When parents and teachers have to cope every day with an unruly, disruptive, sometimes aggressive child in the home and classroom, and when every attempt at control has met with failure, the idea that the child's diet is the cause of the problem is often embraced with great enthusiasm, especially if the alternative is behaviour-modifying drugs. Although food is certainly not the only culprit in triggering disruptive behaviour, there are a number of ways that items of food may elicit behaviour problems in children, and several strategies that parents and care-givers might be able to implement to help their child in this situation.

by Janice Joneja PhD, RDN

The idea that dietary components may be a cause of aberrant behaviour is not new; it has been considered at various times since it was first suggested in the 1920s. Allergic reactions to wheat and corn, as a cause of fatigue, irritability and behaviour problems was suggested in the 1940s[1].

Since then numerous theories, some backed by well-conducted research studies, others merely anecdotal and not supported by science, have been put forward to explain why food may be involved in triggering disruptive behaviour in children. The most convincing of these suggest that:

- Components of the food, either naturally-occurring chemicals, or man-made additives, act in a pharmacological manner on body systems and result in behavioural changes
- Inflammatory mediators released in an allergic response to the food may be the pharmacological agents responsible for behavioural changes
- Nutritional deficiencies may result in central nervous system dysfunction
- Stress, or anxiety associated with food, may release neuropeptides[2] that can themselves trigger the release of inflammatory mediators and cause clinical symptoms.

A great deal of concern arose in the 1970s from the widespread use of stimulant drugs, such as Ritalin (methylphenidate), to control children's hyperactive behaviour. Some clinicians moved to the opposite extreme and advanced claims that childhood hyperactivity was a perception created by intolerant teachers and parents and was caused by environmental factors rather than any neurological deficit. In response, components of a child's diet became the focus of attention as an alternative to drugs, and repudiation of the psychological stigma attached to the care-givers of hyperactive children.

[a]Neuropeptides are chains of amino acids released by the nervous system during various reaction pathways related to brain function. Endorphins, enkephalins, and vasopressin are examples.

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In 1975 Dr Benjamin Feingold published an article, and then a book[3], promoting the theory that a toxic reaction to food additives was responsible for hyperactivity in children. He claimed that up to 70% of his hyperactive patients improved when food dyes, artificial flavours, and natural salicylates were eliminated from their diet. After the publication of Dr Feingold's book in 1975 the "Feingold diet" became very popular as a non-drug treatment for childhood hyperactivity. Feingold Associations as sources of information and support for parents were formed in most states within the United States of America.

In response to Feingold's claims, a number of research studies were conducted in an attempt to confirm or refute his theories. All of these studies can be criticized on the basis of differences in methodology, no clear consensus on diagnostic criteria, inadequate controls and the diversity of the independent variables employed[1]. However, the consensus reached was that Feingold's claims were exaggerated and his findings were anecdotal and lacking in objective evidence. Finally, the idea that diet and food additives were the cause of "hyperkinesis"[4] was strongly refuted in a statement from the National Advisory Committee on Hyperkinesis and Food Additives[5][5] (1980). Nevertheless, all of the studies had actually demonstrated that a few hyperactive children did benefit from an additive-free diet.

[b]Hyperkinesis: abnormally increased motor function or activity; hyperactivity.

Attention-deficit hyperactivity disorder (ADHD) is the most recent diagnosis for children with problems in attention, impulse control and overactivity. However, the diagnosis and cause of the symptoms that constitute this disorder have been in dispute since the condition was first recognized.

The disorder is currently considered to be divisible into several subcategories such as the Inattentive Type, the Hyperactive Impulsive Type, and the Combined type[6] (Barkley 1990). But the debate still continues: to what degree are the symptoms due to a neurological deficit, and how much can be attributed to aberrant environmental factors? Furthermore, there is no clear consensus that these are scientifically divisible conditions based on physiological differences.

