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ABSTRACT

This report reviews 23 controlled studies of the effect of food dyes and other dietary constituents on the behavior of children with Attention-Deficit/Hyperactivity Disorder (ADHD) or other behavioral problems. Findings indicate 17 of the 23 studies found evidence that some children's behavior significantly worsens after they consume artificial colors or certain foods such as milk or wheat. Limited research with such tools as electroencephalography indicates that certain foods trigger physiological changes in sensitive individuals. The report includes the following recommendations: (1) the government, private agencies, and health practitioners should acknowledge the potential for diet to affect behavior and advise parents to consider diet modification; (2) parents should consider dietary changes (along with behavioral therapy) as the first course of treatment for children with behavioral problems; (3) the National Institutes of Health should sponsor research to determine which foods and food additives affect behavior, develop methods of identifying sensitive children, and sponsor a conference on diet and ADHD; and (4) the Food and Drug Administration should require certain new and existing additives to be tested. Appendices include further information on sugar and ADHD, diet and behavior, diet and ADHD, and food sensitivity. A guide for parents is included. (Contains 136 references.) (CR)

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Diet, ADHD & Behavior

A Quarter-Century Review

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Diet, ADHD & Behavior

A Quarter-Century Review

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The contents of this pamphlet are not intended to provide personal medical advice, which should be obtained from a qualified health professional.

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Executive Summary

This report reviews 23 controlled studies of the effect of food dyes and other dietary constituents on the behavior of children with Attention-Deficit/Hyperactivity Disorder (ADHD) or other behavioral problems. Though the studies are limited due to the number of subjects, extent of dietary changes tested, assessment techniques, and other factors, 17 of the 23 studies found evidence that some children's behavior significantly worsens after they consume artificial colors or certain foods, such as milk or wheat. Limited research with such tools as electroencephalography (EEG) indicates that certain foods trigger physiological changes in sensitive individuals.

Notwithstanding the evidence from numerous studies, many health organizations and medical experts deny that diet can provoke adverse behaviors and that modified diets may benefit patients. The National Institute of Mental Health (NIMH) largely dismisses diet as a treatment approach, and the U.S. Food and Drug Administration (FDA) has cosponsored with an industry trade association a misleading pamphlet that denies the effect of diet on behavior.

Ignoring or denying (or exaggerating) the effect of diet on behavior is not helpful to children and their families. The federal government, the food industry, organizations concerned about children with behavioral problems, and psychiatrists, psychologists, and social workers should recognize that diet sometimes can help children who have behavioral problems. Parents should consider modifying their children's diets for several weeks to ascertain any benefit before resorting to medications. That is particularly the case because the stimulant drugs routinely used to treat ADHD may cause side effects, and the most commonly used drug, methylphenidate (Ritalin), increased the incidence of liver cancer in a study on mice. Of course, modifying a child's diet can be difficult in a society in which problem foods are ubiquitous, though perhaps no more difficult than adhering to a kosher or vegetarian diet.

This report recommends:

- Government, private agencies, and health practitioners concerned about children with ADHD and other behavioral problems should acknowledge the potential for diet to affect behavior and should advise parents to consider modifying their child's diet as a first means of treatment. Those organizations should update their publications to describe accurately the effect of diet on behavior and the evidence that methylphenidate caused cancer in mice and may pose a risk in humans.
- Parents should consider dietary changes (along with behavioral therapy) as the first course of treatment for children with behavioral problems before turning to stimulant drugs.
- The National Institutes of Health should sponsor research to determine which (and to what extent) foods and food additives affect behavior, develop methods for identifying children most sensitive to foods, investigate the underlying biological bases for sensitivity to dietary constituents, develop techniques to reduce the impact of foods on children's behavior, develop techniques for increasing the ease and effectiveness of dietary treatment, conduct animal studies to investigate possible long-term effects (carcinogenic, behavioral, reproductive, teratogenic, and other) of stimulant drugs, conduct long-term studies on large numbers of users of stimulant drugs to identify any adverse effects (such as behavioral disorders, social problems, cancer, reproductive problems, or other health problems), and study the efficacy of nutritional supplements (including fatty acids, minerals, and vitamins) in treating behavioral disorders. Also, NIH should sponsor a new consensus conference

on diet and ADHD/behavior to supersede a previous inadequate conference.

- The FDA should require certain new and existing additives to be tested for behavioral effects. It should consider banning from foods consumed widely by children any dyes and other additives that affect behavior. The FDA should stop endorsing literature that denies that diet can affect behavior. Also, it should advise the public that because methylphenidate caused liver cancer in mice that drug should not be the primary choice for treating ADHD.
- Fast-food chains and manufacturers of foods, drugs, and vitamin supplements popular with children should minimize the use of dyes and other unnecessary additives.
- Pediatric hospitals and psychiatric clinics, as well as schools and camps, should minimize the use of food additives that may contribute to behavioral disorders.

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a syndrome diagnosed in millions of American children and adults.* The main symptoms of ADHD are reduced attentiveness and concentration, excessive levels of activity, distractibility, and impulsiveness. Additional children are affected by other behavioral problems. For the past quarter-century, controversy has swirled around the hypothesis that diet can trigger symptoms of ADHD and other behavioral problems.

The exact percentage of children with ADHD is not known. The usual estimates are 3 percent to 5 percent of school-age children.[1] Using broader diagnostic definitions, some surveys find that the percentage is as high as 17 percent.[2] School-age boys with the disorder outnumber girls by a margin of roughly two or three to one. On average, at least one child in every classroom in the United States needs help for ADHD. Indeed, one recent study found that in 1995 18 percent to 20 perent of fifth-grade white boys in two Virginia cities had been diagnosed with ADHD and were being treated with stimulant drugs.[3]

Children often outgrow or learn how to control their symptoms. But symptoms sometimes persist into adulthood, making it more difficult to succeed in careers, to start and maintain families, and to become involved in community activities. Adults with ADHD have higher rates of alcoholism, drug use, and imprisonment.[4]

ADHD takes an enormous toll on affected children and their families. The child falls behind in school, does not learn what his or her peers are learning, loses self-esteem, and needs extra help. A family must cope daily with the need to focus the child's attention on essential activities or restrain his or her impulsive behavior. A family must also deal with the fact that its child is not always welcome in other people's homes, in play groups, or on teams. Siblings may suffer because their own needs are not met, and many marriages suffer from the constant stress of dealing with ADHD.

ADHD is most often diagnosed with the use of a checklist of typical behaviors, such as the one published in the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders–IV* (see box on page 2), and by considering other factors, such as age of onset and degree of impairment. Many of the studies on diet and behavior discussed in this report evaluated children's behavior by means of the 10-item Conners' Parent-Teacher Questionnaire, an earlier, widely used means of identifying hyperactivity.[5] That questionnaire rated ten behaviors, such as failure to finish tasks, fidgeting, excitable/impulsive, restless or overactive, and disturbs other children, on a scale of 0 to 3. Scores of 15 or greater indicate hyperactivity.

