be expected, lack the crucial component of behaviour directed towards the achievement of a particular skill or habit by another individual.

There are, of course, many examples in animal behaviour of activities which continue until a defined change has been made in the environment. The most obvious are the making of structures such as webs and nests. The only unequivocal examples of working towards a clearly defined type of behaviour in a pupil are those that involve punishment for approaching or obstructing the mother or another member of the group. There are only hints that it occurs also in non-punishing situations. Yerkes and Tomilin[26] have described the behaviour of female chimpanzees in captivity. When her infant becomes active, the mother stretches its limbs by holding it up as if to make it walk. She also evidently encourages climbing: the infant may begin by pulling itself up on its mother; later she carries it to a place where it can practise climbing. According to these authors, a young chimpanzee climbs up at once, just as a human baby spontaneously crawls up stairs; then it cries when it gets to the top, and is rescued by its mother. A female chimpanzee is also said to encourage her young to walk by dragging it with one hand, or by crouching in front of it and calling. Unfortunately, behaviour of this kind seems not to have been observed in natural conditions. J. van Lawick-Goodall (in litt.), who has made extensive observations of chimpanzees in the wild, states that she has never observed chimpanzees teaching their young anything at all. She writes that adults, far from adjusting their behaviour to the needs of young chimpanzees watching them, either ignore them or push them aside.

The "Instinct to Teach"?

In common parlance, if we refer to teaching as "an instinct", we imply a behavioural propensity common to a whole species. How can such a notion be investigated? There are two frames of reference within which it might be discussed, the phylogenetic and the ontogenetic. Unfortunately, statements about the evolution of teaching or other social behaviour are inevitably speculative. Analogies can be drawn between the behaviour of different species, and these may lead to hypotheses that can be tested by experiment, but the analogies themselves prove nothing. In the same way, statements about the evolution of "altruism" or "aggression" or other features of social behaviour are nearly always metaphysical: no means exist, or can be proposed, by which they can be validated.

In contrast, the second frame of reference, the ontogenetic, offers plenty of opportunity for fruitful investigation of social interactions. It is possible to rear chimpanzees in a variety of social environments and then observe their behaviour as parents. If it could be shown that *Macaca* parents teach their young, it would be even easier to carry out an experimental study of the ontogeny of teaching. The possibilities of experimenting on human children are much less, but the human species offers a vast variety of social organization, and studies of teaching in diverse cultures might well be profitable. Children teach younger children, apparently "spontaneously". To what extent is this imitation of their elders? According to Piaget[27], children alone are responsible for the rules of certain traditional games: hence older children teach younger ones some of the features of moral behaviour. Teaching is certainly a general feature of human behaviour, and we may be sure that it is influenced by early experience. Knowledge is now rapidly increasing on the ways in which adult behaviour and attitudes are influenced by experience in childhood. Teaching could be included in these studies.

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Niels Bohr Institute and NORDITA

by

STEFAN ROZENTAL

Niels Bohr Institute and NORDITA

The Niels Bohr Institute and NORDITA have a tradition of international cooperation in physics research.

For more than 10 years two institutions devoted to research in physics have been working in the same building at Blegdamsvej in Copenhagen: the Niels Bohr Institute and NORDITA. Notwithstanding differences in size, means and organization, this coexistence in close cooperation can be characterized as a symbiosis to the mutual benefit of both parts.

The Niels Bohr Institute forms a part of the University of Copenhagen and thus comes under the Danish Ministry of Education. Besides teaching students to an advanced level it has an extended research programme both in theoretical and in experimental physics. NORDITA (the abbreviation stands for Nordisk Institut for Teoretisk Atomfysik) is an international organization established and run by five countries—Denmark, Finland, Iceland, Norway and Sweden—to promote research in theoretical physics.

Institute for Theoretical Physics

To understand the background for this fruitful cooperation, it is necessary to go back half a century in time. In 1917, Niels Bohr returned to Denmark from Rutherford's laboratory in Manchester and was offered a chair of theoretical physics especially created for him by the University of Copenhagen. A few years later, in 1921, he moved into the new institute building erected for this purpose.

From the beginning it was Bohr's idea to create in this institute a place for the widest possible cooperation in science. This idea was a natural consequence of his general attitude towards life and human relations. Real progress in any domain—he said—can only be achieved by a common effort. In science in particular, development in recent years shows strikingly the importance and the efficiency of world-wide cooperation which disregards political and cultural frontiers and differences in approach.

Thus from the very beginning the Institute for Theoretical Physics (renamed in 1965 on the eightieth anniversary of Bohr's birth) was a place where theoreticians and experimenters could collaborate and help each other. In the early period the close intercourse between the results of spectroscopic measurements and the theory of atomic constitution proved to be most fruitful. Later the centre of interest moved towards the study of nuclear transmutations, which paved the way for the development of new ideas of nuclear structure. Here, too, the cooperation of the experimental and theoretical groups at the institute was of paramount importance.