In the 1990s, the role of food allergy, and intolerance to food additives, in learning and behaviour disorders in children, was the subject of a number of well-conducted studies. A comprehensive review of the research in this field appeared in 1992[77], which discusses current thought on the link between diet and behaviour disorders. An important point made by these reviewers is that: "It must be recognized that adverse effects of foods on behaviour may be either a manifestation of (probably pharmacologically based) food intolerance, or they may be psychologically based (e.g. via suggestion or adverse conditioning)".

The medical and scientific literature abounds with the results of studies on the

role of food components in behavioural dysfunction in children. However, the first criticism that is frequently levelled at these experiments is that the criteria used for selecting the research subjects leaves room for doubt about the diagnosis of the behavioural condition that was being studied[8].

All of the studies that are designed to demonstrate a role for food components in children's behaviour are plagued by two major handicaps:

- The lack of clear diagnostic criteria for the behavioural conditions that are being studied
- The absence of any definite tests that unequivocally demonstrate allergy to food or intolerance of food additives.

Allergy tests such as skin prick and RAST (radioallergosorbent test) are not clearly diagnostic in most cases of food allergy and intolerance, especially when hyperactivity is the most significant symptom. The only way to demonstrate an adverse reaction to a specific food component is elimination and challenge: the suspect food or additive is removed from the child's diet for a specified period of time, and then reintroduced to determine the child's reactivity to it. Double-blind, placebo-controlled, cross-over food challenge is the standard method used to identify reactive foods to rule out as many confounding variables as possible.

Following the decline in the belief that the Feingold diet was an effective management strategy for childhood hyperkinesis, the idea that refined sugar was an important etiological factor in the disorder became very popular.

"Reactive hypoglycaemia"[9] or "functional hypoglycaemia" (FH) due to sugar in the diet has been blamed for many emotional problems, hyperactive behaviour and irritability. However, there have not been any reported studies that conclusively demonstrate low blood sugar levels and impaired insulin response in conditions other than diabetes. The scientific view regarding FH is that the condition is quite rare, but "has become popular because it is a respectable metabolic illness rather than a symptom of psychological distress"[6].

The adverse effect of sugar in sensitive individuals may be mediated by mechanisms other than defective insulin control. A 1986 study on the response to sugar and aspartame in 39 children diagnosed with ADHD indicated that catecholamine control of sugar regulation may be impaired in children with ADHD[7]. The ADHD children performed significantly worse on behavioural evaluation following a sucrose challenge compared to an aspartame challenge after a breakfast of *carbohydrate*, but the behaviour improved in these children after a sucrose challenge following a *protein* breakfast. Normal children in the study were unaffected by the challenges after either a carbohydrate, protein, or fasting breakfast condition. This means that **children with ADHD require protein** to offset the potential adverse effects of sugar.

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[c]Hypoglycaemia: abnormally low level of glucose (sugar) in the blood

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Although an excess of sugar in the diet is often been blamed for a range of behavioural problems, such as irritability, anxiety, violent behaviour and fatigue, in most cases **sugar has the effect of making a person feel lethargic** because it promotes the production of serotonin, the "sleep chemical", in the brain. Many people are exhibiting the effects of a high sugar/starch breakfast such as toast or croissant and jam, or breakfast cereals containing high levels of sugars and processed starches, when at mid-morning they reach for a cup of high caffeine coffee to keep them alert; or they feel hungry and compound the problem with a snack of a muffin or doughnut to give them an "energy boost", which is inevitably followed by another rapid drop in alertness and energy as a result of the high sugar and free starch content of the snack. A high sugar/starch lunch is often followed by sleepiness in mid-afternoon. These same people wonder why they can't sleep well after a supper high in meat or fish proteins – which is going to promote alertness rather than sleep. Children are no different. We all need a breakfast with a high percentage of protein to give us energy to start our busy day.

