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RAISING I.Q. THROUGH VITAMIN AND MINERAL SUPPLEMENTATION: AN INTRODUCTION

H. J. EYSENCK
Institute of Psychiatry, University of London, London SE5 8AF, England

Summary—This short paper introduces a number of reports of studies which lend support to the hypothesis that many children in the U.S.A. and the U.K. suffer from vitamin and mineral deficiencies which keep their I.Q. below optimum level, and that suitable supplementation can help them approach that level more closely.

It is well known that a low I.Q. prevents many children from reaching a satisfactory scholastic level, or achieving a reasonable standard of living (Eysenck, 1979). Many attempts have been made to raise the I.Q. of under-privileged children, but these have had little success, and where success has been claimed, it has usually been due to fraud and deception (Spitz, 1986). These attempts to use educational means have usually resulted, where genuine, in increases which were small and temporary. There has been a notable failure to realize that it is the brain which enables us to think, learn, remember, solve problems, and generally deal with cognitive processes, and that the brain is a physical entity, needing nourishment and stimulation. The possibility needs at least to be considered that there may be *biological* ways of improving brain function, including giving the brain additional nourishment to enable it to function at an optimal level (Lloyd-Still, 1976).

What is at issue here is not severe malnutrition, such as Kwashiorkor, practically unknown in countries like the U.S.A. or the main European countries, Canada, Australia, etc. It is possible to have a perfectly adequate diet as far as calories are concerned, and yet to lack essential vitamins and minerals. Beriberi, a disease endemic in eastern and southern Asia, and caused by a dietary deficiency in thiamine, is one example. Scurvy and Vitamin C is another. It seems at least possible that even with what is usually regarded as a more or less adequate diet, some components essential for optimal mental functioning might be missing, even though many studies have indicated that inadequate pre- and post-natal nutrition may have a negligible effect on I.Q. (except in the most extreme cases) (Rutter & Madge, 1976; Stein, Susser, Saenger & Marolla, 1972).

There is a steady trickle of papers, from the early days of Harrell, Woodyard and Gates (1955) to the recent work of Benton and Roberts (1988) and Schoenthaler (1991), which provided evidence for such an hypothesis. Thus Harrell *et al.* showed that in New York City women of low socio-economic status, who were given vitamin and mineral supplements during pregnancy, had children who, at 4 years of age, averaged 8 points higher in I.Q. than a control group of children whose mothers had been given placebos during pregnancy. Benton and Roberts and Schoenthaler found similar improvements in children directly administered the additional vitamins and minerals.

Criticisms, many of them justified, have been made, particularly of the earlier work, but these cannot completely destroy the evidential value of all that has been done. There remains a strong probability that many children (and adults, too!) suffer from specific deficiencies which lower their general cognitive level, and which would be remedied by suitable supplementation, either (preferably) by improving their diet, or else by using pills containing the necessary vitamins and minerals. What was required was, of course, a really convincing study to settle the question once and for all, large enough to allow several levels of supplementation to be studied, well enough controlled to avoid damaging criticism, and with a built-in replication to satisfy any remaining doubts. The present set of papers records the results of such a study, specially undertaken to throw light on what is regarded as an important social and scientific problem.

The study took its origin from a TV programme broadcast in January 1988 in the BBC science series Q.E.D., entitled: "Your Child's Diet on Trial". The programme reported on the work of Benton and Roberts (1988) and Schoenthaler (1991), concluding that some children in Britain were significantly malnourished, and that their poor diets might be adversely affecting their behaviour and academic performance. (Schoenthaler had shown that, in addition to lowering I.Q., vitamin

and mineral deficiency also had an adverse impact on behaviour, increasing aggressive, impulsive and anti-social behaviour.) The programme had a very strong impact, and produced much controversy. However, its main effect was to interest the Dietary Research Foundation (DRF), a private charitable foundation owned by Graham Aaronson, Q.C., a leading financial lawyer in London. He considered the debate thus opened up so important that he was prepared to back further studies to the tune of over half a million pounds.

Professor S. Schoenthaler was asked to carry out the research, and a Scientific Directorate was appointed to supervise the work, assist in formulating the format and methodology, and control the analysis of results. The Directorate consisted of Professor Linus Pauling, double Nobel Prize-winner, representing biochemistry; Professor John Yudkin, well-known nutritionist; Professor Eric Peritz, eminent Israeli statistician; and myself, representing psychology. The American study, led by Professor Schoenthaler, was to be duplicated in Great Britain under the guidance of Dr Dov Tamir, M.D., a leading Israeli pediatrician. The study was to be double-blind, and results would be analysed by Professor Peritz. We met three times, twice at Leeds Castle near London, and once in San Francisco, to discuss plans, results, and publication. This Special Issue of *Personality and Individual Differences* is the outcome.

The Issue has four parts, apart from this Introduction. The first part contains brief summaries of earlier studies, published and unpublished, by Professor Schoenthaler, to set the scene; his earlier work is important in making clear the questions asked, the problems encountered, and the results obtained which helped to direct our attention to the most likely methodology to give positive results. Those articles which had been published appeared for the most part in Journals not easily accessible, at least to European readers; it seemed worthwhile to make them, and those not published, available in this form.

