lovers who were content to watch their pigeons and ducks in a completely unbiased way, unburdened by any hypotheses. However, he also appreciated their ideas. He credited Whitman with having discovered what he called the 'Archimedean point' on which the new science of ethology revolved. This was the idea that, as Whitman expressed it in 1898, 'Instinct and structure are to be studied from the common standpoint of phyletic descent.' Heinroth became a model for Lorenz for his studies of how instincts function in avian social life.

Lorenz's first scientific publication (in 1927) was an empirical study reporting his observations on the behavior of a tame, pet jackdaw. His experiences with this bird led him to want to understand how its instinctive behaviors functioned in the life of a jackdaw colony. To this end, he established a colony of jackdaws in the attic of the family home, marked the birds for identification, and began studying the social life of jackdaws. His successes in this regard led him to study night herons and then graylag geese (along with a host of other species). He promoted his practices as the key to advancing animal psychology. In his Kumpan paper of 1935, he wrote that the proper method for the animal psychologist in studying any species was to begin with 'an extensive period of general observation' prior to any experimentation, and furthermore to focus on instincts before tackling learning. The investigator unwilling to begin by gaining a thorough familiarity of the full behavioral repertoire of his subject species, Lorenz admonished, 'should leave animal psychology well alone.'

## The Conceptual Foundations of Ethology

Lorenz's publications became increasingly theoretical in the 1930s, as he addressed the nature of instincts and the role they play in the social life of birds. In a 1932 paper on instinct, he argued that instincts and learning are wholly distinct from each other, even when they are 'intercalated' in complex, coordinated chains of behavior. In 1935, in his remarkable '*Kumpan*' monograph, he advanced his theorizing further by employing the concept of the 'releaser' (an idea previously enunciated by the theoretical biologist Jakob von Uexküll, with whom Lorenz had been interacting and to whom Lorenz dedicated the monograph). By Lorenz's account, lower animals such as birds are adapted to their environments not very much through acquired knowledge (as are humans) but instead through highly differentiated instinctive motor patterns, created over time by natural selection. To function effectively, they need to be released only by a very few stimuli emanating from the thing to which the animal is responding. These stimuli, however, must characterize the object sufficiently well that the animal does not respond to similar stimuli coming from an inappropriate object. Like a key fitting a lock, the proper combination of stimuli evokes a response from an 'innate schema' (later to be called the innate releasing mechanism or IRM), releasing the performance of its associated instinctive motor pattern.

The interrelations of stimuli and innate schema, Lorenz proceeded to explain, were subject to even greater refinement when the sender of the stimuli and their recipient were members of the same species. Then the releasing stimuli and innate schema could be mutually fine tuned over time by natural selection so as to make the fit between them ever more precise, resulting in combinations of such overall improbability that an animal's instinctive reactions would only rarely be triggered by stimuli from the 'wrong' object. Lorenz used the word 'releasers' (*Auslöser*) for characters that serve to activate the innate schemata of conspecifics. Releasers could be morphological structures or conspicuous behavior patterns or, most often, a combination of both.

Lorenz went on to describe how the highly organized social life of jackdaws depends on a surprisingly small number of instinctive reactions to releasers provided by fellow jackdaws. Borrowing the idea of the 'companion' from Uexküll, who had used the word in the first place to describe what Lorenz had told him about the social life of jackdaws, Lorenz maintained that every jackdaw has a number of social drives with respect to which other jackdaws serve as 'companions.' As 'parental,' 'infant,' 'sexual,' 'social,' or 'sibling' companions they provide stimuli that release the innate behavior patterns appropriate to the jackdaw's drives.

Lorenz's *Kumpan* paper was also the site in which he called attention to the phenomenon he called 'imprinting' (*Prägung*). Whitman and Heinroth, among others, had

been familiar with the phenomenon, but Lorenz was the first to focus scientific attention upon it. He reported that in most bird species, the newly hatched baby bird does not have an innate ability to recognize its own kind; rather, the object of its instinctive behavior patterns is imprinted upon it in a brief, early period in its life. Thus, if a baby gosling sees a human before it sees a mother goose, the gosling will follow the human, directing toward this foster parent the instinctive behavior patterns that would under normal circumstances have been directed toward members of its own species. Lorenz distinguished imprinting from learning, likening it instead to embryological induction. He maintained that imprinting was irreversible.