Probably, the reason for the idea that sugar causes hyperactivity in children is that the foods that contain large amounts of sugar, such as soft drinks, candies and other sweet manufactured foods, also contain artificial food colours and preservatives. It is now thought that it is the latter that are responsible for the hyperactive behaviour, not the sugar. In addition, a diet high in commercial snack foods and drinks with a great deal of sugar and processed starches tends to lead to a lack of "whole foods", often resulting in nutritional deficiency, especially of essential vitamins and minerals.

Phosphate, as well as a variety of other ingredients, has been considered as a dietary component that could play a major role in hyperkinesis, based on anecdotal evidence. Again, this was refuted by controlled studies[1]. Importantly, however, children on either a restricted sugar diet or a restricted phosphate diet would avoid many potentially allergenic foods and a variety of artificial colours and preservatives, which might be the real reason for the apparent improvement in their behaviour.

In 1986 the results of a four-year dietary intervention program in 803 New York City schools affecting 800,000 children was published. All school meals were virtually free from sucrose, all artificial food flavours, artificial food colours and two preservatives (butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT)). Academic achievement rather than behaviour was chosen as a more objective measure of the performance outcome of this intervention. The average percentile rankings of the students in the study on the California Achievement Test (CAT) over the four year test period rose 15.7% from 39.2% to 54.9% with no changes in the school curricula or teaching staff[11]. The hypothesis was made that the improvements in academic achievement were due to diet, which treated *marginal malnutrition*[12]. Elimination of foods high in sucrose, artificial flavours, artificial colours and preservatives removes many "junk foods" from a child's diet, giving place to more

nutritionally dense foods and a more nutritionally adequate, balanced diet.

A study published in 2004 indicated that *all* children, regardless of whether they would be considered abnormally hyperactive or not, demonstrate some degree of hyperactive behaviour when they consume **artificial food dyes and benzoate preservatives.** 277 3-year-old children on the Isle of Wight in England were studied for the effects of artificial food colourings and benzoate preservatives on their behaviour[13]. The results showed that these food additives triggered some level of hyperactivity in all children, based on the parents' assessment of their child's behaviour. Even children who had no history of behaviour problems became more active after consuming the additives. The effect of behaviour was more striking on those children already diagnosed as hyperactive; their level of activity increased noticeably. Interestingly, the change in behaviour was very obvious to the parents, even though they had no idea whether their child had been given the test drink or a placebo, but psychological tests administered by trained psychologists did not show any changes after either the test drink or placebo.

A follow-up study of 137 3-year-old and 130 8/9-year-old children by the same research team in 2007[14] produced a very similar result. Artificial colours or a sodium benzoate preservative (or both) in the diet result in increased hyperactivity in 3-year-old and 8/9-year-old children in the general population.

At the present stage in our knowledge we can say that artificial colours and preservatives, specifically benzoates, in manufactured foods seem to have the potential to trigger hyperactive behaviour in the greatest number of children, regardless of whether the child has food allergy or not, and should not be part of any child's regular diet.

Artificial colours and preservatives are added to most prepared foods. The four colours and benzoates identified as possible triggers for hyperactive behaviour in the IOW study are found in the foods listed in Table 1.

When we look at the many different types of hyperactivity and related behaviour problems in children, which may or may not be attributable to a variety of biochemical or physiological triggers, it is difficult to advocate that diet, either as a cause (for example, a food additive or a natural chemical in the food acting like a "drug") or as a deficiency (vitamin or mineral deficiencies) could be the major etiological factor in all of these phenomena. However, it is clear that some food components do trigger hyperactive behaviour in some children. Of course, the question that every parent and guardian of a child with abnormal behaviour levels and patterns asks is, "which child and what food components?"need for special diets can

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In response to this question, we can say with some degree of confidence that:

- A child suffering an allergic reaction will respond as any child would to an acute or chronic illness. He or she will feel miserable and appear irritable, restless, have difficulty sleeping and may be unable to concentrate. The obverse of this will be that the child will experience fatigue and listlessness. The condition may result in prolonged absences from school, which will have a negative effect on scholastic achievement.