Researchers generally agree that ADHD has genetic roots. Thus, if one child has the syndrome, his or her siblings have a greater risk of developing it.[6] Doctors cannot yet diagnose ADHD by using blood analyses, brain scans, or other laboratory tests, but researchers are working hard to develop such methods. Recently, researchers have found subtle differences in brain structure and metabolism between children with and without ADHD.[7]

The Feingold diet

In the mid-1970s, Benjamin Feingold, a California allergist, generated a firestorm of excitement and controversy by maintaining that artificial colorings and flavorings and certain natural chemicals (salicylates in apricots, berries, tomatoes, and other foods) could trigger ADHD.[8] Feingold, who was Chief

*ADHD was formerly called hyperactivity or attention-deficit disorder (ADD). The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV*) identifies three types of AD/HD: predominantly inattentive (ADD), predominantly hyperactive (ADHD), and combined subtype (the most common).

Emeritus of the Department of Allergy at the Kaiser Foundation Hospital and Permanente Medical Group in San Francisco, stated that 30 percent to 50 percent of the hyperactive children that he had treated benefited from diets free of those substances.[9] He discovered that when he prescribed a restricted diet (but not other treatments) for hives, asthma, or other allergic reactions, his patients' behavioral problems (if present) sometimes also would diminish.

Thousands of beleaguered families, eager for drug-free relief for their hyperactive children, tried Feingold's diet. Many reported marked improvement in their children's behavior. Those parents launched Feingold-diet support groups throughout the country to share information and provide encouragement and help to other families.

But not everyone agreed that diet might affect children's behavior. The processed-foods industry and many child-behavior experts and researchers were skeptical of Feingold's claim, noting that it was based solely on his and parents' observations and was not supported by any controlled studies. The reported successes of his diet could be due to something else the families were doing, they said, and not to the absence of chemicals in the food. Until the relationship between diet and behavior was demonstrated in well-conducted research, they insisted, Feingold's claim should be considered an unproven hypothesis. Nevertheless, in 1975 a committee of the U.S. Department of Health, Education and Welfare concluded that "the evidence taken as a whole is sufficient to merit further investigation into the relationship of diet and the hyperkinetic syndrome."[10]

DSM-IV Checklist for Diagnosing ADHD

The *Diagnostic and Statistical Manual of Mental Disorders IV*, published by the American Psychiatric Association, describes three patterns of behavior that indicate ADHD. People with ADHD may show several signs of being consistently inattentive. They may have a pattern of being hyperactive and impulsive. Or they may show all three types of behavior.

Signs of inattention include:

- becoming easily distracted by irrelevant sights and sounds
- failing to pay attention to details and making careless mistakes
- rarely following instructions carefully and completely
- losing or forgetting things like toys, or pencils, books, and tools needed for a task
- avoiding tasks that require sustained mental effort

Signs of hyperactivity and impulsivity include:

- feeling restless, often fidgeting with hands or feet, or squirming
- running, climbing, or leaving a seat in situations where sitting or quiet behavior is expected
- acting as if driven by a motor
- blurting out answers before hearing the whole question
- having difficulty waiting in line or for a turn

Because everyone shows some of those behaviors at times, the DSM contains specific guidelines for determining when they indicate ADHD. The behaviors must appear early in life, before age seven, and continue for at least six months. In children, they must be more frequent or severe than in others the same age. Above all, the behaviors must create a real handicap in at least two areas of a person's life, such as school, home, work, or social settings. So someone whose work or friendships are not impaired by those behaviors would not be diagnosed with ADHD. Nor would a child who seems overly active at school but functions well elsewhere.

(Adapted from *Attention Deficit Hyperactivity Disorder*, National Institute of Mental Health, 1994.)

Slowly, university researchers began testing Feingold's claim. The first study, conducted by C. Keith Conners and his colleagues at the University of Pittsburgh and published in 1976, found that at least four of 15 children diagnosed with ADHD improved on a diet free of artificial colors and flavors, according to evaluations by parents, teachers, and the researcher.[11]

Within the next five years, about a dozen controlled trials of varying quality were conducted. In those studies, children with ADHD (most of whose parents believed their behavior was affected by diet) were either put on a reduced-additive diet and then challenged with specific additives or provided with diets containing (placebo) or not containing (test diet) those substances. Most of those studies found some evidence of a dietary effect on behavior. (The hypothesis that foods containing salicylates affect behavior remains essentially untested.[12])

In 1982, the National Institutes of Health (NIH) convened a "consensus development conference" on "Defined Diets and Childhood Hyperactivity."[13] That NIH panel concluded that food additives and certain foods affect a small proportion of children with behavioral problems. The panel stated that controlled studies "did indicate a limited positive association between defined [Feingold-type] diets and a decrease in hyperactivity." It noted that a major limitation of the research was that most studies tested only food dyes and not flavors and preservatives that also might promote hyperactivity. It recognized "that initiation of a trial of dietary treatment . . . may be warranted" for hyperactive children. Also, it recommended that more animal and human research be conducted to determine which foods and additives cause problems, how those ingredients affect the brain and behavior, and which children may be most likely to respond to dietary treatment.

> *"[Controlled studies] did indicate a limited positive association between defined [Feingold-type] diets and a decrease in hyperactivity."*
>
> NIH 1982 Consensus Conference

During the 17 years since that NIH meeting, the NIH has sponsored little of the research recommended by its consensus panel. Nevertheless, a number of studies conducted by researchers in the United States, Canada, Europe, and Australia provided new evidence that synthetic colors and possibly other additives and foods, such as milk and corn, adversely affect some children with behavioral problems.

The issue of diet and ADHD needs to be considered in the context of current treatment practices. Pediatricians, though they often have reservations about treating ADHD with medications, typically prescribe stimulant drugs for children along with behavioral counseling for parents and children. The drug most frequently prescribed is methylphenidate (Ritalin and other brands). The use of methylphenidate increased by 2.5-fold between 1990 and 1995, according to one study, with an estimated 1.5 million youths aged five to 18 taking the drug in 1995.[14] The U.S. Drug Enforcement Administration (DEA) of the U.S. Department of Justice, which treats methylphenidate as a controlled substance, reports that manufacturers' sales increased nearly five-fold between 1990 and 1998[15] and that the U.S. now consumes 90 percent of the methylphenidate produced throughout the world.[16] While prescriptions for methylphenidate began leveling off between 1995 and 1997, prescriptions for amphetamines, which are also used to treat ADHD, tripled, so overall use of stimulant drugs has continued to rise.[17] One reason for the increase is that more elementary-school children are remaining on those drugs into their teens.[18] Later in this report, we consider safety concerns about methylphenidate.

