THE EFFECT OF UNDERNUTRITION ON BRAIN-RHYTHM DEVELOPMENT*

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The evidence that early undernutrition has long-term effects on mental development has wide social implications.

In an 11-year follow-up study, Stoch and Smythe[1] suggested that undernutrition at a critical period in brain growth might be responsible for mental retardation. On psychometric testing, a pattern emerged in the undernourished group which resembled that found in some brain-damaged children.

There have been very few EEG studies on the undernourished child, and those that have been done concern the changes in the acute stages of kwashiorkor.

Engel[2] found slowing of the dominant rhythm which coincided with the stage of mental apathy in acute kwashiorkor. Clinical improvement was accompanied by an increase in the frequency of EEG rhythms, and all records except two returned to normal. Engel suggested that kwashiorkor might be responsible for permanent brain damage.

Nelson,[3,9] confirmed Engel's finding of generalized slowing of cortical activity, but also found a significant number of focal temporal lobe abnormalities in the acute stages of kwashiorkor. Even after clinical recovery of the children, it was found that the dominant frequencies were mostly below the range for normal American children of the same age.

In both Nelson's and Engel's studies, the changes which they found were regarded as being either permanent brain damage, or an impairment of the development of mature brain rhythms.

The purpose of this study was to determine the permanence of EEG changes found during the acute stage of a nutritional insult.

METHOD

The subjects used in this study were those selected by Stoch and Smythe[1] on the basis that each child had suffered severe marasmus. The undernourished group consisted of 20 Cape Coloured children. The group was matched for age and sex with a group whose early nutrition was supervised in a crèche. The follow-up study by Stoch and Smythe[4] revealed no obvious evidence of further nutritional deficiency after the infantile marasmus.

A 30-minute EEG recording was taken from each child, and it included 3 minutes of hyperventilation and photic-stimulation. Where there was a possibility of hypoglycaemia, glucose was given orally, and care was taken to prevent drowsiness during the recording. Electrode placements were according to international standards. A 16-channel Offner Type TC electroencephalograph was used. Records were taken and assessed blindly, ie. without knowledge of the child's group membership.

Alpha index (the percentage time that alpha rhythm is present) was calculated according to the method of Davis and Davis.[5] The intelligence-test results were those obtained by Stoch and Smythe[4] using the New South African Intelligence Scale. Statistical analysis of the data was carried out, using the t-test for significance of difference between paired groups, and the Spearman Rank Correlation Test.

RESULTS

There were 2 abnormal records, both children being in the undernourished group. One had a primary epileptic dysrhythmia and the other showed a slow-wave focus. All the other records were classified as being within normal limits.

When the alpha index was calculated, a significant difference was found between the marasmus and the control groups ($t = 2{\cdot}7$, $p < 0{\cdot}02$).

Correlation between alpha index and intelligence score was not significant in the marasmus group ($r = 0{\cdot}09$, $p > 0{\cdot}6$), but a very highly significant negative correlation was found in the control group ($r = -0{\cdot}69$, $p < 0{\cdot}001$).

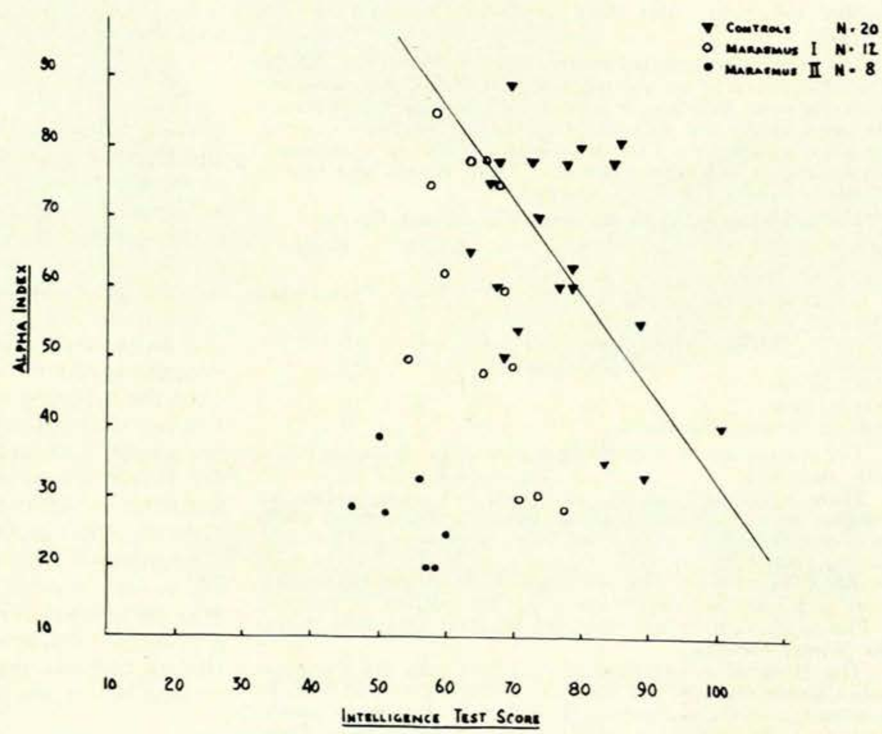

Fig. 1. Scattergraph.

*Date received: 28 February 1968.

