A Critique of Nutritional Recommendations

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The Orthomolecular approach to medicine has been under constant criticism ever since its origin. One cause for this may be the somewhat conflicting experimental results, but I suggest that an even more important reason for the lack of acceptance results from the traditional conceptual approach towards nutrition. Understanding the nature of this conceptual hindrance may be relevant for the Orthomolecular school in arguing for the general acceptance of the "optimal intake" approach.

The traditional approach towards nutrition is illustrated by the influential Recommended Dietary Allowances (RDA). In my opinion RDA also reflects widely accepted attitudes among people, who do not have any primary acquaintance with these recommendations. It seems reasonable to familiar-ize oneself with the basis for RDA to understand the limitations of the traditional approach.

The RDA levels of intake of essential nutrients are considered "to be adequate to meet the known nutritional needs of practically all healthy persons." (RDA, 1980, p.l). However, "nutritional need" is a vague concept and it is not defined in more detail by the RDA. The concept of "nutritional need" gives the false impression that specific amounts of nutrients are required daily, which is not the case.

There is a balance in the body: all that is ingested is metabolized to other chemical forms or is excreted unaltered from the body in the long term. Larger intakes of nutrients cause faster metabolism and/or excretion. What is important, however, is that the concentrations in the body depend on intake. Larger intakes cause higher steady state concentrations. The concentrations further determine reaction rates and how the body functions.

The lack of a biochemical basis for "nutri-tional need" may be understood even better by considering the physiological roles of essential nutrients (Hemila, 1984). For example, they may function as cofactors of enzymes or they may participate in nonenzymatic reactions.

A number of enzymes, but not all of them, need cofactors in order to be active. Especially the B-group vitamins are transformed into cofactors in the body. A cofactor (C) binds to an inactive apoenzyme (E) and

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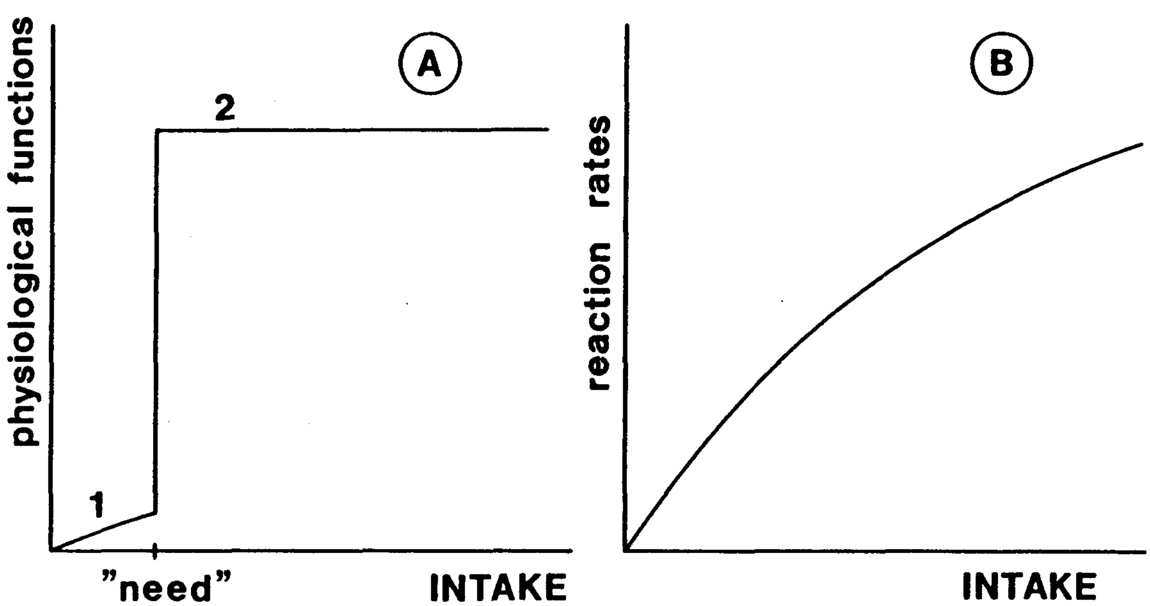
causes the formation of an active holo-enzyme (E-C):

C + E = C-E. The percentage of an enzyme in the active form (E-C) is determined by the concentration of the cofactor, as is well known from the theory of chemical equilibria. This kind of cofactor binding is a specific case of the general ligand binding phenomenon. In addition to the change in the equilibrium, the cofactor may affect the total concentration of an enzyme. For example there are proteases, which degrade specifically only the inactive apoforms of certain Pyridoxine enzymes (Katunuma, 1977). Degradation of the apoform amplifies the effect of a cofactor on the enzyme activity, as both the total amount of an enzyme and the percentage in the active form change at the same time. The maximal activity of an enzyme is limited by the total enzyme concentration, but maximum (i.e. total saturation) is approached smoothly as the cofactor concentration increases. As an example of nutrient effects on enzyme activity, thiamine and riboflavin intakes affect the activities of erythrocyte transketolase and glutathione reductase, respectively (Aebi, 1982). The changes in enzyme activity caused by cofactors (or nutrients) occur smoothly and hence there is no specific concentration or amount of nutrient which could reasonably be interpreted as the "need" at the biochemical level.