Studies on Diet and Behavior

We review in this report 23 double-blind (plus several other) studies* that investigated the effect of food additives and/or foods on children's behavior. We do not include studies that tested the effect of minimal amounts (1-5 mg) of food coloring,[19] nor do we address research on dietary deficiencies of, or supplementation with, vitamins, minerals, or fatty acids. Because some people contend that sugars can affect children's behavior, we review the limited research on sugars and behavior in Appendix 1.

The children studied had been diagnosed with ADHD or suffered from other behavioral problems, such as irritability and sleeplessness. However, for several reasons, those children generally were not representative of all children with ADHD or behavioral problems. In some of the studies the subjects were thought by their parents to behave worse when they ate certain foods or additives and had been kept on restricted diets. In several studies, many of the children suffered from asthma, hives, eczema, and other allergies or sensitivities. And in several studies, the children had severe behavioral disorders.

The double-blind studies compared the behavior of the subjects when they were consuming suspect additives or foods to their behavior when consuming presumably inactive placebos. For instance, in some studies children were given cookies or capsules containing food colors, and their behavior was compared to when they were given similar cookies or capsules free of food colors. (As discussed later, the "placebo" sometimes contained chocolate, wheat, or other ingredients to which children might be sensitive.) Many studies focused only on dyes and, in some cases, on only one dye, tartrazine (Yellow 5), the second most widely used dye in the United States. In several studies, after being placed on restricted diets, children were challenged not with individual dyes or foods, but with whole different diets that contained additives or foods suspected of affecting behavior. Some of the double-blind studies included preliminary non-blind phases, such as when baseline diets were replaced with experimental diets.

The effects of the ingredients or diets on behavior usually were rated by parents, teachers, and/or researchers using standardized checklists (most often the Conners' scale), inventories based on the children's previous behavior, or open-ended questionnaires. In some cases, laboratory tests of attention, distractibility, locomotor activity, or neurophysiologic activity were employed.

Let us turn now to the studies themselves and review the results of some of the more significant ones. Additional details are provided in Appendix 2.

Studies that found some effect of diet on behavior

The early controlled studies of diet and behavior focused on possible effects of artificial colorings and, sometimes, flavorings and salicylate-containing foods. In the first study, published in 1976, Conners *et al.* compared the Feingold diet, which was free of certain foods, including those with artificial colors and flavors, to a diet that included those substances.[20] The researchers sought to make both diets appear to be experimental diets so that participants couldn't guess which was the "elimination" diet. In a group of 15 children diagnosed with hyperkinesis (the older term for ADHD), four or five children improved on the Feingold diet, two showing "dramatic results." (See Table 1 on page 5.) The average improvement was about 15 percent, though there was an "order effect" (improvement on the Feingold was seen primarily in the subjects who ate the control diet before the Feingold diet; see Appendix 2 for further discussion). A possible flaw in this study is that, according to the researchers, some mothers might have been able to figure out which diet their

*In double-blind studies, neither the researchers/observers nor the subjects know when the subjects are consuming the treatment or placebo. Non-blind studies are not as reliable, because the participants' knowledge of the subjects treatment can affect the results.

Table 1 Studies (Double-blind) of Diet on Behavior

These double-blind studies compared the behavior of children who had ADHD or other behavioral problems when they consumed certain foods or additives (usually dyes) to when they did not. The duration of the test diets varied from one exposure to several weeks. The percentage of responders is shown below. The degree of response varied from slight to dramatic. Some subjects (not shown) appeared to respond adversely more to the restricted diet than the diet containing provoking ingredients. See text and Appendix 2 for further information and citations.

Double-blind study	Number of Subjects	Percent of subjects improving on diet
Wilson and Scott (1989)	4	0%
Conners et al. (1980)	9	0%
David (1987)	24	0%
Conners (1980)	30	0%
Harley et al. (1978)	7	0%-11%
Goyette et al. (1978)	16	0% (parents), 19% (lab test)
Weiss et al. (1980)	22	9%
Williams et al. (1978)	26	13%-31%
Schmidt et al. (1997)	49	24%
Rowe (1988)	8	25%
Conners et al. (1976)	15	27%-33%
Goyette et al. (1978)	13	31%
Harley et al. (1978—school-age)	36	36% (mothers' ratings); 47% (fathers'); 17% (teachers'); 11% (both parents and teachers')
Kaplan et al. (1989)	24	42% (strong response); 58% (any response)
Egger et al. (1985)	28	54% to 71%
Rowe and Rowe (1994)	34	65%
Boris and Mandel (1994)	16	69%
Carter et al. (1993)	19	74%
Swanson and Kinsbourne (1980)	20	85%
Pollock and Warner (1990)	19	89%
Harley et al. (1978—pre-school)	10	100% (mothers' ratings); 57% (fathers')

children were on, potentially influencing their judgments. Future studies sought to overcome that problem by providing special foods that hid the ingredients being tested.

In several follow-up studies, Conners' research team put children on a "modified Feingold diet" from which dyes were excluded. In two studies, when the children were switched from their normal diet to a dye-free diet (not in a double-blind manner), the behavior of up to 88 percent of the children improved significantly.[21,22] (That high percentage of responders is typical in the non-double-blind phases of studies when children switch from their conventional diet to one that lacks certain foods that might provoke symptoms [see Table 2 on page 6]. Part of that apparent improvement is undoubtedly due to the Hawthorne effect [any change in the environment might affect behavior] and wishful thinking on the part of the parents or researchers.) When the children consumed cookies with the dyes, some children showed markedly worse behavior. In one double-blind study, performance of three out of 16 children worsened as judged by a lab test, but parents did not notice a difference. In the other study, parents of four of 13 children observed significantly worse behavior during periods their children were consuming dyes. (See below for negative studies by Conners' team.)

In the late 1970s another research group,

All ten mothers and four of seven fathers rated their children's behavior better on the reduced-additive diet.

this at the University of Wisconsin, compared the effect on ten hyperactive preschool boys of diets containing or lacking "ordinary" levels of dyes and salicylate-containing foods.[23] Those researchers controlled the diets by replacing all foods at home (and at parties) with specially coded foods. All ten mothers and four of seven fathers rated their children's behavior as being better on the reduced-additive diet than on the ordinary diet.

Harley *et al.* also studied a group of 36 hyperactive school-age boys using the same kinds of diets.[24] The results were mixed. Laboratory tests and teacher ratings did not indicate improvements, but "improved behavior [was] found on the experimental diet" according to the fathers' and mothers' ratings. As in Conners *et al.*'s first study, an order effect was seen.