Lorenz's *Kumpan* monograph evoked a strong, appreciative response among behaviorally oriented ornithologists, including Julian Huxley and Henry Eliot Howard in Britain and Margaret Morse Nice and Wallace Craig in the United States. Lorenz had not yet, however, arrived at his final explanation of how instincts work physiologically. Up to this time, he had endorsed a chain-reflex theory of instinct. Between 1935 and 1937, he decided that that theory was wrong. His interactions with the American Wallace Craig and especially the German Erich von Holst led him to jettison it in favor of a theory involving the internal build up of instinctive energies. Holst's studies of the endogenous generation and central coordination of nervous impulses led Lorenz to conclude that instincts involve some kind of energy (later called 'action-specific-energy') that builds up in the organism until it is released or it overflows. This new theory made sense of what Craig had called 'appetitive behavior,' where the animal seems internally motivated to seek the stimuli that will elicit its instinctive motor patterns. It also served to explain two phenomena that were apparently related to each other: 'threshold lowering' and 'vacuum activities.' Threshold lowering described the finding that the longer it had been since an instinctive action was last performed, the easier it became for the behavior to be released. A 'vacuum activity' was when an instinctive behavior pattern was performed 'in vacuo,' that is, it 'went off' without any apparent or appropriate releasing stimulus and thus without serving its proper biological function. These findings made no sense if one viewed instincts as chains of reflexes set in motion by external stimuli. They did make sense, Lorenz decided, if instincts were understood to be internally generated.

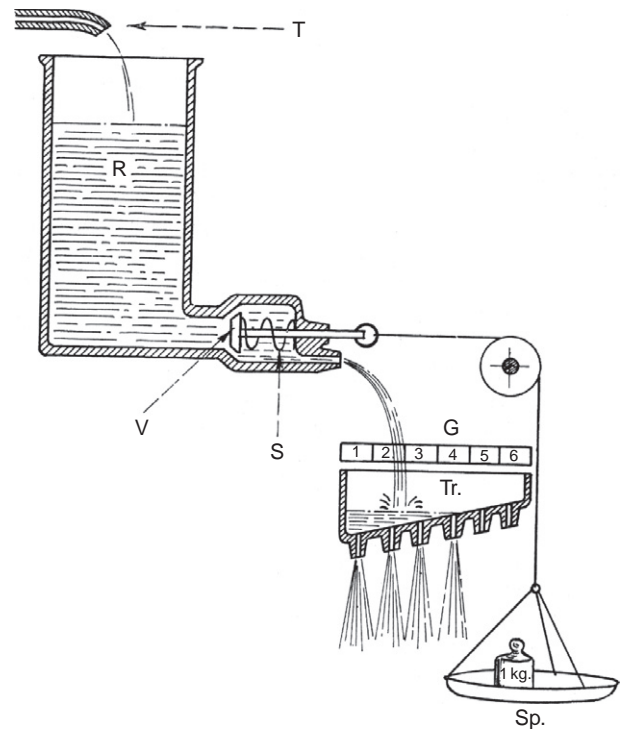
While Craig and Holst were of special help to Lorenz in his theory building, the arrival of Niko Tinbergen on the scene provided Lorenz with an ally who gave Lorenz's key concepts critical experimental support. The two men first met at a conference on instinct held in Leiden in November 1936. In the presence of older animal psychologists who seemed primarily interested in gaining insights into the animal mind, Lorenz and Tinbergen found themselves sharing a different commitment. They both wanted

to put animal behavior studies on a much firmer, objective, physiological foundation. Tinbergen was impressed by Lorenz's insights and ambition as a theorist. Lorenz was ecstatic to learn of the experiments that Tinbergen and Tinbergen's students at Leiden had been doing on the instinctive behavior of the three-spined stickleback. Their analysis of the stimuli eliciting the sticklebacks' instinctive movements struck Lorenz as precisely what he needed. The following spring Tinbergen was given a leave of absence from his department at Leiden to go to Austria to study with Lorenz in Altenberg. There the two men worked together for three and a half months, conducting, among other projects, their classic study of the egg-rolling behavior of the graylag goose. And there too they established a firm friendship. This friendship, which survived the strains of war and lasted for the rest of their lives, was of major importance for the development of ethology as a scientific discipline.

