(Bolt, Beranek and Newman Inc., USA) summarized the work involved. He described a typical experiment with a surprising result, carried out by Sternberg, who also attended the congress. A subject is required to remember a group of up to eight alphanumeric items. He is then presented with similar characters on a screen, one at a time. The subject has to press one button if the items are in their well remembered original set, and another button if they are not. Reaction times in this task indicated that it takes longer in all cases to make the decision that an item is not in the remembered set than to discover that it is. But graphs of reaction time as a function of number of items in memory had equal slopes for both positive and negative cases. This indicates that subjects always conduct an exhaustive search through the items in memory before reacting. The conclusion is surprising, for if the presented item is in the memory the subject ought to be able to leave the search procedure as soon as the item is identified. On average this would be half way through the list and would be expected to give rise to a function for positive items which was only half the slope for the items not in store.

This type of experiment illustrates well the current activities of many experimental psychologists. By measuring the time taken to react, or the errors made in various tasks in which subjects have to process information, they hope to begin to understand the organization of mechanisms subserving recognition, storage and decision processes.

As a taste of things to come, psychologists are already becoming interested in artificial intelligence. Earl Hunt (University of Washington) sketched something of the relevance of this activity for understanding the brain. Technology now demands automatic systems which recognize patterns, learn to control complex plant, to sort and retrieve information and conduct conversations with people. Clearly the brain is still the most sophisticated computer we have. It is as important for the engineers and programmers developing automatic systems to understand what is known about brain function as it is for psychologists not to miss any fundamental new advances in the development of intelligence in non-living systems.

SPIN-LABELS

Inside Membranes

from our Molecular Biology Correspondent

ALL manner of physical methods have been applied to membranes and their components in the attempt to define their physical state, to detect transitions in response to environmental changes, and to clarify the nature of the interactions with various biologically active agents. One approach which has recently received much attention is the spin-label technique of McConnell. An interesting elaboration of this method is described by Calvin *et al.* (*Proc. US Nat. Acad. Sci.*, **63**, 1; 1969). In place of the usual small nitroxide-containing compound, they have introduced biradicals, synthesized to give the desired distance between the sites of the unpaired electrons. The electron spin resonance (ESR) spectrum of such a molecule is governed by the extent of interaction between the two unpaired spins, and this in turn will depend on their separation, and so on the flexibility of the chain joining them. The hope then is that this flexibility will be controlled in some interpretable manner by the medium with which the label interacts. In the isolated radical, interaction of the unpaired spin with the adjoining nitrogen nucleus gives rise to three lines in the spectrum. In the biradical, new energy levels are created by electron exchange between the sites, and basic theory shows that this situation will give rise to five energy levels in all. A spectrum of five lines is indeed observed when the bridge between the two radicals is both short and flexible. As the distance is increased, the spectrum becomes distorted, and gives place finally to the three-line spectrum of two equivalent non-interacting radicals. The intermediate distorted state corresponds to slower exchange.

When such a biradical was introduced into a nerve, diminished exchange was observed, and it was inferred that its flexing motion had become inhibited by attachment to the membrane. The molecule as a whole was not immobilized, however, as the line-widths, which are sensitive to the freedom of tumbling motion, clearly showed. In solution in both water and esters, the ESR spectrum betrayed a high degree of flexibility (five-line spectrum), and only in alcohols, near 40°, was the spectrum similar to that in the membrane. Any alteration in the environment leading to a change in the flexibility of the label would be expected to generate a transition between the three and five-line forms of the spectrum, and therein lies the promise of the method. It comes as a slight let-down that when the spectrum was followed during excitation of the nerve there was no detectable change. Calvin *et al.* suggest that the label enters the lipid layer of the membrane, which is not subject to changes during the generation of an action potential.

A further study by Hubbell and McConnell (*ibid.*, 16) describes the introduction of spin-labelled steroids into both membranes and phospholipid vesicles. The radical is in a five-membered ring, rigidly attached to the steroid, and the ESR line shapes can therefore be interpreted in terms of the freedom of the entire molecule. From the inaccessibility of the label to a water-soluble reducing agent, it is concluded that it is in the lipid layer. The high degree of kinetic freedom of the steroid is taken to demonstrate the feasibility of transport by the movement of carriers across the lipid zone of the membrane.

Phase transitions in phospholipids have been the subject of extensive studies, especially by Luzzati and his group, and transitions between lamellar forms have also been detected by several physical criteria. Steim *et al.* (*ibid.*, 104) report the detection of a phase transition in extracted lipids of *Mycoplasma* membranes as well as in the intact cells. They have observed the effect by scanning calorimetry, in which the heat capacity of the sample is monitored as a function of temperature. Depending on whether the cells contain unsaturated or only saturated derivatives (the composition being determined by the fatty acids supplied to the growth medium), the transition occurs at −20° C or at +40° C or higher, depending on the composition). The transition is thought to be from a crystalline to a disordered liquid-like state of the lipid, and the latter form makes it possible for the transport processes to operate. The possibility of a phase transition in a membrane in the physiological temperature range is in itself, of course, an interesting result.