Much of the next wave of studies concentrated on possible effects of dyes, even though many more substances also might affect behavior. One such study was conducted by Weiss *et al.* and used an experimental design different from that of most other studies.[25] Instead of having children consume diets with and without certain foods for several weeks each, the children were kept on a diet free of artificial colors, flavors, and certain other additives and foods and then covertly challenged with dyes on certain days. (The 22 subjects, though not diagnosed as hyperactive, were suspected by their parents of having behavioral reactions to artificial colorings or flavorings and had been kept on some sort of restricted diet). For 77 consecutive days, each child drank a specially prepared beverage. On eight randomly selected days, the drink concealed a mixture of seven dyes (35.3 mg). Two subjects showed clear reactions according to their parents. A 34-month-old girl "reacted dramatically" on the days she received the dyes. A three-year-old boy displayed convincing evidence of

Table 2 Studies (not Double-blind) of Diet on Behavior

These studies (some of which were part of studies that also included double-blind phases) compared the behavior of subjects (who had ADHD or other behavioral problems) on a restricted diet to their behavior on an ordinary diet or to a test diet (when they ate provoking foods or additives.) The duration of the test diets varied from one exposure to several weeks. The percentage of responders is shown below, though some of the reported response likely was due to the Hawthorne effect. The behavior of some subjects (not shown) appeared to worsen on the restricted diet as compared to the diet containing provoking foods. See text and Appendix 2 for further information and citations.

Non-blind study (or phase)	Number of subjects	Percentage of subjects improving on restricted diet
Egger et al. (1992)	185	63%
Uhlig et al. (1997)	45	71%
Conners (1980)	30	73%
Carter et al. (1993)	78	73%
Rowe (1988)	55	73%
Boris and Mandel (1994)	26	73%
Rowe and Rowe (1994)	200	75%
Goyette et al. (1978)	13	77%
Breakey et al. (1991)	516	80%
Egger et al. (1985)	76	82%
Goyette et al. (1978)	16	88%

> *This experiment not only demonstrated unequivocal individual susceptibility, but also disclosed that even relatively normal children may be sensitive to the behavioral toxicity of food dyes."*
>
> *Bernard Weiss*

sensitivity to the color challenge for behaviors his mother considered typical of his outbursts: throwing things inappropriately, and biting, kicking, and hitting.

"These data further strengthen the accumulating evidence from controlled trials, supplemented by laboratory experiments, that modest doses of synthetic colors, and perhaps other agents excluded by elimination diets, can provoke disturbed behavior in children," the researchers stated.

One limitation of most of the studies using dyes is that they tested only 26 to 33 mg per day, a level of consumption considered average at the time, but much less than many children actually consumed. In a 1980 study, Swanson and Kinsbourne tested 100 mg and 150 mg doses of dyes.[26] They put 20 hyperactive children and 20 children who were probably not hyperactive on a Feingold diet for three days, then gave them dyes or a placebo for one day each and assessed their behavior. Compared to the placebo, the dyes decreased the attention span of the hyperactive children, but not the others. Seventeen of the 20 hyperactive subjects suffered impaired performance in a learning test. The authors suggested that negative results in some of the previous studies were due to the use of too low a dose of dyes.

Similarly, I. Pollock and I.O. Warner put 19 fidgety, inattentive children (two diagnosed with ADHD) on a diet that eliminated food additives and challenged them with 125 mg per day of four dyes or a placebo.[27] Seventeen of 19 sets of parents rated their children's behavior as worse—sometimes sharply worse—while their children were consuming the dyes.

Rowe and Rowe extended the research on dyes by testing six different doses—ranging from 1 mg to 50 mg—of tartrazine on children who suffered from irritability, sleep disturbances, and restlessness (two out of 34 were diagnosed as having ADHD). The researchers found that the greater the dosage of dye, the greater the effect on behavior.

Beginning in 1985, researchers began to broaden their focus beyond dyes and conducted studies that tested the effects of other additives and ordinary foods. The underlying rationale was that children might have allergies or sensitivities to numerous substances.

Using a highly restricted diet, Egger *et al.* studied 76 children suffering from severe hyperactivity, often accompanied by neurological disorders, allergies, and other symptoms.[28] Thus, the children were not representative of all children with ADHD and other behavioral problems. They placed the children on a severely restricted "few food" ("oligoantigenic") diet that consisted of two meats, two carbohydrate sources (for example, potatoes and rice), two fruits (banana and apple), a variety of vegetables, and vitamin-and-mineral supplements. That diet excluded dyes, milk, chocolate, citrus fruit, and other foods suspected of affecting behavior. Sixty-two subjects (82 percent) responded favorably to dietary modification, though that phase was not double-blind. Subsequent dietary challenges (also not double-blind) led the researchers to conclude that all of those 62 children were affected adversely by tartrazine, benzoic acid (a food preservative), milk, wheat, oranges, eggs, chocolate, or other ingredients, but because of the open testing protocol, those results are unreliable.

> *"[A modified diet] did seem to make a remarkable difference to the lives of many of these families."*
>
> Joseph Egger et *al.*

Next, 28 of the children who were considered to be diet-sensitive participated in a double-blind study. Depending on which researcher was doing the rating, 54 percent or 71 percent of the children behaved better on the restricted diet than they did during the one to two weeks they each were covertly fed one

food to which they were thought to be sensitive. Irritability and unreasonableness were more affected than hyperactivity and poor concentration. Eighteen percent of the children did worse on the restricted diet.

Carter *et al.*, who studied 78 children with ADHD, reported that 73 percent improved on a few-food (oligoantigenic) diet, though that phase of the study was not double-blind.[29] In a follow-up double-blind, placebo-controlled trial of 19 responders, ratings by parents of 14 children indicated that dyes, chocolate, milk, and other foods affected behavior.

Another study that used a highly restricted diet was conducted by Boris and Mandel on 26 children with ADHD, most of whom also suffered from asthma, eczema, or hives.[30] In a non-blinded phase, 15 out of 17 children who had those allergies appeared to respond to that diet, compared to only five of nine children lacking those allergies. Then, in a placebo-controlled, double-blind phase, the researchers challenged 16 children with dyes (100 mg per day) or foods to which the children appeared to be sensitive. The behavior of 11 (69%) of the children deteriorated when they consumed the foods or dyes.

In a double-blind trial of a restricted diet, Kaplan *et al.* tested 24 preschool boys diagnosed with ADHD.[31] During a seven-week period, each boy's family ate only the foods the researchers provided them. During four of those weeks, the meals were free of artificial colors, flavors, and other substances, such as chocolate, MSG, preservatives, and caffeine, that families thought might be affecting their children. During the other weeks, the foods included those substances. On the restricted diet, according to their parents, ten boys improved an average of 50 percent, while four more averaged a 12-percent improvement.

A study by Uhlig *et al* went a step further than previous studies by using electroencephalograms (EEG) to monitor brain electrical activity when children with ADHD were eating a diet that did or did not include provoking foods.[32] In a first phase that was not double-blind, the behavior of 71 percent of 45 children appeared to improve on an oligoantigenic diet. The children were then challenged (again, not in a double-blind protocol) with various foods, and some appeared to be sensitive to beet sugar, artificial colorings, wheat, milk, and other foods. In a third phase, the researchers used EEG and found a significant increase in beta-1 activity in certain areas of the brain after the children ate provoking foods but not other foods. One of the researchers examining the EEGs did not know which diet the children were on. The import of that finding needs to be further investigated. (Another study using EEG and other methods found that when food-sensitive hyperactive children avoided provoking foods they experienced increased beneficial REM sleep and decreases in the number of arousals when sleeping.[33])

> *"These data support the hypothesis that in a subgroup of children with attention deficit hyperactivity disorder certain foods may not only influence clinical symptoms but may also alter brain electrical activity."*
>
> T. Uhlig *et al.*

Studies that found little or no effect of diet on behavior

Several studies found little or no effect of food ingredients on children's behavior.