Lorenz's publications during the war varied considerably in nature. They included his writings about domestication and racial degeneration and his paper arguing that evolutionary biology was consistent with National Socialism; an early paper on evolutionary epistemology; an extended comparison of the instinctive behavior patterns of different duck species as a means of assessing their genetic affinities; and a major monograph on 'the inborn forms of possible experience.' He offered his duck study as a confirmation of the idea that the comparative method could be applied successfully to instincts in reconstructing phylogenies. His 'inborn forms' monograph was a sweeping synthesis of his recent thinking in which he addressed such topics as instinctive behavior, domestication phenomena and the threat these posed to racial hygiene, the reinterpretation of Kantian epistemology in evolutionary terms, and what man might make of himself in the future.

### Lorenz in the Postwar Period

The rebuilding of ethology immediately after the war fell to Tinbergen rather than Lorenz, since Lorenz did not return from the war until 1948. Lorenz's first major occasion to present his ideas again after the war occurred at a special conference on physiological mechanisms in behavior, held in Cambridge, England, in 1949. There he offered a visual representation of the instinct theory he had developed. His 'hydro-mechanical' or 'psycho-hydraulic' model, as he called it, featured a reservoir containing a fluid, a spring valve connected by way of a pulley to a scale, and a weight on a scale (Figure 2). In this model, the fluid building up in the reservoir represents action-specific energy; the spring, pulley, and scale represent the innate releasing mechanism; the weight on the scale represents the stimuli serving to trigger the innate releasing mechanism;



**Figure 2** Konrad Lorenz's psycho-hydraulic model of instinctive action. Reproduced from Lorenz KZ (1950) *The comparative method in studying innate behaviour patterns. Symposia of the Society for Experimental Biology 4: 221–268.*

and the instinctive reaction itself is represented by the jet of liquid coming through the valve, producing different results according to its strength. Although Lorenz acknowledged the 'extreme crudeness and simplicity' of this model, he insisted that the model represented 'a surprising wealth of facts really encountered in the reactions of animals.' The model stimulated considerable debate and experimentation over the next decade. Although it came to be generally discredited by the end of the 1950s, Lorenz remained attached to it, and he presented a revised version of it two decades later.

There is no doubt that Lorenz did his most creative work before and during the war, not after it. In 1950, prior to being given his first Max Planck institute, he complained to the British ethologist W. H. Thorpe that he was not gaining any new knowledge but rather simply using up his capital of old knowledge. But this picture did not change all that much even after he had special institutional resources at his disposal. His postwar intellectual activity consisted primarily of recycling, developing, and defending ideas he had formulated earlier. He did this, however, with great gusto, and he continued to be a powerful, charismatic leader of the field. He attracted students to study with him, he energized ethology's international congresses, he challenged psychologists to put behavior in an evolutionary perspective, and he provided the public with an attractive view of the science of

ethology, frequently highlighted by his own charming image as the foster mother of some imprinted ducklings or goslings.

As ethology began to flourish in the early 1950s, several of Lorenz's key concepts drew criticism, both from inside the discipline and from other quarters. Among ethology's own new recruits, Robert Hinde in particular called into question behavioral models involving fluids flowing. Meanwhile, from outside the discipline, the American comparative psychologist Daniel Lehrman launched a multipronged attack on Lorenzian ethology. Lehrman insisted, among other things, that Lorenz's sharp distinction between innate and learned behavior stood in the way of a better understanding of how behavior develops in the individual. Much to Lorenz's disappointment, some of his colleagues, including Tinbergen, came to feel that Lehrman had a point. Lorenz himself, however, was not inclined to make concessions. Although his counterattacks on American behaviorists were not all that successful in addressing Lehrman's actual complaints, Lorenz did in the course of these debates introduce an instructive concept, which he playfully designated 'the innate schoolmarm.' This, as he expressed it in 1965, is the idea that an organism's ability to learn particular things is itself a function of mechanisms that natural selection has built into that organism. In brief, innate mechanisms determine what a species can learn.