- An allergic condition such as exercise-induced asthma may prevent a child from taking part in normal childhood activities, resulting in a feeling of being excluded from its peers. Severe eczema can provoke revulsion in other children. Overanxious and overprotective parents may exacerbate the isolation felt by the allergic child, and the need for special diets can impede the normal socializing associated with food. All of these factors may promote an antisocial climate for the allergic child.

- Food allergy may be a direct physiological cause of behaviour changes. The hypersensitivity reaction releases inflammatory chemicals which may have a direct effect on central nervous system functions. The hypoxia (decrease in oxygen reaching the brain) associated with even mild asthma has also been suggested as having significant effects on cerebral function, which might affect behaviour.

- Additives in foods, such as azo dyes[15] (for example, tartrazine), preservatives (especially benzoates) and artificial flavours (such as glutamates) have a direct physiological effect on central nervous system functions.

However, when considering food allergy as a possible cause of your child's allergy it is important to realize that hyperactivity is *never the only symptom of allergy*. If your child has allergies, he or she will have other signs of allergy, such as skin reactions (eczema or hives), stomach problems (diarrhea, stomach ache), or a runny, stuffy nose and itchy watery eyes. Accurate identification of a child's food allergies, and removal of the culprit foods from the child's diet is of first importance. Equally important is that the allergic child should be provided with alternative foods that supply all his or her nutritional needs.

Several reasons have been proposed for the observation that a surprisingly large number of behaviourally disturbed children improve significantly on a "hypoallergenic diet". These include:

- When food allergens are excluded from the diet, an allergic child's symptoms will disappear. They are then able to sleep, have more energy, and generally feel better, so their behaviour will naturally improve.

- When food additives are excluded from a child's diet, it is often the "junk

[d]Synthetic food colours containing nitrogen in their chemical structure.

food" and simple sugars that are removed. The resulting diet is often nutritionally much more adequate and balanced. The child's behaviour is a response to a more nutritious diet.

- If artificial colours and preservatives have a "drug-like" effect on a child's behaviour, removing them from his or her diet will obviously result in a noticeable improvement in behaviour.

- When a specifically formulated diet is prescribed, parents will take extra care in food preparation. The child feels "special" and commands more attention within the family. This change in status and family dynamics has a positive psychological effect on the child and behaviour improves.

Undoubtedly most of these factors will have some effect on a child, especially an allergic child. Whatever the scientific basis may be, the opportunity to improve the quality of life for the child and family by dietary management is justified, as long as the diet does not pose any psychological, nutritional, or economic distress on an already stressed family situation. The best candidates for dietary intervention are children with poor eating habits and physical as well as behavioural symptoms.

- With the help of your child's doctor and a registered dietician find out exactly which foods are contributing to your child's allergy symptoms, separate and distinct from his or her behaviour. These symptoms typically include skin reactions such as hives or eczema; respiratory symptoms such as hay fever or asthma; digestive tract problems such as stomach ache, diarrhoea, nausea and vomiting; occasionally migraine headaches with nausea and vomiting. The food identification process ideally will include elimination of the suspect foods, with subsequent challenge. This will clearly identify which foods are involved in your child's symptoms when he or she loses the symptoms when the food is eliminated, but they recur when he or she eats the food in the "challenge" part of the trial. Carefully remove all of these problem foods from your child's diet and provide complete balanced nutrition from alternative foods. (For complete details of the elimination and challenge procedure, and information on how to provide a complete balanced diet for your child while eliminating the problem foods, please see References 12[16] and 13[17], below.)

- Eliminate all artificial food colouring and preservatives, especially benzoates, from your child's diet. Be particularly careful in reading labels on manufactured foods, and becoming familiar with the terms that indicate the presence of these additives.