Conners and his colleagues put 30 children, 22 of whom were diagnosed as hyperkinetic, on an elimination diet.[34] In that non-blind phase, the behavior of 73 percent of the children improved. However, in the more important double-blind phase, the researchers found "no effect whatsoever" when the children ate cookies containing dyes or placebo cookies alternately for four one-week periods.

In a small study, Conners *et al.* tested nine hyperactive schoolchildren who had previously appeared to improve on the Feingold diet.[35] While on that diet, the children were challenged, double-blind, on just one day each with cookies containing 0 or 26 mg of artificial colors. Consumption of the dyes was not associated with significantly more errors

> *"[W]e must surely conclude that the artificial color hypothesis of hyperactive behavior is unproven."*
>
> C. Keith Conners

on a learning task, and no differences were seen with regard to physical activity. Though he later concluded that diet can affect behavior, on the basis of this study Conners stated that the "artificial color hypothesis of hyperactive behavior is unproven." (Of course, Feingold had not proposed an "artificial color hypothesis," but claimed that many different additives and foods cause symptoms of hyperactivity.)

A study by T. J. David, of the University of Manchester in the United Kingdom, tested 24 children (six with ADHD), all of whom were on restricted diets because their parents said they suffered behavioral reactions after consuming tartrazine and sometimes benzoic acid and other additives. In a double-blind, placebo-controlled study, the children consumed tartrazine or benzoic acid for just one day each.[36] None of the children reacted after consuming a huge amount (300 mg) of the dye or benzoic acid.

Mattes and Gittelman tested 11 children, most of whom were thought to have ADHD.[37] Parents claimed that each child was sensitive to additives and was on the Feingold diet. With the children remaining on the Feingold diet, their behavior did not appear to be affected in a placebo-controlled, double-blind study by consuming up to 78 mg of dyes. Whether the children might have reacted to substances excluded from their diets other than dyes was not tested.

Discussion

The possibility that food additives and natural food constituents could affect children's behavior, particularly those with ADHD, was first raised by Feingold in the mid-1970s. In 1982, an NIH consensus conference reviewed the early research and concluded that dyes and other dietary components do, indeed, contribute to ADHD in a small fraction of children. However, the panel did not agree with Feingold's claim that diet is responsible for as many as half of all cases of hyperactivity.

Subsequent to the NIH conference, additional studies found that synthetic dyes and certain foods affect the behavior of some children. In all, 17 of 23 double-blind studies found that the behavior of some children significantly worsened after they consumed dyes and certain foods. Six studies did not find an effect. Diet, with dyes being the component most frequently studied, appears to affect some children dramatically, others slightly, and many others not at all. In uncontrolled portions of eleven studies, the behavior of about three-fourths of the children appeared to improve when they switched from their conventional diet to a diet restricted in numerous foods and additives. Those observations need to be investigated further.

Conners, who conducted several of the early studies and was skeptical that diet affected behavior, in 1990 reviewed the research on diet and behavior and concluded:

> I have to admit that I have changed my mind about the Feingold idea since the 1970s.... my judgment is that the evidence is strong enough, at least for preschoolers, and especially those with confirmed allergic symptoms, that one should eliminate a broad range of unnecessary and possibly harmful ingredients from these children's diets.... Taken with the caveat that diets do not cure, there seems good reason to try them as part of a total therapeutic effort including medical, educational, and behavioral treatments.[38]

Boris and Mandel found that children with behavioral problems who also suffered from asthma, eczema, or hives might be particularly helped by dietary changes. That suggests that children with those symptoms are good candidates for dietary therapy. Other studies (Weiss, *et al.* (1980), Harley, Ray, Tomasi, *et al.*) indicated that younger children

might be likelier to respond to dietary restrictions than older children, though that was not always the case (Carter *et al.*). It was the two youngest children in the Weiss et al. study who reacted, and Harley, Ray, Tomasi, *et al.* found a greater effect in preschool than in school-age children. However, the greater apparent sensitivity of younger children might be due to the fact that in studies that tested sensitivity to dyes all subjects consumed a fixed amount of dye regardless of their weight. Thus, lighter children were exposed to a significantly higher dosage per kilogram of body weight.

> *"Through a simple elimination diet symptoms can be controlled.... Elimination of the causes of ADHD is preferable to the pharmacologic therapy of this condition."*
>
> Marvin Boris and Francine S. Mandel

Weiss *et al.*'s 1980 study offers several important lessons concerning the conduct and interpretation of studies. First, if the two children who reacted to dyes had not been included among the 22 subjects, the study would have been interpreted as "proving" that dyes do not affect behavior. Negative results from studies involving small numbers of subjects might, simply by chance, not include any of a sensitive subgroup. Second, the study demonstrates the importance of examining each subject's behavior individually, rather than averaging together the effects on all the children. Had Weiss and his colleagues done that averaging, they would not have observed any effect. Finally, the researchers individualized their questionnaires so that the parents' ratings were based on the problems their children usually experienced. In contrast, most other studies used a standardized questionnaire, even if it did not include the behaviors that the children actually had problems with. For instance, the Conners' questionnaire "places little emphasis on irritability and contains no measure of sleep disturbance," which behaviors are not part of ADHD but appear to be caused by dyes in some research.[39]

How many children with ADHD are affected by diet?

The exact percentage of children with behavioral problems who are sensitive to food ingredients is not known, because most of the studies tested children who were suspected by their parents of being sensitive to certain foods. NIMH estimates that "5 percent of children with ADHD, mostly either young children or children with food allergies" are food-sensitive, but does not provide a basis for that estimate. That figure is consistent with several of the studies (such as Weiss *et al.*'s [9 percent]) using food dyes. Greater percentages of children responded in double-blind studies when they were challenged not just with dyes but also with foods to which they were suspected of being sensitive. Thus, in several studies that eliminated a wide variety of foods and then added one or more of them back, half or more of the subjects appeared to be affected by foods or dyes: Kaplan *et al.* (42 percent-58 percent), Carter *et al.* (74 percent), and Boris and Mandel (69 percent); (see Table 1).

> *"This trial indicates that diet can contribute to behaviour disorders in children."*
>
> Christine Carter et al.