Nutrients may also participate in non-enzymatic reactions such as the reactions of ascorbate with superoxide, histamine and nitrite (Basu and Schorah, 1982). For example the reaction of ascorbate with superoxide is of great interest as superoxide is produced by phagocytes in order to facilitate the killing of bacteria and viruses. However, superoxide production is also supposed to participate in inflammatory processes. Higher ascorbate concentration may cause more effective protection against the pathological effects of superoxide by decreasing its steady state level in extracellular medium (Hemila, Roberts and Wikstrom, 1984). The relationship between reaction rates and amounts of intake shows a gradual rate of change and hence choosing some level as the "need" is also arbitrary in the case of non-enzymatic reactions (Fig. 1).



A) The idea of an exact "nutritional need" suggests that sharp changes in physiological functions would occur between deficiency (1) and normal health (2).
B) In reality the rates of biochemical reactions change smoothly as a function of intake and hence choosing a level of "need" appears completely arbitrary.

Figure 1.

To know the effect of a nutrient concentration on particular reactions one needs data relevant for the specific case. However, in general the metabolic functions of nutrients clearly depend on the concentrations and intakes, there being no fixed levels which would accurately correspond to specific "nutritional needs." Accordingly, the principles of biochemical reaction kinetics have not become integrated in the traditional approach towards nutrition.

There is an interesting resemblance between the "nutritional need" and the "vital force", a term used to describe the supposed mystical properties of living things that were not explicable by physical and chemical principles. Both of these concepts may be apparently useful at the systemic level, but neither of them has any validity at the biochemical level. Clear thinking requires precise concepts, and the concept of "vital force" has indeed been discarded from serious scientific discussion long ago. The use of "nutritional need" should similarly be discouraged because of its false implications and the lack of an interpretation at a deeper level.

Belief in the fictional "need" has important consequences within the study of traditional nutrition. At the physiological level an inevitable result is the "magic bullet" attitude towards vitamins: vitamins are cures for specific deficiency diseases and there is no benefit from more vitamins if there is no deficiency. The naivete of this kind of reasoning is clearly seen from the previous discussion of the smoothly occurring changes in reaction rates in the body caused by changes in nutrient amounts. Yet the recognition of the conceptual limitations of traditional nutritionists makes it easier to understand the often very unjust and sometimes even irrational criticism of the Orthomolecular approach. Experimental evidence can always be criticized at least by *ad hoc* arguments if the results strongly disagree with the accepted conceptual model, which is in this case the idea that vitamins are needed only for the prevention of deficiencies.

In addition to the "nutritional need" and the corresponding general approach, further criticism can be levelled at the RDA. Several points of criticism are, however, due to the general approach such as the artificial and misleading labeling of large intakes of nutrients as "pharmacological", which suggests that there would be a major difference between a normal and a large intake. In fact the reactions are the same, but only the rates of reactions depend on the concentration in the body and the level of intake.

In contrast to the case of "nutritional need" there is a definite biochemical basis for the notion of "optimal intake" (Pauling, 1968; Hemila, 1984). Change from deficiency to toxicity results from a gradual increase in the concentration and the reaction rates of a nutrient in the body. Somewhere between these extremes there are optimal concentrations and rates of reactions, which correspond to the best possible health. Optimal concentrations are maintained by optimal levels of intake. Optimal amounts may be expected to vary between different individuals because of their differences at the biochemical level (Williams, 1956). Furthermore, within an individual, disease and other factors may change the biochemical reactions in the body and may accordingly change the optimal levels of intake.

The "optimal intake" approach is biochemically sound as it recognizes that the metabolic functions of the body depend on the amount of of nutrients. Yet the optimal amounts must be determined from criteria at a higher level of physiology, because "health" is a notion which has meaning only at the systemic level. Thus, relevant data may be obtained from clinical and epidemiological studies or in the case of an individual by the trial and error method. The terms "Orthomolecular" and "optimal intake" are preferable to the term "megavitamin". "Megavitamins" immediately suggests the idea of "the more vitamins the better", which is certainly not true when passing the optimum level. This leads to misunderstandings.

There seems to be a deadlock in the discussion of the value of the Orthomolecular approach. Advocates may claim that "vitamins are useful" and opponents strongly disagree. Of course, the attitude of opponents is rational within their "magic bullet" framework that states that vitamins are only required for deficiencies. The controversy in nutrition very much resembles the historical

examples of crises in science described by Kuhn (1970), who points out the difficulty if not impossibility of understanding the trains of thought on the opposing sides of the gulf. However, understanding the conceptual reasons for resistance makes it possible to put forward more effective arguments when advocating the optimal intake approach. In addition to discussing the experimental evidence, I suggest that a scholarly and well-formulated critique of traditional approach (e.g. RDA), as pointing out the false ideas concerning the dose-effect relations of nutrients, may be useful in convincing more people of the soundness of the Orthomolecular approach.

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