The second paper precedes in point of time the Dietary Research Foundation studies, but constitutes an important introduction which throws light on the effects of supplementation of brain functioning, as well as on I.Q. and behaviour. The third paper reports the main results of the American study. Finally, in the fourth paper Professor Yudkin summarizes the general outcome of the experiment in the light of nutritional science. That completes the account of what has been a very complex series of of studies, hopefully readers will agree with our unanimous view that we have succeeded in providing convincing evidence that it is possible to raise I.Q. levels *substantially* in a large group of children who were not undernourished in any obvious sense, and whose eating habits would not have been thought to be unhealthy. This conclusion is well in line with Linus Pauling's repeated statements to the effect that humankind is suffering from severe under-nourishment as far as vitamins and minerals are concerned. On the other hand, Professor Yudkin and I were from the beginning rather sceptical, doubting very much whether any positive results would be achieved. The outcome has convinced both of us that such scepticism is not appropriate any longer; it is clear to us that much can be achieved by suitable dietary supplementation.

A few words may be apposite concerning future research, and regarding the social and scientific implications of our findings. We believe that we have shown that a reasonably random selection of school children in Great Britain and the United States contains a sizeable number whose I.Q. can be raised through supplementation, compared to a control group, by some 11 points of I.Q. Such responders are presumably characteristic by an initial vitamin/mineral deficiency; non-responders presumably already have all the vitamins and minerals required. Optimum results were achieved with supplementation equal to the 100% RDA (recommended daily allowance); 50 and 200% RDA were less effective.

It will be obvious that these findings raise numerous complex and difficult questions. The supplementation followed the shot-gun principle; numerous vitamins and minerals were included. Were these all necessary, or only some? Did they act singly, additively, or synergistically? Is dietary deficiency general or specific? Is the 100% RDA dose optimal for all responders, or only some? Are there other vitamins or minerals that ought to be included? These and many other problems will give ample occasion for many more inclusive and detailed researches in this field; we have clearly raised more questions than we have settled. That, of course, is the usual fate of scientific advances; once the floodgates have been opened, much new knowledge is likely to repay those who follow. But it is important to stress the severe limitations of our knowledge; we know that something important is happening, but we do not know precisely what it is.

Other problems raised but not answered concern such questions as:

(1) Are the effects age-restricted, i.e. do they occur only with young children, or are they applicable at any age?
(2) Is there an optimum age when supplementation has maximum effect—pre-natal, neo-natal, babyhood, or what?
(3) Can supplementation counteract the effects of old age, or even Alzheimer's disease (Deary, Hendrickson & Burns, 1987)?

These are questions concerning the range of likely effects which demand an empirical answer.

A final set of questions concerns the precise nature of the cognitive functions which are affected by nutritional supplementation. We believe that we have been able to show that supplementation affects only non-verbal ("fluid") intelligence, not verbal ("crystallized") intelligence. This is as hypothesized; supplementation is unlikely to affect material learned in the past. But the taxonomy of intelligence has a finer grain than that (Eysenck, 1979), and it is possible that more specific relations may be observed between the many different factors discovered by factor analysis, and specific nutrients. Clearly, experiments planned on a much larger design than ours would be needed to answer questions of this kind.

Most important in this connection, perhaps, would be a study of the connection between the biological determinants of brain function in the form of vitamins and minerals, and the actual functioning of the brain as determined by behavioural measures like EEG, averaged evoked potential (AEPs), and positron emission tomography (PET scan). These constitute the fundaments of the "new look" in intelligence measurement (Eysenck, 1982, 1985; Eysenck & Barrett, 1985), and give us some leads to the brain function underlying I.Q.

What are the social and scientific consequences of our findings? The social ones will be most obvious. The "underclass" growing up in ever increasing numbers in both the U.S.A. and the U.K. is characterized by a mixture of low I.Q. and poor school performance; it seems likely that children growing up in that culture will be particularly at risk as far as nutritional deficiencies are concerned. For them supplementation increasing their mental performance by an average of 11 points would constitute a lifeline, enabling them to perform adequately at school, acquire competence in reading, writing and arithmetic, and thus take up reasonably well-paid jobs upon graduating. The possible improvement in behaviour demonstrated in several of Schoenthaler's studies to follow supplementation would also be of considerable help in rescuing such children from becoming members of the underworld.

Of course the "underclass" is not alone in providing likely samples of malnutrition in our sense; the children used in our studies were normal, average children whose parents did not belong to any "underclass". Thus great improvements could also be produced in the general population by suitable supplementation, always remembering of course that not all children would benefit (although none would be harmed). The national need for highly intelligent students, doctors, engineers, lawyers, politicians and other professionals, as well as for an intelligent and highly trained work force would be better met by a new generation of children growing up without being hindered in their intellectual development by dietary deficiencies.

