The Effects of Nutrition, Diet and Biochemical Factors on the Etiology of Learning Disabilities: A literature Review

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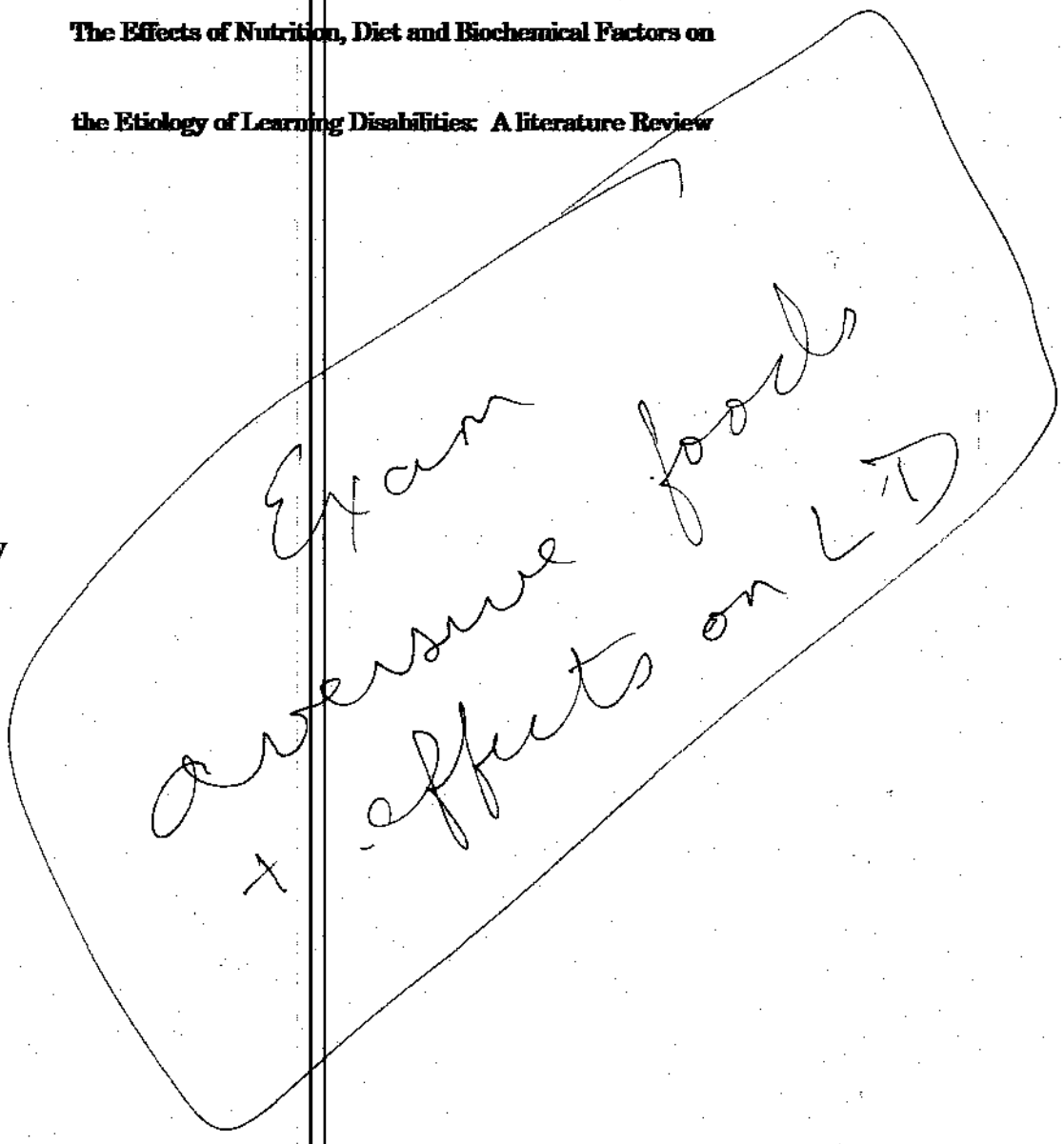

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1.0 Introduction

Orthomolecular medicine theorists believe that nutrition, diet and biochemical influences are important factors in analysing the etiology of learning disorders. Literature covering this broad spectrum is copious and medically based. The theorists assert that augmenting the concentration of essential nutrients in the body will treat chemically caused mental disorders(Pruess *et al*, 1989). Much of the research has occurred in the last fifteen years and is challenged by traditional medical theorists, creating an ongoing dialogue(Hui, 1985).