One of the few studies that did not test subjects preselected for food sensitivities was Schmidt *et al.*'s. That study found that 24 percent of the children studied improved on a diet that eliminated tartrazine, cereal proteins, and citrus fruit. However, those children were severely hyperactive and disruptive inpatients and not representative of the average child with behavioral problems. (Only 44 percent of the subjects improved when given methylphenidate, suggesting that many had problems other than ADHD.) Similarly, Carter *et al.* found that the behavior of 14 out of 19 children (74 percent), who had not been selected for being sensitive to foods, reacted to dyes or foods.

Of course, the overall percentage of children affected by foods does not matter when it comes down to *your* child.

Commenting on the inconsistencies of studies and the fact that some children respond to the Feingold diet, Conners observed, "If there are *any* children whose behavior is reliably worsened by food additives, then the problem is significant."[40] The obvious public-health response would be to remove the irritants, if possible, from the foods that children eat.

How much dye do children consume?

The interpretation of studies in which children were challenged with dyes is clouded by the lack of information on how much dye children actually consume in their everyday lives.[41] Several of the studies used a dose of 26 mg per day, the presumed average daily consumption of six to nine dyes. However, children may well consume more dye than adults, because so many child-oriented candies, beverages, cakes, frozen desserts, breakfast cereals, and other foods are artificially colored (and also contain a multitude of preservatives, artificial flavorings, artificial sweeteners, and other additives).

In 1976 an FDA scientist estimated that 10 percent of children between one and five years old consume more than 121 mg of dyes per day and 10 percent of children between six and 11 consume 146 mg or more.[42] The average level might have been as high as 76 mg—not 26 mg—and the maximum as high as 315 mg per day. Those figures suggest that many studies used dosages of dyes inadequate to elicit the behavioral reactions that some children's ordinary diets may produce. Indeed, Conners, who used a challenge dose of 26 mg in one study, later regretted using so little.[43] In contrast, two of the studies (Pollock and Warner; Swanson and Kinsbourne) that challenged children with 100 mg or more of dye per day found effects in comparatively large percentages of children.

It is noteworthy that, according to FDA data, dye production has been increasing steadily. Production per capita amounted to 12 mg in 1955, 32 mg in 1975, and 47 mg in 1998, a fourfold increase over four decades.[44] While true consumption figures are not known, current production levels are greater than the amounts used in most studies. The increased exposure to dyes may be causing higher rates of behavioral disturbances.

Limitations in study designs

The designs of many of the studies might have limited their power to detect effects of diet.[45] One limitation is that most double-blind studies tested only the effects of food dyes, and not anything else in the diet. If children are sensitive to several foods or additives, their behavior might not change much if they avoid just dyes. As the old saying goes, if a child is limping because he has five nails in his shoe, removing one nail won't help him much.[46] Studies might have yielded more dramatic effects if additives in addition to dyes, as well as potentially reactive foods, had been eliminated from the diets and then added back as challenges.

Some researchers used chocolate cookies as the vehicle for administering dyes and placebo. Some children might have reacted to the chocolate, thereby making it more difficult to detect effects of the dyes. Egger *et al.* (1985) concluded that chocolate caused symptoms in 59 percent of the subjects tested, though that observation was not based on a controlled study. Breakey *et al.*, whose uncontrolled study found that 31 percent of 516 children were sensitive to chocolate, commented: "With hindsight, it is probable that the results of early research were confounded by the usage of chocolate bars and cookies as the vehicle for test doses of colours..."[47]

Another limitation concerns the assessment tools. The laboratory tests or Conners' scale used in many studies did not assess certain behaviors, such as irritability or sleep disturbances, that might be caused by foods or additives. To overcome that problem, Rowe and Rowe developed a 30-item checklist based on children's past behavior. Similarly, Weiss *et al.* (1980) worked with parents to identify ten problem behaviors specific to each child and then to rate their children on those behaviors.

Also, some studies might underestimate the effect of diet if sensitive children selectively

refused to participate or dropped out. Conners acknowledged that problem in his own research, observing, "If these children dropped out because they experienced severe reactions to the artificial colors, then we would have inadvertently screened out some of our most promising subjects."[48]

On the other hand, some of the research might imply that the effect of diet is greater than it really is. For instance, some of the effects seen in laboratory tests might not be meaningful in the child's real world.

Experts' denials of effects of diet

In spite of the substantial evidence to the contrary, several prominent public and private health organizations—and researchers themselves—have ignored, downplayed, or dismissed any relationship between diet and children's behavior (see Appendix 3 for a more detailed discussion). It is not surprising that organizations funded by the food industry, such as the International Food Information Council (IFIC) and the American Council on Science and Health (ACSH), would dismiss the evidence for such a relationship. It is surprising that some of those who conducted studies finding an effect would seek to dismiss their own findings. For instance, Harley *et al.* concluded that "the overall results [of the study on preschool children] do not provide convincing support for the efficacy of the experimental (Feingold) diet" because the teachers' evaluations and the laboratory tests did not corroborate the parents' reports.[49] Noting that all ten mothers rated their child's behavior as improved, neurotoxicologist Weiss subsequently observed: "[Harley *et al.*'s] astonishing claim, offered after results embarrassing to the sponsors of the study, is a salient example of the extra-scientific barriers posed to the Feingold hypothesis."[50] (The sponsors Weiss alluded to were the Nutrition Foundation and Wisconsin Food Research Institute, both funded by industry.)

Even a 1998 NIH Consensus Panel on the treatment of ADHD virtually ignored the studies on diet—despite the fact that the expert invited to describe non-drug treatments summarized the research showing that dietary treatment is beneficial to some children.[51] L. Eugene Arnold, a psychiatrist at the Ohio State University College of Medicine, wrote in his published review, "The oligoantigenic or few-foods diet has convincing double-blind evidence of efficacy in multiple trials for a properly selected subgroup [of patients]."[52] The NIH conference report noted only in passing, "Some of the dietary elimination strategies showed intriguing results suggesting future research." The committee then failed to include dietary research in its recommendations for future research.

Likewise, the FDA, which funded an important study (Weiss, Williams, Margen, *et al.*) demonstrating that food dyes can trigger adverse behavior, nevertheless endorsed a pamphlet published by IFIC, an industry group, stating that studies have produced no evidence that food additives cause hyperactivity.

Some of the leading authorities on ADHD appear to be unaware of, or dismiss, the research showing that foods can affect behavior. Russell A. Barkley, a professor at the University of Massachusetts Medical Center and a widely respected expert on hyperactivity, wrote: "many studies have discredited the [diet-behavior] hypothesis."[53] While they may believe, correctly, that drugs offer much more reliable relief, researchers should recognize that diet contributes to some children's behavioral problems and dietary changes might provide partial or sufficient relief.

Denying that food ingredients can exacerbate ADHD or other behavioral effects reflects ignorance of the scientific research, and ignoring that research jeopardizes children's well-being. Millions of young children have been prescribed stimulant drugs that may have unpleasant or serious side effects, as discussed below. Parents, physicians, teachers, and school officials need to know that some children benefit from avoiding certain additives and foods, and it makes sense to remove from children's diets unnecessary contributors to behavioral problems.

