SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLOGY

July 9th, 1965

Discussion on Dr. Melvill Jones's Paper

MR. E. G. WALSH (Edinburgh) said: It is sometimes informative to consider an engineering approach to problems of stability—to stand back for a while and discard our biological backgrounds. The head is maintained in a relatively fixed position by the operation of a number of control systems. Some take their origin in the proprioceptive endings of the neck; others originate in the various sub-divisions of the VIIIth nerve complex. In walking and in running a variety of forces which vary in waveform, frequency and amplitude often need to be neutralized. Artificial control systems must sometimes be designed to solve comparable problems. Thus the stabilizing fins of the Queen Mary are required to counteract in good time the tendency for the ship to roll about as it is buffeted by the sea. It is necessary to measure not only the list but the angular velocity and acceleration of the roll. The engineer has need of transducers sensitive, not only to displacement, but also to the rate at which the changes are occurring.

For the head it would be amazing if adequate stabilization could be achieved if the only information available related to the tilt that had already been reached. Those who have recorded activity in the VIIIth nerve—Ashcroft and Hallpike (1934), Adrian (1943), Lowenstein and Roberts (1951) and others—have found units described as being vibration detectors. What is their function? It has been implied in some otological literature that such vibration sensitive detectors are *ipso facto* unrelated to problems of equilibration. On the contrary they are what would be expected, a necessary complement to the tilt sensitive endings described in this paper. I wonder if the author has investigated the activity of this rather neglected but perhaps vitally important group.

DR. MELVILLE JONES replied: The stabilization of the head is well seen in some birds. The righting reflexes acting on the head may be observed in a duck. The head tends to keep almost the same position as its body is turned in a sagittal plane, but in human beings, comparable changes may be seen. Many people with orthopædic lesions have much body sway as they walk along, but healthy people with a good gait carry their head in an almost straight trajectory as they move. With vestibular lesions, there seems to be some difficulty, for in walking and turning corners people with bilateral lesions proceed more cautiously and their vision too may deteriorate as they move. I would think that receptors sensitive to acceleration and its derivatives are pretty important not only for the bird, but also for ourselves.

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Discussion on Dr. Bosher's Paper

J. T. Y. Chou asked Dr. Bosher what information he has on the enzyme activities in the inner ear tissues and in the inner ear fluids (endolymph and perilymph)?

Dr. Bosher said in reply to Dr. Chou, that the investigation had been confined to a straightforward histological examination of the labyrinth and so no special studies of enzyme activity had been undertaken.

Replying to Mrs. Cavanagh's enquiry regarding the "change-over period", he stated that during fœtal life a large, thin-walled blood vessel spiralled from base to apex of the cochlea under Corti's tunnel and it was now generally accepted that the nutrition of the developing organ of Corti was, in large part, maintained by this vessel, the vas spirale. During the final stages of cochlear development the vessel underwent involution, and Corti's organ, for the first time, became solely dependent upon the endolymph for its nutrition. It was this period of change from a direct type of nutritive supply to an indirect one which was defined as the "change-over period". The finding that at this time both the stria vascularis and the external spiral sulcus were still incompletely differentiated thus seemed of great importance. It appeared conceivable that, in some instances, these structures would only be able to maintain the nutrition of Corti's organ with difficulty, if at all, and consequently the "change-over period" could be considered to constitute a critical and hazardous phase in the development of the cochlea.

Mr. Maxwell Ellis's query as to the nature of the stimulus producing the change-over in nutritive supply was a particularly pertinent and important one. Unfortunately, little was known of the physiological changes taking place within the labyrinth during this period, and further studies of it were, therefore, highly desirable. However, especial attention had been paid to the timing of the change-over period, and it was possible to say that in the cat it always occurred at the same stage of cochlear development. Although this was usually reached about the fourth day after birth, the post-natal ages of the animals did, in fact, vary considerably and there was, therefore, no constant relationship to parturition. Thus the change from intra- to extra-uterine life would not appear to be a major factor, a view supported by the fact that in man the change-over period probably occurred before birth.

The variation in the post-natal age at which the change-over period occurred almost certainly reflected corresponding variations in the duration of gestation. Mr. Allinson's suggestion of recording the age from the date of conception would certainly be more accurate but, unfortunately, it was not always possible to obtain this information.

