33 Nutrition and the brain

Summary

Under-nutrition can adversely affect brain development of the foetus or in the first two years of life. Restoration of good nutrition can partly reverse these adverse effects in the first two years. Some components of food are precursors of chemical neurotransmitters or signals in the brain. Alcohol abuse can adversely affect the brain of adults and of the unborn child. Some non-nutrient chemicals in food might adversely affect brain function, but assessment of this problem is difficult.

Effects of under-nutrition

Amongst poor children, the shorter perform less well on tests of intellectual function; this also appears to apply when socio-economic factors are considered. Since nutritional status relates to stature, it seems likely that it is also related to intellectual performance. The adverse effects of nutrition on intellect appear possible either during intra-uterine development or in the first two post-natal years.

Is it reversible?

Variably nourished Korean children (malnourished, marginally nourished or well nourished) who were adopted by North Americans after the first year of life, but before their second birthday, have been studied. The period of malnutrition as well as the initial period of nutritional rehabilitation in North America took place before the end of the brain growth spurt. The most rapid period of brain development is from mid-gestation until sometime in the second post-natal year. By the age of seven, there was no significant difference in intelligence quotient (I.Q.) between the children from the malnourished and marginally nourished groups (mean I.Q.s of 102 and 106 respectively), but the previously well-nourished children had significantly higher I.Q.s (112). Thus, as far as I.Q. is concerned, any nutritional effect may not be completely reversible. 'Achievement' in school grades was also assessed and, in this respect, all three groups performed similarly at seven years.

Food supplement studies during pregnancy in Mexico and Guatemala indicate that maternal nutrition is important for mental development in early life. A maternal iodine deficiency, associated

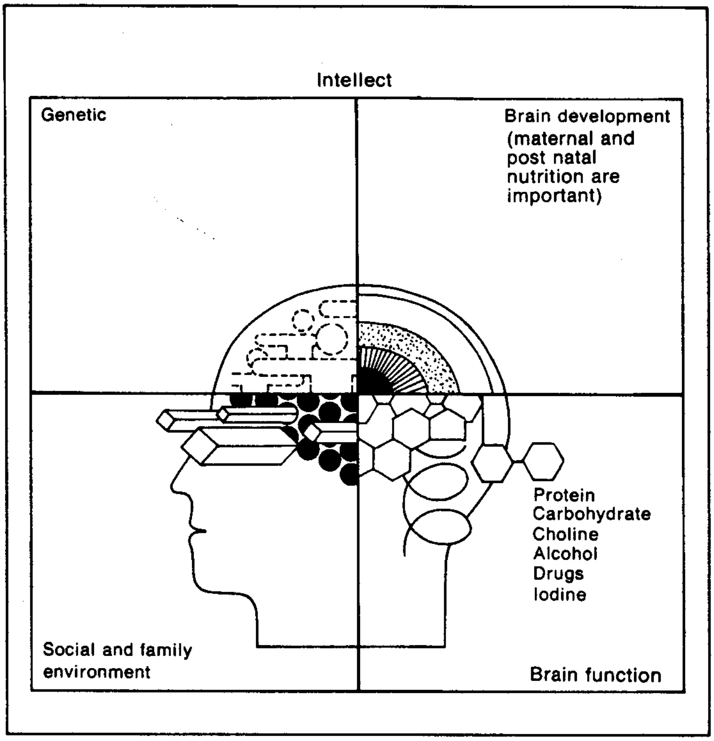

Figure 33.1 Intellect will ultimately depend on genetic factors, factors affecting brain development and function and on social and family environment; nutrition can affect brain development and function

with goitre, can lead to cretinism. In cretinism there is both growth and mental retardation from which there is never complete recovery.

Diet and brain function

There are broadly two ways in which components of food could influence brain function. The first would be by influencing the metabolism of nerve cells and the second by influencing neurotransmission, which is the process whereby one nerve cell (neuron) communicates with another by liberating a chemical substance known as a neurotransmitter. Neurotransmitters are formed from precursors obtained from the diet, such as amino acids. There can be meal to meal variations in neurotransmitters in the brain.

Acetylcholine is a neurotransmitter, and its levels in the brain can be low in certain clinical conditions (for example tardive dyskinesis, a disorder of movement). It is possible to replete acetylcholine in these conditions by an increase in dietary choline and produce beneficial effects in patients with this disorder. Lecithin is a source of choline (see chapter 17, Lipids and chapter 6, Food Faddism). This does not mean that where acetylcholine levels are normal additional choline will make them 'better than normal'. Erroneous thinking of this kind can lead to 'food faddism' (see chapter 6, Food faddism).