Choosing a treatment: medication or diet?

In contrast to the ease of use of stimulant drugs, controlling the diets of children is difficult, particularly once the children go to school. Problem foods are advertised aggressively and are available everywhere, and children who do not eat whatever their friends are eating may feel left out or stigmatized. However, some of the dietary changes involved in the Feingold diet, or simply avoiding dyes, may be manageable in many families. (Adhering to the highly restricted oligoantigenic diet is complicated and might best be reserved for severely affected children and institutionalized or hospitalized patients.) Breakey, an Australian dietitian, observed: "Compliance was surprisingly high considering the effort involved in monitoring all meals, including food eaten at school and socially."[54] Some parents consider the Feingold diet to be no more troublesome than a kosher or vegetarian diet: perhaps difficult at the beginning or a nuisance at times, but relatively easy once one becomes accustomed to it.

Each family will need to consider for itself whether even a several-week test of a restricted diet is feasible. To facilitate the dietary changes that may benefit children suffering from ADHD or other behavioral disturbances, the entire family should seek to modify its diet. Change may be easier in certain situations. For instance, hospitals and psychiatric facilities, as well as overnight camps and boarding schools, should be able to exercise substantial control over children's diets.

Parents need to recognize that most children will not respond strongly or at all to dietary changes. In contrast, 70 percent to 90 percent of children respond to stimulant drugs. The most effective option might be to use a restricted diet and a stimulant drug in combination (and might allow a reduced dosage of the drug).[55]

> *Pediatricians and other practitioners might consider dietary modifications worth trying, particularly in younger children."*
>
> Bonnie Kaplan *et al.*

Ideally, considering the difficulty of avoiding provocative foods and the adverse side effects of drugs, ways would be developed to reduce or neutralize an individual's sensitivities. Much more research needs to be conducted, possibly along the lines of a desensitization technique tested by Egger *et al.* (1992).[56]

Until some preventive method or cure is developed, parents of a child with ADHD need to determine, based on their own personal considerations and in consultation with open-minded professionals, whether to attempt to keep their child on a restricted diet or to use stimulant-drug therapy. In either case, experts routinely recommend that parents should use behavior-modification techniques to supplement the drug or diet in improving behavior.

Concerns about stimulant drugs

Parents need to consider the potential adverse effects and cost (several dollars a day) of drugs used to control attention and hyperactivity disorders. Methylphenidate (Ritalin) and other drugs, such as amphetamines (Adderall is a popular brand), provide relief to many children (and their parents, teachers, and classmates), but may cause reduced appetite and weight loss, stomachaches, and insomnia. And, rarely, methylphenidate has been reported to cause tics or Tourette's syndrome. Pemoline (Cylert) has been associated with fatal liver failure and is strongly discouraged as a treatment for ADHD.[57] Furthermore, long-term studies have not been done to determine whether treatment in childhood (or adulthood) with stimulant drugs has adverse effects on the nervous system (or on reproduction, aging, etc.) later in life.[58] As Richard Bromfield, a psychologist at Harvard Medical School, noted in an article about the overprescription of Ritalin, "But the brain, the neurological seat of the soul and the self, must be treated with the utmost respect."[59]

One cause for concern is that in 1995 the federal government's National Toxicology Program (NTP) found that methylphenidate

caused liver tumors in mice (but not rats).[60] Females developed benign liver tumors (hepatocellular adenomas), while males developed both benign and malignant (hepatoblastomas) liver tumors. Unlike many animal studies that have been criticized because of the extraordinarily high dosages that were used, the dosage of methylphenidate that caused cancer in the NTP study was as little as 2.5 times higher than the maximum recommended dose in humans.[61] In another NTP study, amphetamine did not cause tumors in animals.[62]

Samuel Epstein, professor of occupational and environmental health at the School of Public Health at the University of Illinois, is particularly concerned about the hepatoblastomas, which are normally extremely rare. Epstein says, "The NTP study sends a strong warning that Ritalin may cause cancer—in the liver or other organs—in humans. Millions of young children take Ritalin for years on end, and children may be especially vulnerable. It would be prudent for the FDA to discourage doctors from prescribing Ritalin as the first choice of treatment for ADHD."[63]

> *"The NTP study sends a powerful warning that Ritalin may cause cancer ... in humans."*
>
> Samuel Epstein

The FDA acknowledges that the NTP findings constitute "a weak signal of carcinogenic potential," but still considers methylphenidate to be safe.[64] The FDA notes that the drug did not cause cancer in rats and questioned whether the mice used in the study were good predictors of human risk.[65]

There is no evidence that methylphenidate has caused cancer in humans, but that simply may be because no good studies have been conducted.[66] Studies are expensive and difficult to conduct, because if the drug does cause cancer those tumors might not occur for several decades. What is needed, in addition to more animal studies, is studies that follow for as many as 50 years thousands of children who took methylphenidate for long periods of time.

Clearly, parents face troubling choices. First, should they consent to treating their child with a drug to make him or her behave more appropriately at home and in school? And if they decide to go the drug route, should they use the most popular drug, methylphenidate, which is simple to use and often effective, but may have side effects, possibly including a slightly increased risk of cancer? It would be a tragedy if a small percentage of children developed cancer later in life because of a drug they took in childhood. One escape from that dilemma is to try, as a first course of treatment, changing the child's diet for several weeks to see if his or her behavior improves significantly. (See Appendix 4.) In some cases, diet may help enough to eliminate the need for medication; in other cases, diet may make it possible to reduce the dosage. If the dietary approach proves inadequate or is considered inappropriate for a particular child, amphetamines (or other drug) could be tried. In any case, parents who want to try helping their child by modifying his or her diet deserve sympathetic and knowledgeable assistance from physicians and dietitians, as well as by government agencies and health organizations concerned with children's welfare. Parents may obtain information and assistance (and perhaps the names of local health professionals) from the Feingold Association of the United States (Box 6550; Alexandria, VA 22306; 703-768-3287 or 800-321-3287; www.feingold.org).

The need for research

Numerous studies of varying quality have shown that dietary constituents affect some children's behavior, but many of the studies involved just a handful of children, involved children who were not representative of most children with ADHD, or tested inadequate dietary changes.

> High-quality research is critically needed to determine how best dietary changes and supplements could be used to treat ADHD.

Despite the 1982 NIH consensus conference's call for more research on diet and ADHD, the

government has sponsored precious few studies. High-quality research is critically needed to determine how best dietary changes could be used to treat ADHD in childhood and beyond. NIH should fund research to:

- study large numbers of randomly chosen children with ADHD and other behavioral problems to determine how many are affected by various dietary constituents (food dyes; benzoate; conventional foods such as wheat, egg, milk, soy, chocolate; salicylates; etc.);
- identify subgroups of children (type of behavioral problem, age, gender, race/ethnicity, types of allergies or other health problems, *in utero* exposure to nicotine or alcohol, etc.) who are most responsive to dietary changes;
- develop ways to promote adherence to modified diets;
- compare long-term efficacy and effects of diet and drug therapies;
- develop means of minimizing children's reactions to foods, such as through desensitization techniques.
- study the efficacy of nutritional supplements (including fatty acids, minerals, and vitamins) in treating behavioral problems.