Although always considering himself a good Darwinian and always insisting on the importance of bringing evolutionary perspectives to bear on animal behavior, Lorenz was better at applying the methods of comparative anatomy to behavior than he was at thinking about the mechanisms by which evolution operates. His remarks in the latter regard simply reflected his confidence that natural selection typically works for 'the good of the species,' a view that came to be regarded as old-fashioned in the 1960s and 1970s as evolutionary biologists, behavioral ecologists, and sociobiologists promoted ideas of individual selection or kin selection instead of group selection. In contrast, Lorenz's efforts to understand human cognitive processes in evolutionary terms have been viewed as much more farseeing in nature, and he is regarded as a pioneer in evolutionary epistemology. His book *Behind the Mirror* (published first in German in 1973) represents his mature thinking on the philosophical ideas he began developing in the 1940s, when he found himself in his professorial chair descending from Kant.

Lorenz from early in his career was eager to explore the broader human implications of his studies of behavior. He enjoyed playing the role of the scientist-prophet bringing the lessons of biology to a society in peril. This motif appeared in his prewar and wartime warnings about genetic deterioration in civilized man. It reappeared in his first popular book, *King Solomon's Ring*. Though that book is best known for Lorenz's charming accounts of

his experiences and observations as an animal-raiser, Lorenz concluded the book with a somber claim. The human species, he maintained, is unique among higher animals in that it lacks innate inhibitions against killing its own kind. He returned to the theme of human nature in his bestseller, *On Aggression*. There he portrayed aggression as an instinct that builds up naturally in humans as in animals and ultimately needs release. The problem of civilized man, Lorenz argued, is that he does not have sufficient outlets for his aggressive drive. In the 1970s, in his slender volume entitled *Civilized Man's Eight Deadly Sins*, Lorenz became ever more pontifical, reciting a whole litany of dangers threatening humankind, including overpopulation, environmental destruction, genetic deterioration, and nuclear warfare.

## Lorenz's Legacy

As early as the 1930s, Lorenz planned to write a general textbook on the study of animal behavior. He did not succeed in doing so until 1978, when he published his *Vergleichende Verhaltensforschung: Grundlagen der Ethologie* (the English translation appeared 3 years later as *The Foundations of Ethology*). By then, he was not trying to write an up-to-date textbook on ethology. His emphasis instead was on the founding concepts of ethology, which he felt modern ethologists were forgetting, to their detriment. In the book's preface, and with some bitterness, he likened the recent development of ethology to the way that the tips of a coral reef grow quickly away from its foundations, sometimes breaking off from where they started, and then dying or failing to develop in any clear direction. Most of the reviewers of the book found it disappointing. They saw Lorenz as clinging to concepts that had outlived their usefulness. Lorenz's text included, among other things, a revised version of his old psychohydraulic model of instinctive action.

Although many of Lorenz's specific concepts did not remain central to the field, his historical significance for the field's development should not be understated. When Lorenz began his researches, zoologists showed only marginal interest in behavior, European animal psychologists tended to endorse quasi-vitalistic or subjectivistic approaches to behavior, and American comparative psychologists had little appreciation of interspecific differences in behavior or the value of looking at behavior from an evolutionary perspective. Lorenz was the key figure in transforming this landscape. He demanded that the student of behavior gain, through assiduous and detailed observation, a knowledge of the whole range of behaviors of multiple species, and that biological questions – questions in particular of evolutionary history, survival value, and physiology – be brought to bear on this material. He provided ethology with its early



conceptual foundations; he attracted talented researchers to his cause; and he served as a highly visible and popular promoter of the ideas and practices of his field. Although his model of human aggression was disputed, his insistence that human behavior be considered in its broader, evolutionary context remains of fundamental importance.

**See also:** Behavioral Ecology and Sociobiology; Comparative Animal Behavior – 1920–1973; Ethology in Europe; Future of Animal Behavior: Predicting Trends; Integration of Proximate and Ultimate Causes; Neurobiology, Endocrinology and Behavior.

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