With regard to Mr. Edward's enquiry, no study of the ocular changes in these animals had been undertaken. These did not, however, appear to result in any gross functional disturbance, although the subject had attracted little attention since the time of Darwin. Retinal nutrition was subserved by a direct blood supply throughout life but a change-over in nutritive supply did occur, of course, in the case of the lens, the hyaloid artery involuting in the final stages of development. However, it was interesting, in the context of the present study, that many cases of so-called congenital human retinal disease

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were now thought to arise as the result of degeneration of a normally developed retina in the early post-natal period.

It was a great pleasure to see Dr. Fraser in the audience and to learn that he, too, agreed that the environmental factors described could be of considerable practical importance in the field of human "congenital" deafness. Certainly Waardenburg's syndrome, in which the escape phenomenon is so marked a feature, and the deafness of premature infants both appeared to be disorders in which further investigation of the role of these factors could be expected to provide valuable information and even, eventually, to lead to prevention of the deafness in these and other similar conditions.

As Mr. Malcomson had suggested, when premature labour resulted from or was associated with some toxic agent, it was theoretically possible that this agent might also have a direct toxic action on the cochlea. However, in premature infants there did not seem to be any significant increase in the incidence of the deafness in any one ætiological group or groups, and for this reason it appeared likely that deafness, when it occurred, was due not to a secondary effect of the primary pathological condition but to some change resulting from the prematurity itself. Although at present the nature of the underlying ætiological mechanism must be a matter for conjecture, the well known difficulty in maintaining fluid and electrolyte equilibrium in these children would almost certainly lead to exacerbation of the changes in body water and electrolyte known to occur in full-term infants, and this in turn might well be a significant factor in the causation of the deafness.

MR. K. G. MALCOMSON (Bristol) said that Mr, Bosher has provided us with some very interesting information which may give further insight into some types of congenital deafness.

I would like to ask a question about premature babies. Prematurity is said to exist when the birth weight is less than 2·5 kilo ($5\frac{1}{2}$ lbs.). The common causes of spontaneous prematurity are pre-eclamptic toxæmia, diabetes mellitus, chronic nephritis and essential hypertension; prematurity may also result from non-toxic antepartum hæmorrhage (not placenta prævia) or induction for suspected hæmolytic disease of the newborn or dystocia. In former days syphilis and tuberculosis were associated with premature labour but these diseases are both relatively rare and easily amenable to specific treatment.

In cases where toxic factors are the cause of prematurity would it be reasonable to conjecture that these same factors could have an adverse influence upon the cochlea similar to toxic damage of this organ in post-natal life?

G. R. FRASER (London) said: Dr. Bosher and Dr. Hallpike in their paper have pointed out the possible relevance of their findings to problems of human childhood deafness. Among the 846 children in my series whom they have described as the enigmatic group, I should quite agree that in a substantial proportion the cause of the deafness was not hereditary. This being so, what was the cause?

As I understand it, Dr. Bosher and Dr. Hallpike say that the inner ear degeneration in their white cats, and perhaps many other forms of inner ear degeneration is due to an interaction of genetical and environmental factors.

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If the latter are favourable, the escape phenomenon occurs and the inner ear degeneration does not take place; if unfavourable they may cause inner ear degeneration even in the absence of any recognizable genetical factor and here we have the explanation of deafness in a proportion of the enigmatic group. The practical problem which confronts us is of course the nature of these environmental factors and of the escape mechanism and on these points I have two brief remarks to make.

The first concerns the unduly high proportion of premature children in the enigmatic group. That this is a significant factor in the causation of inner ear degeneration accords well with what Dr. Bosher and Dr. Hallpike have suggested, namely that one of the environmental factors concerned in the initiation of the degeneration is the inadequate renal homœstasis in early life, occurring *a fortiori* in the premature child.

The second point concerns the practical importance of the escape phenomenon in the field of human deafness. It is particularly frequent, for example, in the case of Waardenburg's syndrome in which deafness can be associated with partial albinism of the skin and hair, heterochromia of the irides and malformation of eyelid structure. Only a minority of genetically affected individuals, however, develop bilateral severe deafness.