The obvious advantages within our common cultures are paralleled by those which might ensue if Third-World countries, particularly African, could be liberated from the vicious circle of hunger and deprivation which is so characteristic of their present state. They more than any other group are likely to provide "responders", i.e. children whose mental development was held back because of malnutrition, and who might thus show spectacular increases in I.Q. upon receiving supplementation. It seems possible that the large racial differences in I.Q. so often observed (Eysenck, 1984) could be eliminated in large measure, or even completely, by such dietary aid. Ideally of course this would be accomplished by providing a more adequate diet, but in practical terms this would be prohibitively costly, and supplementation by pills would appear more realistic. The cost would be relatively small, and the beneficial effects incalculable.

Mankind has for long sought for means of reducing the inequalities in endowment so characteristic of mental abilities; dietary supplementation would seem ideally suited to fill this role. It seems most likely to benefit those deprived of proper nutritional balance, which world-wide means the poor, the down-trodden, the victims, the losers. Those at the top might also benefit, but

probaby much less so as a class. Supplementation would not actually benefit the victims of starvation, whose main need is of course food. But fortunately the numbers actually starving is relatively small compared with the number of those suffering from specific dietary deficiencies. How such aid can be provided is of course a political, not a scientific question, and the answer must be left to politicians.

As regards the scientific consequences of our findings, these are numerous. In the first place, it seems clear that these results strengthen the *biological* view of intelligence, namely the view that cognitions are the product of the brain cortex, and that the constitution and nourishment of the cortex, and the brain as a whole, are vital elements in contributing to intelligent behaviour. Such a view does not of course disregard environmental influences such as education, professional learning, and general experience; obviously the development of intelligence is furthered and constrained by many influences (Eysenck, 1979). But "environment" has usually been construed in terms of education and similar social factors; it is time we realized that some powerful environmental factors may be biological in nature, with direct results on brain functioning.

To take but one example, the increases in I.Q. consequent upon adoption, averaging around 10–12 points (Locurto, 1990), are usually ascribed to better education, more mental stimulation, and other social factors; our findings raise the possibility that the effect may be a simple function of better nutrition. There has been little interest in this possibility hitherto; it certainly should be looked at in the light of our findings.

Another area which might benefit from a new look would be the nature–nurture controversy. The "nurture" side usually cites as likely causes of higher I.Q. such factors as early upbringing, social interaction with parents, education and the like (Storfer, 1990); nutrition is seldom if ever mentioned. But if our results are correct, the influence of nutrition may be much larger than that of the social factors mentioned. Future studies would certainly have to bear this in mind. Environmental factors of a biological kind (intra-uterine events, ante-natal nutrition, post-natal vitamin and mineral deprivation) may be far more instrumental than those of a social kind, whether acting in isolation or producing complex interactions.

A final example. Flynn (1984, 1987) has shown that tested I.Q. has shown a massive rise over the past 50 years in 14 European and American nations. How can this be explained? Lynn (1990) has suggested that improved nutrition may have been the crucial factor, and our own results certainly support this view quite strongly. They also suggest that additional average rises of up to 4 points or so are possible if we brought up the standard vitamin and mineral intake to nearer optimal levels. For Third-World countries, as already mentioned, such an increase might be significantly larger.

A last point that requires discussion is the degree to which our findings are limited by our methodology. It would be quite wrong to claim, for instance, that we have discoverd the "optimal" dose for I.Q. improvement. We have used RDA doses (50, 100, 200%) to compare for effectiveness, but of course RDAs are fairly arbitrary—thus American values are much higher than British ones, for example! There is no obvious reason why RDAs established on the basis of maintaining reasonable levels of physical health should be relevant to mental efficiency; quite likely they are not. The "optimal" level for one specific vitamin or mineral may be quite different from that for another; our shot-gun approach does not enable us to say. Furthermore, the "optimal" dose for a person depends, of course, on his habitual uptake, which may vary for the different constituents of our pills. We can say that for children reasonably similar to those studied by us, with similar dietary habits, an RDA dose of 100% gives the best results, but for deprived children an RDA dose of 200% might give better results. There is here a large area of uncertainty, inevitable of course near the beginning of research into this complex field. Nevertheless, it is essential to stress the fact that such an area of uncertainty exists.

Clearly many children receive what appears to be an adequate diet as far as mental functioning is concerned; thus not all children will be "responders", only some 40% will benefit from supplementation. Responders might be discovered by complex analysis of blood samples, but that is probably not practical for the majority. At the moment the best policy would seem to be to administer a 100% RDA dose to all children, knowing that for a large minority there will be little if any effect on I.Q. The future may suggest better ways of arranging these matters.

We do not know how long the effects of such short-term administration as we have used may last. It seems likely that within a few months the effects will be reduced very much, possibly to nil. Perhaps life-long supplementation is required to ensure lasting effects; here again is an area where research is urgently required. For the moment, we just do not know. Replication and extension of our work are obviously needed; clearly supplementation is an important issue, and much careful work will be required before we know the answers to the many questions which remain.

One final point. It should not need to be said, but may nevertheless be useful to add, that members of the Scientific Directorate have not gained any personal financial benefit of any kind as a result of their activities, and that none of them are in any way concerned with the marketing of any vitamin or mineral supplements, on the market now or in the future. Our concern is exclusively with the scientific issues; practical, social and political problems are for others to solve.

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