Some of the recent major writers in the area are reviewed and their views are summarised. Included are Feingold's hypotheses, views on allergies and their effects on hyperactivity and behaviour, theories relating sugar consumption and hypoglycemia to learning disorders, and the megavitamin debate. Effects on behaviour and learning of trace elements and toxic metals, and nutritious versus malnutritious diets are also examined.

Evidence from research studies is summarised in relationship to these topics and to learning disorders to demonstrate strengths and weaknesses in the arguments. Finally, some difficulties in conducting the research are noted.

2. The Biochemical Link

Baker (1985) has emphasised the importance of nutrition to learning disorders in his assertion that "the widespread imbalance of the biochemistry of young people ... created by the consumption of altered, adulterated, sweetened, fatty, and refined foods makes the biochemical issue of at least equal importance to the psychological."(p. 581)

This viewpoint is buttressed by Bradfield and Fones (1984) who have demonstrated that even special education teachers themselves represented by a sample of forty one, risk susceptibility to emotional stress and 'burnout' from poor dietary habits, eating foods deficient in fibres and

vitamins and excessive in fats and proteins. With teachers as poor models, their students could be expected to follow similar maladjusted eating patterns.

Fishbein and Meduski (1987) argue that nutrition is directly related to learning disorders because dietary constituents are related to brain functions. Excesses or deficiencies of diet affect the central nervous system and behaviour. They note that behaviour, mood, emotions and cognition may be controlled by ingesting certain types of food. These foods increase certain levels of neurochemicals, being the chemical messengers at axon terminals. Restricting certain foods reduces undesirable levels of neurotransmitters. Acetylcholine, for instance, is a neurotransmitter responsible for memory and learning and is made from choline found in fish, poultry and eggs. A deficiency of this neurotransmitter interferes with learning.

The theorists believe that the presence of certain chemicals in the bodies of susceptible or sensitive individuals from ingestion of certain foods, or diets may cause behavioral disturbances, depression, irritability, violence, irrationality, hyperactivity, and impaired mental functions. Individuals may be treated as intellectually impaired due to marked deficits in reading, writing, language and mathematical abilities. Delinquency or criminality may be long term consequences. Treatment is one of dietary modifications. Fishbein and Meduski (1987) urge practitioners to apply nutritional regimens as well as therapy, since good nutrition may improve behaviour and responsibility.

3. The Feingold Diet

The connection between diet and behaviour was popularised in the early 1970's by a doctor, Ben Feingold, who noticed the allergic reactions of some of his patients to aspirin. Noting the natural presence of salicylates in certain foods, he generalised that allergic reactions with symptoms such as hyperactivity may be caused by consuming artificial additives and flavours in foods as well as salicylates(Feingold, 1976). Allergies were grouped into three classes. People in the group I category suffered hyperactivity, compulsive aggression, impulsiveness, lack of patience and poor sleep habits. Group II experienced lack of gross and fine motor coordination. Group III demonstrated cognitive and perceptive disturbances. IQs were normal but the children failed with boys affected seven times as often as girls. Age influenced the speed and

degree of reaction.

Feingold (1976) stated that children experiencing difficulties with learning in school who followed a Kaiser Permanente (K-P) diet eliminating these chemicals "showed a marked adjustment to the classroom environment and rapid improvement in scholastic achievement"(p. 555). Hyperactivity, aggression and impulsiveness were reduced, followed by better coordination, improved hand writing, drawing, speech and loss of clumsiness. Disturbances in perception and cognition also disappeared. Children between 5 to 12 years required ten to fourteen days of dieting to show improvements. Feingold (1976) found that thirty to fifty percent of his learning disabled children showed improvements. Infractions in the diet caused behavioral disturbances which lasted from one to four days.