International Cooperation

The activities of the institute were also based on international cooperation. Even before the building was finished, the first worker from abroad, H. A. Kramers, arrived; he was the forerunner of a list of nearly 700 foreign guests from all parts of the world who, through the years, worked for reasonably long periods at the Niels Bohr Institute. In the first years difficulties in obtaining grants kept the number of visitors rather low, but today the number of such "long-term" visitors at the institute fluctuates around thirty-five (plus fifteen at NORDITA). The tradition of international cooperation which has developed and strengthened through the years has become the most characteristic feature of daily life at the institute and is a firm basis for its research work.

With this background, it was a natural and harmonic development that plans should be proposed to locate other international research projects at the Niels Bohr Institute. The first extension of this kind was in 1952 in connexion with the decision of a number of European countries to establish CERN. At a meeting held in 1951 to discuss the scientific programme for the new organization and the proposed powerful accelerator project, it was decided that a theoretical group be set up immediately in Copenhagen, at the premises of and in close cooperation with the Bohr Institute. The reason for the choice of this site was the institute's tradition of international collaboration.

The CERN group started work in the autumn of 1952, and the somewhat vague original idea as to the scope and objectives of its activities soon crystallized in a scheme for training younger theoretical physicists in scientific research, one from each member country. The training was directed by a small senior staff supported by the staff and the visitors of the Bohr Institute.

NORDITA

During the 5 years that the theoretical group had its seat in Copenhagen, the project proved its soundness and valuable experience was gained. Even before the CERN theoretical group was transferred to Geneva a Swedish proposal to set up a similar group on a Scandinavian basis was accepted by the five Nordic countries. In fact, on the same day in the autumn of 1957 as the CERN group moved from Copenhagen, NORDITA started its activities on very much the same lines, with the same location in the buildings of the Bohr Institute and in close cooperation with its staff and co-workers. The main authority of NORDITA is the board, composed of representatives of the member states. The rules state that these representatives shall be theoretical physicists with a broad outlook on developments in physics. The board lays down the general lines for the work of NORDITA and it also appoints the scientific staff, among them one to act as director.

The main objective of NORDITA is to run a research and training centre in Copenhagen with a small permanent staff supplemented by visiting professors from abroad and in close contact with the Bohr Institute. Between fifteen and seventeen fellows from the member countries are awarded grants from NORDITA to receive advanced training and gain experience in research work. The grants are nominally given for 1 year at a time but as a rule the fellows stay for 2 years.

Besides this, NORDITA has the task of promoting cooperation between theoretical physicists in the member countries. This is achieved by the exchange of scientists and also by inviting professors from other countries either for longer or for shorter visits. A reservoir of prospective lecturers can be found in the group working in Copenhagen, both among the permanent staff of the Niels Bohr Institute and NORDITA and among the visitors.

Scientific Programme

While the administrative bases of the Niels Bohr Institute and of NORDITA are fundamentally different and have to be kept strictly separated, the scientific activities are united. Seminars and lectures are in common. The question of who works with whom, the links between the staff and the visitors and between professors and younger physicists depend only on what subject they are working on. A close and smooth running cooperation also exists in more technical matters. An example is the joint operation of the important computing section, which has at its disposal a Danish built GIER computer and an IBM 1130 as well as access to the IBM 7094 of the Northern European Universities' Computing Centre (NEUCC).

The scientific programme carried out in the two institutes is deeply influenced by the ties between experimental and theoretical work. On the experimental side, the equipment of the Bohr Institute is modest as compared with the facilities in larger countries because of the limited economic resources available. During the past 10 years, however, the equipment has been essentially improved, mainly through the acquisition in 1961 of a 12 MeV tandem Van de Graaff (from the High Voltage Engineering Corporation). Because of lack of space at the institute, the accelerator has been placed on a site at Risø, about 40 kilometres from Copenhagen, close to the Research Establishment of the Danish Atomic Energy Commission. In the near future (probably in 1969–70) the accelerator will be replaced by an 18 MeV Super King Size.

The principal work with this accelerator was concerned with nuclear reactions and nuclear states. The planning and the performance of this work were strongly inspired and influenced by the theoretical group working on nuclear structure and comprising people both from the Bohr Institute and from NORDITA. Problems arising from the development of new theoretical ideas could in many cases give the starting point for experimental investigations.

For technical reasons, nuclear reactions induced by bombardment with tritium could not be carried out here. These experiments have in recent years been performed in cooperation with British colleagues at Aldermaston.

On the Copenhagen site itself several experimental groups are working with a few larger pieces of apparatus. A small cyclotron (90 cm diameter, 22 MeV alpha-particles) was in operation as early as 1938, but since then it has been reconstructed and improved several times. It was used for the study of nuclear reactions induced by alpha-particles and also for the passage through matter and stopping of swiftly moving atomic particles in gases. This is a problem in which Niels Bohr took particular interest since his youth, an interest revived in the 1940s by the peculiar features exhibited by the passage of fission fragments through gases.