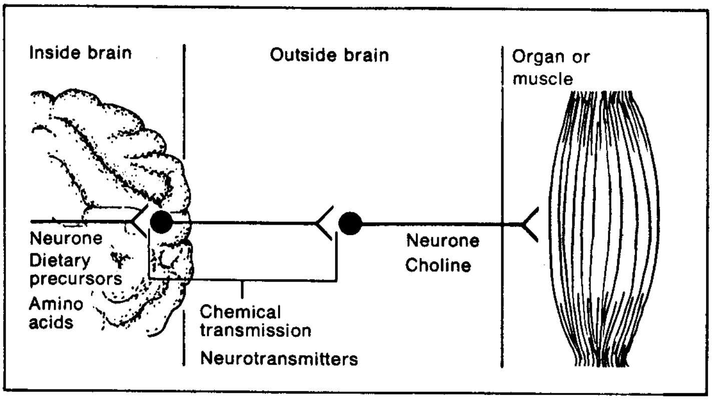

Figure 33.2 The transmission from one nerve cell to another and to organs such as salivary glands and muscle is effected by chemicals known as neurotransmitters; diet may change neurotransmitter levels

The nerve cells themselves derive their energy from blood glucose except in prolonged starvation when keto-acids contribute more and more to brain energy (see chapter 13, Metabolism). When the blood glucose drops suddenly (hypoglycaemia), nerve cell function deteriorates and consciousness can be lost (see chapter 15, Carbohydrates). In healthy people this is never a problem because the kinds of foods they eat allow a smooth rise and fall of blood glucose and, when the blood glucose tends to drop excessively, insulin-antagonists counteract this phenomenon.

Effects of alcohol

It has been known for some time that with alcohol abuse, the brain can actually get smaller. The implication has been that its functional mass might be less. More objective documentation of this process has been possible with the advent of a sophisticated X-ray technique known as 'computerized axial tomography' (CAT scanning). With this technique it has also now been possible to show that the process is partly reversible if alcohol abuse ceases.

Alcohol can affect various parts of the nervous system—the brain, the brain stem and the peripheral nerves—as discussed in chapter 23 on Alcohol.

Effects of other food toxicants

The possibility that chemicals that are not nutrients in food (i.e. chemicals which do not provide energy or are not essential to life) might cause brain damage or behavioural disturbances has received much attention in recent times.

In particular, the idea that certain food additives and naturally occurring chemicals might lead to 'hyperkinesis' has been promoted by Dr Ben Feingold (see chapter 34, Food allergies).

Although the brain has an immune or defence system dissimilar to the rest of the body, and incompletely understood, the suggestion has been made that immune reactions take place in the brain as a result of ingestion certain chemicals in food, hence the notion that food allergies lead to disturbance of brain function. There is no evidence at this stage that such reactions do take place in the brain. Although it was reasonable to ask whether particular chemicals could in any way affect the brain, efforts to legitimize particular claims by reporting to have a mechanism are not helpful to rational scientific analysis of the matter.

Further reading

DOBBING, J. 'Nutrition and Brain Development', chapter 44 in *Nutrition Review's Present Knowledge in Nutrition.* Fourth edition. Edited by D. M. Hegsted, C. O. Chichester, W. J. Derby, K. W. McNutt, R. M. Stalbey and E. H. Stotz. New York, Nutrition Foundation Inc., 1976.

FERNSTROM, J. D. and WURTMAN, R. J. 'Nutrition and the Brain'. Chapter 4 in *Human Physiology and the Environment in Health and Disease, Readings from Scientif American.* Edited by A. J. Vander. San Francisco, W. H. Freeman &Co., 1976.

Questions

1. How important do you think the relationship between food intake during pregnancy and in infancy might be for the mental development of young Australians?

2. If insulin decreases the blood levels of branched chain amino acids and thereby increases the ratio of tryptophane to branched chain amino acids, the uptake of tryptophane by the brain will increase. The level of free tryptophane in the brain determines the rate of synthesis of serotonin, a neurotransmitter, which affects alertness. What situations do you know where blood insulin concentrations might be raised and which might, therefore, influence alertness?

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