Feingold's research was anecdotal in nature, based on clinical observations. He found his research was complicated because individual reactions were idiosyncratic, varied over time and could not be predicted either for speed or degree of response. It was also impossible to predict who would respond. The diet was demanding in food preparation since it eliminated many prepared foods such as manufactured baked goods, luncheon meats, ice creams, candies, soft drinks, tea, coffee, and fast and restaurant foods. Consequently the diet involved all family members. The diet itself was nutritious and safe(Feingold, 1977).

Early studies supporting the Feingold's clinical research have been criticised by Spring and Sandoval (1976) for failing to define and operationalise the concept of hyperkinesis for careful measurement. Measures were global rather than specific. Scholastic ability was never carefully defined or measured. Nor was attention span defined. The studies failed to use control groups or to hide treatments with a double blind design.

With extensive publicity, the theory was popular because it allowed parents to blame the food industry for their children's behaviour. There was also a readiness of the public to fear chemical additives, and contamination and to be disposed favourably towards a theory restricting artificial substances.

Impressions of school achievement were easily altered to conform with expectations especially with subjective reporting. The extra work involved in the diet made parents justify the work by perceiving

improvements, as predicted by dissonance theory. Parents looked for infractions of the diet to explain poor behaviour but attributed good behaviour solely to the diet.

Because of the novelty of the diet and its demands on the whole family, family dynamics were altered causing social demands and social support for children. Such demands could alter children's behaviour without the chemical aspects of the diet being involved in the behavioral change. Such alterations are called placebo effects.

4. Research Related to Efficacy of the Feingold Diet

Substantial research of a scientific nature has been undertaken in the late 1970's and early 1980's to ascertain the merits of the Feingold diet(Smith, 1981). By 1990, the research question had been resolved and specific research located in the bibliographical index Medline came under the heading of allergies and additives, aversive effects rather than Feingold and diet.

Scientific research which occurred in the late 1970's and early 1980's has defined hyperactivity operationally, and randomly selected children for the diet. Other advances included switching them to the control diet (reversal or cross-over), and limiting knowledge of whom was on what diet, a process called double-blinding(Spring and Sandoval, 1976). Objective behavioral data was collected with each child acting as his or her own control.

The American Council of Science and Health as a result did not believe that artificial colours, additives and salicylates caused hyperactivity and did not recommend a restricted diet(Smith, 1981). The American National Institute of Health reported a "limited positive association between the 'defined diets' and a decrease in hyperactivity"(Silver, 1987, p. 58).

Other research (Silver, 1987; Lipton, 1977) shows that the diet is effective with approximately one to two percent of hyperactive children. As Grossman (1981) noted, researchers selected only hyperactive children who responded to the diet and challenged a subsample of this subsample. Then, only a small subgroup responded, a third order subset of all children. He concluded that the diet played a minor role in

hyperkinesis. It was also unclear whether an allergy to food additives or colouring or to the food itself was responsible for the improvement when a food was eliminated because of the diet(Grossman, 1981; Spring and Sandoval, 1976; Arnold, 1984; Wender, 1986).

A single-subject experiment using an ABAB design with a six year old New Zealand hyperkinetic male, demonstrated the diet to be effective and nutritious although moderately difficult to implement(Burlton-Bennett, 1987). The child was selected because tests had indicated a diet responsiveness. The dependent measures included two scales (Conners Teacher Rating and Werry-Weiss-Peters Activity Scale) and classroom observation of behaviour. There were two observers with high inter-observer reliability (82% to 97%) for measures of inattention to task, moving out of seat, and inappropriate movements.

A two week baseline period on a normal diet indicated a high infraction rate with 26% attention to tasks. A three week diet demonstrated a substantial reduction in infractions with 80% on task behaviour. On a one week withdrawal, behaviour returned to the baseline level. The diet recommenced for two weeks, again with improved behaviour of 80% to 90% on task. This behaviour was maintained during a one and three week follow-up.

The Conners Rating showed more attentiveness during the diet although at a level slightly less than New Zealand norms. The mother reported an improvement on the Werry-Weiss-Peters Activity Scale.

The study is useful because it possessed a high degree of validity by using independent observers in the classroom rather than subjective rating scales. Since few hyperkinetic children respond to the diet the single subject design does not hide the subject who does respond well with those who don't.