The tandem Van de Graaff in the institute branch at Risø was acquired to replace two smaller electrostatic generators, of 2·5 and 4·5 MeV, respectively, both built at the institute in the 1940s. The larger is still used for the study of analogous states of isobaric nuclei.

An isotope separator—with a 90° deflexion magnet and constructed during the Second World War—has for a number of years served for the preparation of targets. It was supplemented by several particle spectrometers. A new isotope separator has been constructed recently, and the group will also participate in the European ISOLDE project (Isotope Separation on Line) to be carried out in CERN to study short-lived isotopes.

Another experimental group is occupied with high-energy research. To begin with, photographic emulsions were exposed to radiation either in balloon flights or by means of the Berkeley accelerator. From 1960, the large CERN accelerator has been used. Bubble chamber pictures can be scanned rapidly after apparatus for this purpose has been acquired. Since the installation of the computer at NEUCC in Copenhagen a couple of years ago it became possible to evaluate the results in a much more systematic way. At present, steps are being taken to construct an automatic scanning apparatus in collaboration with Swedish institutions.

Besides these examples of international cooperation with institutions in the West, the institute also maintains contacts with research centres in the East, especially with Dubna and the Ioffe Institute in Leningrad. For several years until the autumn of 1967 the institute had two or three long-term visitors from the People's Republic of China.

When considering theoretical research, one has to treat the Niels Bohr Institute and NORDITA together. A considerable group with members of both institutes is involved in work on nuclear structure. In Copenhagen, the theory of nuclear constitution has always been in the centre of interest, not least in the past decade, when remarkable progress has been made here by the development of new models of the nucleus. As already mentioned, this development could not but strongly influence the experimental programme.

Another group is engaged in problems of theoretical high-energy and elementary particle physics including the structure and interactions of elementary particles. Other subjects treated by theorists in the two institutes are relativity theory, statistical physics, astrophysics and cosmology.

At the beginning of the past decade and until his death in 1962, Niels Bohr—even though he had retired from his chair at the university—was still director of the institute and was leading its work. In the last years of his life he was chiefly occupied with the formulation of his views on the epistemological problems which confront us in quantum physics. This interest is still very active among the physicists here.

This report shows clearly how strong was Niels Bohr's influence on the whole Copenhagen group, not only during his life but also later through the tradition he had created. Of course, Bohr's influence extended far beyond the small circle in Copenhagen, and can be followed through his extensive correspondence and other extant documents which have now been collected and arranged in a special archive at the Bohr Institute for the benefit of those who may want to study one of the most thrilling periods in the history of physical science. The material will also be useful in the preparation of the forthcoming edition of Bohr's writings.

Survey of Ross's Original Deep Sea Sounding Site

by

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The first successful sounding of the ocean depths was carried out by Sir John Ross in 1840. As a commemorative gesture, in January of 1968 a survey was made over an area of 47 square miles in the vicinity of the Ross site, and soundings were recorded. In this article, the depth recorded during the survey is compared with Ross's original figures.

"ON the 3rd of January [1840], in latitude 27° 26′ S, longitude 17° 29′ W, the weather and all other circumstances being propitious, we succeeded in obtaining soundings with two thousand four hundred and twenty-five fathoms of line, a depression of the bed of the ocean beneath its surface very little short of the elevation of Mount Blanc above it." This laconic statement was made by Captain Sir James C. Ross of HMS Erebus during the British Antarctic Expedition of 1839–1843 (ref. 1).

Although attempts to obtain deep soundings were made in the early 1500s[2], apparently none was successful before Ross made this sounding*. Before this time, the oceans were either regarded as bottomless, or their depths were intuitively estimated. Many scientists argued, for example, that the oceans are as deep as the mountains are high. A more quantitative estimate was made by the astronomer Laplace. Based on a deduced relationship between oceanic depth and tide wave velocity, he placed the abyssal depth at 12 miles.

For the sounding, Ross prepared a line (stranded hemp ?) "three thousand six hundred fathoms, or rather more than four miles in length fitted with swivels to prevent it unlaying in descent, and strong enough to support a weight of seventy-six pounds". The line was wound on a free-spooling reel and a plummet was attached to the outboard end. The apparatus was placed on one of the ship's small boats which was lowered over the side, and the plummet was dropped. While the weight was

* In 1818 Sir John Ross recovered bottom mud from depths of 1,000 and 1,050 fathoms (ref. 3). Although this also was a remarkable accomplishment, it cannot be considered an abyssal sounding because the hypsometric curve gives a mean depth of 2,555 fathoms for the oceanic basin province in the Atlantic Ocean[4].