It is quite clear that intensive study of this escape mechanism will be of great importance from the point of view of the possible prevention of the onset of the degenerative process in individuals who are at risk, whether for genetical or environmental reasons.

FLORENCE CAVANAGH (Manchester) asked Mr. Bosher if he could explain in more detail the alteration of the blood supply which occurred at the developmental point which he called the "change-over period".

MAXWELL ELLIS (London) said that many interesting ideas were suggested by this paper which he hoped was the first of many others and he congratulated the Speaker on his maiden effort. It had just been stated that all so-called congenital defects were commoner in prematurely born children. Was anything known of the stimulus which caused the change in the stria from a vascular type of nutrition to an exudative one? Was it, for instance, a time factor, occurring at a certain stage of gestation, or was it due to the change in environment from intra-uterine to extra-uterine existence? Did the Speaker know whether the change-over always occurred at the same age and stage in the life history of the animal or was it perhaps mediated by something that occurred earlier?

MR. W. G. EDWARDS (London) asked if the animal study had shown any ocular defect. Did any evidence exist of a comparable change-over for the nutrition of the retina during the early post-natal period?

MR. S. W. ALLINSON (Boston, Lincs.) said that more information may be obtained if "the change-over period" is timed from the date of conception as well as being timed from the date of delivery.

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Discussion on Mr. G. Dean Beaumont's Paper

MR. JOHN GROVES said he would like to ask Mr. Beaumont two questions about this very interesting work.

Did he find any histopathological changes suggesting squamous metaplasia in the lining of these bony cavities after their communication with the atmosphere had been occluded?

The other question concerns the development of negative pressures which Mr. Beaumont suggested might be a contributory factor in producing the changes described. The demonstration and measurement of such negative pressures would obviously be very difficult, and it would be interesting to know whether this was in fact achieved.

MR. BEAUMONT replied that there was no evidence of any true squamous metaplasia of the lining although a multilayering effect was observed in some areas after the foamy changes had developed. In reply to the second question, no pressure measurements were carried out during the experiments because of the technical difficulties involved in obtaining reliable results over an extended period.

MR. STIRK ADAMS (Birmingham) asked Mr. Beaumont whether his experiments had been extended to ascertain if the pathological changes which occurred as a result of obstruction to the ventilatory pathways were reversible after later removal of the obstruction to allow free reventilation of these spaces.

He was particularly interested to discover whether there was a point of pathological no return, and if so at what stage in the development of these changes this took place, as it had been his personal observation over many years that when similar pathological changes were present in chronic human mastoiditis, both membrane and bone nearly always recovered their normal physiological function with free ventilation of the post-operative radical cavity.

MR. BEAUMONT replied: The important question whether the changes are reversible cannot be answered from the present material, and further work along these lines is required. However, in several bones which had been operated upon quite successfully, but in which it was later found at sacrifice that a pathway of ventilation had been re-established, the lining always appeared normal. Unfortunately there was no means of establishing the time at which reventilation occurred.

MR. F. MCGUCKIN (Newcastle-on-Tyne) said that he was somewhat puzzled that Mr. Beaumont had made no reference to the presence of hyaline deposits. In the middle-ear cleft deposits of hyaline were much more common than the formation of new bone or deposition of plaques of chalk. Dr. Bruce Proctor, in personal discussion, had stressed how often hyaline was present; his argument had carried conviction and it was confirmed by careful observation. He wished to ask Mr. Beaumont whether or not hyaline deposit had been noted in his experiments, or whether new bone formation was the only change seen.

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MR. K. G. MALCOMSON (Bristol) said that he was most interested in Mr. Beaumont's presentation showing that interference with the normal process of aeration of the bones of cockerels produces detachment of the lining cells which undergo degeneration and form a fluid containing cholesterol.

The impairment of Eustachian efficiency in the child by upper respiratory infections and adenoidal hyperplasia is similar to the experimental obstruction of the foramen pneumaticum which Mr. Beaumont has described. The middle-ear effusions have a high cholesterol content, there may be cholesterol granulomata in the mastoid segment, and he had even encountered a solitary cholesteatoma in the inferior part of the mastoid antrum well removed from the conventional site of origin of this lesion.

He would be most interested in Mr. Beaumont's comments on these similarities for they appear to him to be almost exactly comparable.

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