Numerous studies using control and treatment groups, with cross-over groups and double-blind, placebo-masked treatments have failed to show improvements in behaviour from the diet. Thorley (1984), for instance, with ten retarded children, ran the diet for two weeks, then, in the second two weeks administered two high consecutive doses of artificial food colours. Measures of verbal learning, and behavioral rating scales showed no change.

Gross (1987) tested 39 eleven to seventeen year old adolescents suffering from learning disorders at a summer camp which ran the diet for one week followed by foods containing additives and artificial colourings. Children were videotaped at meals, and tapes were analysed by observers unaware of the diets, for motor restlessness, and misbehaviour. No differences in behaviour were found between weeks one and two.

Holborow (1981) involved 300 children with the diet for two weeks with 37 control children and a double blind design. He used teacher ratings from the Conners Teacher Questionnaire, measuring distractibility, attention span, fiddling and demands for attention. Ratings indicated an 8.5% improvement. Changes in foods which reduced allergies as well as the removal of dyes may have bought about improvements.

Problems with these studies are numerous. Even the best designed crossover study could not conceal when the children were on the diet. When on the diet expectations were aroused and social pressures placed on the children for a change in behaviour. Consequently later studies, called 'challenge' studies, placed all children on the diet, then challenged certain participants with the offending foods without their knowledge(Silver, 1987).

For instance, a double blind, double-cross-over study by Spring (1981) involved six hyperactive boys who were learning disabled in reading, spelling and arithmetic and who were all on the diet before the study. Their mothers had reported benefits. These boys were secretly challenged with cookies containing synthetic colours three times every second week on a double-blind basis, group 1 on weeks 1 and 4 and group 2 on weeks 3 and 6. Measures were taken before and after on the Abbreviated Hyperactivity Rating Scale and through neurological signs observation. Problems encountered included family crises which influenced ratings, and responsiveness at one time but not on replication. Spring (1981) concluded that support for the theory was equivocal with no justification for the broad claims made for the diet. He found that a very small percentage of hyperactive children may be responsive to artificial food colours.

A study by Wilson and Scott (1989) of 19 food-additive intolerant children on the diet used a similar technique in London. They employed twelve challenge drinks daily with yellow food colouring and sodium benzoate interchanged with regular drinks, double-blind and in random order. Intolerance was found in

three children with extremely abnormal behaviour in one supporting the conclusions drawn by Spring.

5. Allergies

Allergies refer to altered body reactions involving the body's immune system's intolerance or hypersensitivity and its rejecting certain substances called antigens(Miniken, 1987).

Buist (1984) has commented on the substantial advances made in allergy research since Feingold's pioneer writings of the early 1970's. This research has found that hyperactive children were often sensitive to the foods themselves rather than responsive to the additives or food colourings. Byrd and Byrd (1971) suggest that up to 46% of the population have some physical effects from allergies, with food allergies being most common.

Dr. Joseph McGovern (Buist, 1984) found 75% of hyperactive children were sensitive to petrochemical, diesel, auto exhausts, aerosols, and paints, or reacted to aspirin, dairy products, ethanol, sugars, eggs, corn, some juices or fruits, some fish, beef or mites in house dust. Hui (1984) suggests 2% to 4% of children possess milk allergies. Royster (1983) suggests that allergies are rare but are real for those possessing them. He suggests that other causes for hyperactivity should be checked such as lack of sleep, overstimulation, excessive TV, attention getting and lack of exercise.

Often the allergy is to a common food, regularly eaten in excess in an addictive way. The stress placed on the body by the food and subsequent release of endorphins makes withdrawal from the food difficult(Buist, 1984).

Rapp (1986) reports allergies to cleaning materials in schools, vinyls, pesticides, insulations, moulds, gas leaks, marking pens, glues, chalk, newsprint, perfumes, alcohol or typing correction fluids and even to fluorescent lighting and television. Pollen is a seasonal problem. Royster (1983) notes the effects of caffeine, especially on younger children as causing irritability and anxiety. Certain food additives such as MSG may be a problem.