- Make sure that every meal and snack that your child eats contains protein as well as carbohydrate. This is especially important at breakfast and lunch. Eggs, bacon, ham, sausage, milk, and nut and seed butters, as long as the child is not allergic to them, can be included in breakfast. Tuna and chicken in sandwiches and salads, and meat in soups and stews are good for

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lunch. It is usually easy to include protein in dinner or supper, which may be the traditional Western meat and two vegetables, pizza with meat and cheese toppings, pasta with a meat sauce, or even hamburger. However, avoid processed and "deli" meats that contain additives.

- Limit treats and "junk" foods that are high in sugars, starches, and artificial additives (ideally remove them entirely – but in the real world of older children in school, this is next to impossible!). Try to encourage your child to select "real foods" and beverages instead. You may have to negotiate by allowing a few that have ingredients other than the colours and benzoates listed in Table 1.

- As much as possible provide a "family environment" in your home in which all family members eat together, without the intrusion of television and other distractions. Keep the atmosphere calm, and provide meals made as far as possible with pure foods without a lot of manufactured and processed ingredients.

- Make sure that every meal contains a balanced amount of each of the "Important Three" components:

    - Protein
    - Grain and/or Starch
    - Fruit and/or Vegetable

For examples of these food categories, please see Appendix E in Reference 12.

Table 1: Foods Usually Containing Artificial Food Colour
(E numbers are the EEC designations of additives used on product labels in Europe)

Tartrazine (E102)
Fruit squash, syrups and cordials
Colored fizzy drinks (soda pop)
Instant puddings
Packet convenience foods: e.g. macaroni
Cake mixes
Soups (packets and cans)
Bottled sauces Pickles
Commercial salad dressings
Ice creams and sherbets
Candies Chewing gum
Jams and jellies Smoked fish
Jello Mustard
Flavoured Yogurt

Ponceau (E124)
Cake mixes Packet soups
Seafood dressings
Dessert toppings Canned strawberries
Canned cherry, raspberry and redcurrant pie fillings
Quick-setting jelly mixes ("Jello")
Salami

Sunset Yellow (E110)
Used especially in fermented foods which need to be heat-treated
Hot chocolate mix Packet soups
Candies Yogurts
Commercial breadcrumbs
Cheese sauce mixes Jams and marmalades
Canned shrimps and prawns
Pickled cucumbers (dill pickles)

Carmoisine (E122)
Especially useful for foods that are heat-treated after fermentation
Packet soup mix
Blancmange Packet breadcrumbs
Packet jellies Candies
Packet cheesecake mix
Brown sauce
Convenience food mixes (Uncle Ben's Rice mixes, Hamburger Helper, etc)
Prepackaged cakes Almond paste
Flavoured yogurtsIce creams
Jams and preserves

Foods Usually Containing Benzoates

Benzoic acid (E210)
Jams
Beer
Dessert sauces
Flavored syrups
Fruit pulp and purée
Fruit juice
Marinated fish (herring; mackerel)
Pickles
Salad dressings
Yogurts
Flavored coffees
Margarine
Table olives
Concentrated juices
Soft drinks

Sodium benzoate (E211)
Caviar
Prawns
Candies
Margarine
Fruit pies
Soft drinks
Oyster sauce
Salad dressings
Barbecue sauce
Taco sauce
Cheesecake mix
Soya sauce
Jams and jellies
Dill pickles
Table olives
Concentrated pineapple juice

Potassium benzoate (212)
Margarines
Table olives
Dill pickles
Concentrated pineapple juice

Calcium benzoate (E213)
Concentrated pineapple juice

Ethyl 4-hydroxybenzoate (E214)
Propyl 4-hydroxybenzoate (E216)
Methyl 4-hydroxybenzoate (E218)
Beer
Cooked packed beetroot
Coffee and chicory essence
Coloring dyes in solution
Dessert sauces
Flavored syrups
Frozen drink concentrates
Fruit-based pie fillings
Fruit pulp or purée
Glucose
Marinated fish (herring and mackerel)
Pickles
Salad dressings

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