When this was plotted graphically (Fig. 1), it could be seen that there were 8 children in the marasmus group who had a low alpha index and a low intelligence score. They also fell well below the line of regression for the controls. The records were then reassessed blindly and it was found that these 8 marasmic children had a low alpha index because of theta dominance (see Fig. 2), whereas the other children with a low index had a beta dominance (see Fig. 3). These 8 children were designated marasmus group II. It was found that there was a significant difference between the alpha index of group II and their paired controls (see Fig. 4). This was in contrast to the rest of the marasmus group now called marasmus group I, in which the alpha index was found not to be significantly different from their controls.

Furthermore, marasmus group II differed from group I in that there was no negative correlation between alpha index and intelligence score. Group I and the control group had a negative correlation, as did Mundy-Castle's group of normal adults.[6] The marasmus group I thus approximates the control group in terms of alpha index and the relationship between alpha index and intelligence-test score.

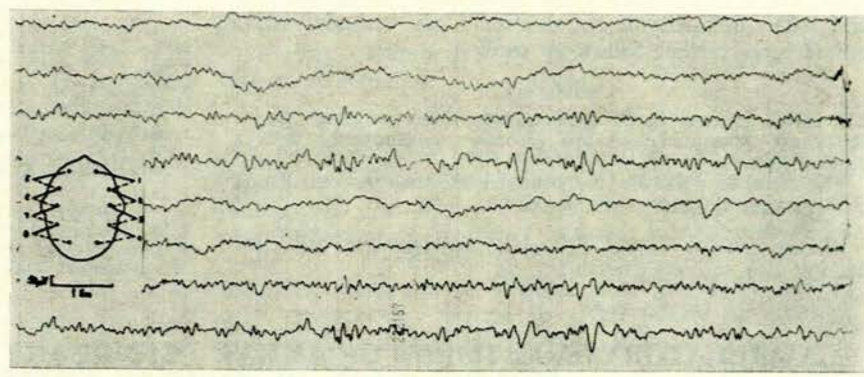

Fig. 2. Marasmus group II.

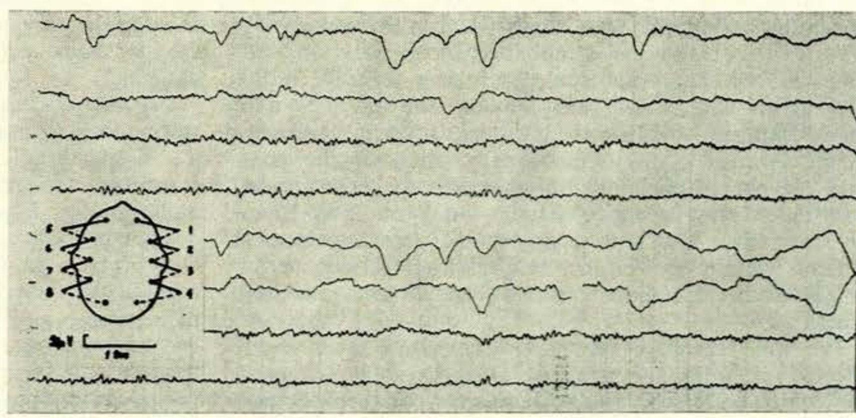

Fig. 3. Marasmus group I.

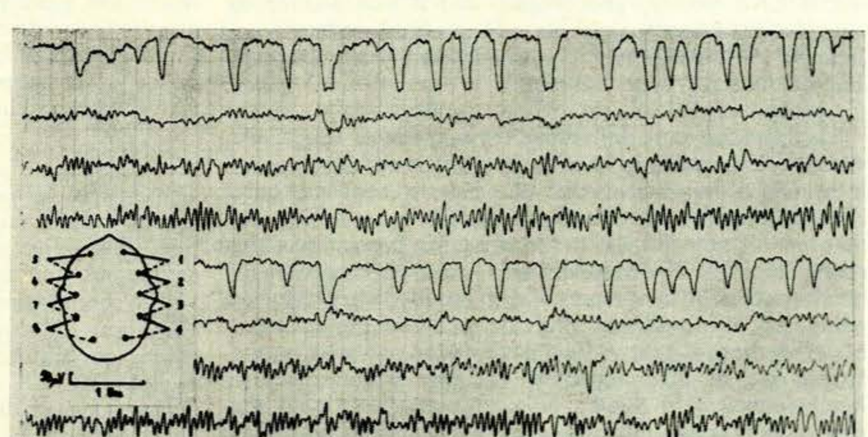

Fig. 4. Normal control group.

DISCUSSION

The most interesting finding concerns the 8 marasmic children who had theta-dominant activity. They differed significantly from the other marasmic children and the control group in that they had a low alpha index and a low intelligence score.

The ontogenetic sequence of the[6] development of cortical rhythms is from delta to theta to alpha. The factors involved in this maturational sequence are not fully known. There are wide variations within each age-group, but Henry,[7] in a study of normal children, found that stabilization of frequencies at 9 - 11 c.p.s. occurred most frequently at the age of 8 years. Whereas it is true that the 8 immature marasmic records were those of children who were among the youngest in the group, all were above the age of 8 years, and the groups were carefully matched for age.

The only other correlation known was that found by Weinbach,[8] who thought that EEG maturation correlated best with brain weight.

CONCLUSION

This study seems to confirm the hypothesis of Nelson that the EEG rhythms are retarded by early undernutrition. It is likely that the 8 marasmic children have not completed the maturational development from theta to alpha as have all the other children in the series. Whether and when this will be accomplished can only be determined by a further follow-up study.

SUMMARY

The EEG findings in 20 children who had marasmus in infancy are presented and the records are compared with a control group.

The role of infantile nutrition in the maturation of the electroencephalogram is discussed.

We are grateful to Prof. P. Smythe and Dr M. B. Stoch for making their subjects available to us.

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