Symptoms of food allergies included glazed eyes, red earlobes, distractibility, impulsiveness, fatigue, headaches, depression and hyperactivity(Rapp, 1986; Grohens, 1988). Byrd and Byrd (1971) suggest allergies frequently to be at the root of emotional disturbances. There were declines in children's writing and drawings, characterised by illegibility, large or tiny characters, or reversed or upside down characters. Personalities changed towards aggressiveness, characterised by biting and violence in drawings. Attention span was shortened. Speech changed to include stutters, rapid highly pitched speech or giggles. Fine and gross motor coordination deteriorated as shown by ripped paper, broken pencils and an inability to judge distances. Attitudes worsened with class outbursts and disruptions. An increased sensitivity was found to sound, and light. Ear infections often occurred disrupting hearing(Byrd & Byrd, 1971). Poor recall, weakness, dizziness, and fatigue may result from chemical sensitivities. School performance regressed. Normal children were often classified as learning disabled (LD).

In case studies of children with allergies, Rapp (1986) described a child suffering an air allergy who crawled under the desk, was vulgar, aggressive, suffered head and earaches, yet reverted to normal when the chemical smell was removed. Another child with a milk allergy was angry, screaming, irritable yet reverted to a happy playful child after treatment. A third with a mite allergy, rocked, kicked yet became quiet and calm after treatment. A fourth child with a corn allergy acted inappropriately, making animal noises, yet regained normal affect and personality on treatment. Generally, with removal of the allergy causing substance, the child became less restless, and showed improved memory, spelling and reading(Grohens, 1988).

Many single case ABAB or ABBA designed medical studies with allergic children are found in the medical literature to support Rapp's (1986) contentions. O'Banion and Greenberg (1982), for instance, found depression, headaches, irritability, hyperactivity, perceptual, learning and motor problems in a female who was sensitive to certain foods. The subject underwent changes in depression, motor and academic performance related to ingesting certain foods. Urges to eat were higher with sensitive foods.

Hyperactivity caused by intolerance to milk or wheat was shown by Trites and Tryphonas (1983) to be common and to lead to learning disabilities and emotional adjustment problems. A double-blind placebo

and treatment diet eliminating sensitive foods substantially improved behaviour in preschool-aged children.

Treatment for allergies usually involves removal of the problem substance. Behaviour at school and at home is compared to assist in diagnosing the source of the allergy. A Dr. Jekyll Mr Hyde personality, sudden decline in IQ, changes from one class to another or appearance of physical symptoms all point to allergic reactions. Diagnoses involve allergy 'elimination' diets which may eliminate single or multiple foods, rotate foods at four day intervals, or challenge the eater with problem foods(Minchin, 1987). Medical tests using skin patches and blood tests are often successful. Diagnoses are often difficult because allergic responses are individualised and learning and behaviour problems cannot be directly matched with allergies. Although a food might be blamed it is difficult to unravel the chemical analysis. An allergy to bread may be a reaction to the yeast, wheat, preservative, additives, or lack of a digestive enzyme(Rapp, 1986).

6. Refined Carbohydrates

Many nutritionists suggest that excessive consumption of refined carbohydrate foods containing sugar, such as candies, white rice and flour, soft drinks and potato chips can cause behavioral and learning disorders(Fishbein & Meduski, 1987; Grohens, 1988). Such disturbances include violence, irrationality, hyperactivity, and impaired mental functioning. Although the mechanism for changes in behaviour are unclear, excessive sugar may cause hypoglycemia, or low blood sugar limiting the brain's ability to operate correctly in producing hormones and neurotransmitters. Norwood (1984) suggests an overabundance of refined carbohydrates restricts the intake of other essential foods containing essential vitamins, minerals and amino acids.

Two Californian prison studies (Schoenthaler, 1983) examining 1,382 and 3399 juveniles placed on a restricted refined carbohydrate diet, indicated by pre to post test results, a decline in antisocial behaviour (thefts, assaults, disobedience, aggression) in both studies. The design of the study was correlational and lacked a control group. Consequently, it is impossible to determine a causal relationship.

Royster (1983) quotes similar studies with similar results but notes experimental problems such as the lack of objective measures of sugar content in food. He concludes that such theories are pseudoscientific and

suggests that hypoglycemia is unrelated to delinquency.

Other controlled studies have shown a negative correlation between sugar consumption and intelligence. Oliver (1983) in a three year double blind study with 19 students showed that a low sugar diet improved student classroom work in pre and post standardised tests as compared to 19 control group children.

Lester *et al* (1982) using regression analysis found that 184 fifteen and sixteen year old children's refined carbohydrate consumption was negatively related to classroom achievement scores. Taking into account sex, socioeconomic status and race, he concluded that eating foods lacking in nutrients contributed significantly to learning disorders.

Stein (1984) using an experimental and control group matched for reading level and grade, found that the treatment group given a low carbohydrate breakfast demonstrated twice the gain of the control group on reading tests. The influence of others foods and the Hawthorne effect may have confounded this experiment.

Silver (1987) suggests that the final answer concerning the effects of carbohydrates is unknown. He is supported by such studies as Milich and Pelham (1977) who found no consistent evidence that sugar affected the behaviour of a boy with attention deficit order. Lapp (1981) found that a high glucose meal raising blood glucose level above 130 mg/100 cc led to superior recall in a paired imagery test of 36 academically matched year 11 students. She concluded that results may reflect heightened arousal due to the removal of such distractions as hunger.

7. Megavitamin Approaches

Proponents of megavitamin therapy believe that large doses of vitamins and minerals may remedy learning disorders caused by chemical deficiencies(Pruess, 1989). For instance, the lack of vitamin B can cause defective eyesight which is reversed by a B-complex supplement(Grohens, 1988). Vitamins such as B1, B3, B6, B12, H and C are found in brain cells and are essential for mental health.

The American Psychiatric Association has disputed the theory stating that there is "no valid basis for the use of megavitamins"(Silver, 1987, p. 582). The American Academy of Pediatrics asserted that there was no validity to the concept or treatment(Silver, 1976). Literature reviews support this view(Arnold, 1984). Substantial data is available on the toxic effects of vitamin overdose. Byrd (1971), for instance, notes depression, headaches, fatigue, dizziness, and brain damage to overdoses of vitamin D.

8. Trace Elements and Minerals

Trace elements such as zinc, calcium, magnesium, iron and potassium are believed to be essential for the functioning of the brain(Fishbein & Meduski, 1987).

For instance, a high intake of iron, being 10 to 20 mg per day, is needed for growth in youngster. Many foods are low in iron, averaging 6 mg/1000 calories"(Royster, 1983, p. 66). Consequently, anemia occurs unless a diet is maintained which includes lean meats, dried fruits, whole grain cereals, and dark green leafy vegetables. In an anemic the haemoglobin blood cells are unable to carry sufficient oxygen for the brain, causing listlessness, lack of exploratory activity, reduced attention, decreased persistence, and learning disorders such as reading disability(Peritz & Putnam, 1982; Grohens, 1988; Royster, 1983).

Pollitt *et al* (1983) in a study of 30 three to six year old iron deficient children divided into treatment and control groups, found a control process deficit in an inability to pay attention amongst the iron deficit group. Learning rates were similar, but iron deficit children scored less well on a battery of memory tests. Differences were eliminated with iron therapy.

Other trace elements such as lead, cadmium and mercury cause learning disorders. Blouin *et al* (1983) reports that the research in this area is correlational and lacks placebo and double-blind conditions. A focus on lead levels often overlooked dietary malnutrition which may have reduced the effects of harmful trace elements.

Nevertheless, Marlowe (1986) has commented, that in spite of methodological flaws, a literature review has suggested that the association of behavioural deficits with low and moderate metal levels was strong.

Typical of the research is Hansen's *et al* (1989) cross-sectional, cohort study of 2412 children divided into high and low lead exposure groups based on shed teeth analysis. The high exposure group was matched with a control group for sex and socioeconomic status. A psychologist, blind to the data, tested 162 students. Impaired performance by the high lead group was found on the WISC Verbal Scores and Full Scale IQ. Impaired function was also found on the Bender Visual Motor Gestalt Test.

Struempler *et al* (1985) analysed 980 naval recruits for hair cadmium levels. Data from forty recruits with high and low levels were correlated by Pearson Product Moment Coefficient with reading ability results and behavioural records. Results indicated that subjects with the highest cadmium levels were poor readers and possessed excessive demerit points. The author concluded that heavy metals such as cadmium and lead damaged the central nervous system, and increased aggressiveness. The process of using extreme scores did tend to exaggerate the size of correlations, and enhanced the chance of finding mineral and behavioural difficulties at the expense of measuring the strength of the relationship.

9. Malnutrition

Smith (1981) has shown the variety in fast foods to be nutritious provided foods were selected according to the basic food groups. Protein levels were adequate although excessive fat was a problem. More roughage was recommended. Vitamin and mineral contents were adequate. He felt that fast foods did not contribute to learning disorders.

Malnutrition has been defined as "the state of impaired functional ability of development caused by inadequate intake of nutrients and/or calories for long term needs(Royster, 1982)". The type of malnutrition which does affect learning occurs early in life, generally in third world countries. The rapid growth of the human brain to 80% of its adult weight by 3 years, and its consumption of 50% of the body's energy and oxygen, has made nutrition early in life critical for normal development(Peritz & Putnam, 1982).

Numerous studies of malnourished children have correlated malnutrition with poor intellectual development and achievement(Norwood, 1984). The magnitude of the nutritional deprivation has correlated with the duration and severity of retardation(Peritz & Putnam, 1982). Damage is permanent and learning ability is limited throughout life.

Nutritious meals have been frequently demonstrated to increase cognitive scores for memory, recognition, perception, inference and verbalisation(Grohens, 1988). Regular nutritious breakfasts and lunches are correlated with higher reading scores, spelling and language. For instance, Warden *et al* (1982) provided a nutritious breakfast at an elementary school and found significant improvements in behaviour and learning patterns after six months.

10. Conclusion

There seems to be some empirical support for the orthomolecular viewpoint that allergic reactions and chemical deficiencies in the human body may lead to altered behavioural patterns and learning disabilities. Students may be unnecessarily labelled as 'special' or 'learning disordered', when a change in diet would alter their dispositions, learning abilities and skills in academic subjects.

It was fortunate that Ben Feingold directed public attention towards allergic reactions and hyperactivity caused by artificial food colours, flavours and salicylates. These substances do cause allergic reactions in one to two percent of children rather than 50% of hyperactive children as suggested by Feingold.
Useful techniques used in scientific research used to analyse the effects of additives have included careful definition of concepts, double blinds, crossovers and use of challenges. Discrediting of the Feingold diet by researchers has been accomplished by using these techniques. In their search for aversive reactions to additives, researchers have tended to overlook the hyperactive and behavioural effects caused in some children by allergic reactions to certain foods themselves. Milk, eggs, meats and other commonly eaten 'nutritious' foods may be more toxic to allergic children than food additives.

Effects of food allergies are numerous and cannot be directly related to any specific food or chemical. Reactions include hyperactivity, headaches, abnormally provocative or aggressive behaviours and declines

in reading, writing and language abilities. Recent advances in medical research into allergic reactions are clarifying the causes and methods of diagnosing such aversive reactions to certain foods. Single elimination, multiple elimination and rotating diets have been found to be useful approaches to diagnoses as well as skin and blood tests.

Research into excessive consumption of refined carbohydrates suggested an increase in aggressiveness. Methodological approaches which utilise large groups of inmates in correlational studies are suspect, reminiscent of the early research into the Feingold diet. For this reason the theories have been characterised as 'pseudoscientific.' However, excessive sugar consumption to the extent of restricting other intakes of essential nutrients has been shown to interfere with learning and academic performance.

There appears to be little support for the megavitamin theory which suggests that large doses of essential vitamins will reduce learning disorders. Research does show the necessity for certain trace elements. Children lacking iron were listless and performed less well on cognitive tests than non-anemic children.

Research into the toxic effects of some trace elements such as lead, cadmium and mercury is largely unequivocal in its assertion that even moderate levels of such metals can severely hamper learning and increase aggressive behaviour.

Malnutrition in babies and very young children cause learning disorders for life. Such malnutrition is not caused by fast or 'junk' foods and is rarely found in the western world. Regular consumption of nutritious breakfasts and lunches has been shown to increase performance on academic tests.

Generally, research has revealed a critical link between diet, nutrition and biochemical factors with learning disorders. The psychologist would be wise to investigate these factors in his examination of the etiology of learning disorders.

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