In addition, because large numbers of children are taking stimulant drugs for increasing periods of time, more animal and human research, conducted by the government or drug manufacturers, is needed on the long-term effects of those drugs.

- The NTP's studies need to be extended by testing methylphenidate and other drugs on other strains of rodents over their lifetime (beginning *in utero*) for carcinogenicity and effects on reproduction and behavior.
- A large cohort of children who take stimulants (and a matched control group) should be followed over their lifetimes to investigate the drugs' long-term effects on behavior, academic performance, and physical health (including allergies, resistance to disease, cancer, reproduction, etc.).

The role of regulation

As long ago as 1977, an FDA-sponsored committee of toxicologists indicated the need to test additives for "psychotoxicology."[67] In 1993, the FDA itself, in a draft protocol for the testing of food additives, recognized the importance of behavioral measures:

> Because of the impact that nervous system toxicity can have on human health, assessing the neurotoxic potential of a chemical proposed for use as a food or color additive should be an essential element in that chemical's toxicological profile.[68]

However, currently the FDA only requires neurotoxicity testing if a chemical is closely related to known toxins or if other toxicological tests or medical reports suggest a problem. Despite the evidence that food colorings can affect children's behavior, the FDA has not proposed any limitations on their use.

To better protect the public's health, greater regulatory activity is needed. The FDA should require that all proposed new additives be tested for behavioral effects, unless there was good reason not to. Following approval, that agency should require further research if consumers or physicians identify possible problems.

Furthermore, the FDA should consider banning the use of synthetic dyes in foods (for example, cupcakes, candies, sugary breakfast cereals, and children's vitamin pills, drugs, and toothpaste) widely consumed by children, because dyes adversely affect some children and do not offer any essential benefits. Safe naturally occurring colorants (such as beet juice or beta-carotene) or real food (orange juice could provide the color and flavor in orange drinks) could be used instead. The FDA also could encourage parents who believe their children are adversely affected by certain additives to avoid buying foods that contain those additives.

Recommendations

1. NIH should sponsor research to:

   (a) determine which foods and food additives provoke behavioral problems and what fraction of children are susceptible;

   (b) develop methods for identifying children who are sensitive to foods and additives;

   (c) investigate the underlying biological mechanisms for how food affects behavior;

   (d) develop techniques (such as desensitization) to reduce adverse effects of dietary constituents on children's behavior;

   (e) develop means of increasing the ease and effectiveness of dietary treatment;

   (f) conduct animal studies to investigate the possible carcinogenic, behavioral, reproductive, teratogenic and other effects of stimulant drugs;

   (g) conduct long-term studies on large numbers of users of stimulant drugs to identify any adverse effects, such as behavioral disorders, social problems, cancer, reproductive problems, or other health problem;

   (h) investigate the potential efficacy of nutritional supplements (including fatty acids, minerals, and vitamins) in treating ADHD.

2. NIH should sponsor a new consensus conference of experts on diet and behavior to provide a full and fair review of studies on diet and ADHD.

3. Public and private health organizations, such as NIMH, the FDA, American Academy of Pediatrics, American Academy of Family Physicians, and Children and Adults with Attention Deficit/Hyperactivity Disorder (CHADD) should inform parents, school officials, and health-care providers that studies show that certain foods and additives provoke symptoms of ADHD or other behavioral problems in some children. They should suggest that dietary therapy, which is benign and inexpensive, be considered as the first course of treatment (along with psychological counseling, skills training for parents, and other behavioral strategies). Young children and children who have asthma, hives, and other allergies may be the most helped by dietary changes. They should revise and reissue publications that dismiss diet as a contributor to ADHD. They also should emphasize that stimulant drugs may have side effects, including possibly cancer in the case of methylphenidate.

4. The FDA should:

   (a) require new, as well as certain existing, food additives to be tested for behavioral effects;

   (b) consider banning the use of synthetic dyes in foods and other products (such as cupcakes, candies, sugary breakfast cereals, and children's vitamin pills, drugs, and toothpaste) widely consumed by children;

   (c) cease sponsorship of any literature that denies that food additives contribute to ADHD/hyperactivity;

   (d) advise the public that methylphenidate caused cancer in animals and is a poor first choice for treating ADHD.

5. Fast-food chains and manufacturers of foods, drugs, and vitamin supplements popular with children should minimize the use of dyes and other unnecessary additives.

6. Pediatric hospitals and psychiatric clinics, summer camps, and schools should make their standard meals and snacks as free as possible from dyes and other additives that may contribute to behavioral disorders.

Appendix I: Sugar and ADHD

Some parents and health professionals have believed firmly that refined sugars trigger hyperactivity. Assessing the effect of "sugars" on behavior is complicated by the fact that several different types of sugar are added to foods: sucrose obtained from sugar cane and sugar beets, and the corn-derived glucose (corn sugar), corn syrup, and high-fructose corn syrup (HFCS). Currently, about half of the refined sugars Americans consume comes from sugar cane and sugar beets, the other half from corn. Of course, sugars are natural constituents of fruits and vegetables, and so, intuitively, it seems unlikely that they would cause problems. However, children typically consume huge quantities of refined sugars at a time, and those sugars might contain contaminants from corn, beets, and cane. Also, dyes, caffeine, and artificial flavors are often present in sugary foods, so even if a soft drink or high-sugar breakfast cereal appeared to affect behavior, identifying the actual culprit would not be easy.

In the best study, 23 supposedly sugar-sensitive children (five with ADHD) and their families were provided with foods for nine weeks, with artificial colors, flavors, preservatives, and other ingredients suspected of affecting behavior being kept to a minimum.[69] The foods were sweetened for three weeks each by sucrose, aspartame, or saccharin. None of the children reacted to sucrose. (The authors note in passing that "behavior ratings and test scores generally improved during the dietary periods, as compared with the base-line values," suggesting that the restricted diet benefited numerous children.)

Three smaller and briefer studies involving a total of 35 "sugar-sensitive" children, including some with ADHD, also found no effect.[70,71,72]

Several other studies attributed some changes in motor activity and attentiveness to consumption of sugars. In a study of 12 psychiatric inpatients with a variety of disorders, Conners and his colleagues found that sucrose or fructose caused a significant increase in total motor activity.[73] Wender and Salient found that sucrose reduced attention to tasks in children with ADHD, but not in other children.[74] Both of those studies were funded by the sugar industry.

In four other studies, a total of 93 children who had ADHD or a supposed "sugar sensitivity" was challenged up to three times with sucrose, glucose, or a placebo. [75,76,77,78] The behavior of one child in each of those studies appeared to be affected repeatedly by sucrose or glucose as compared to the placebo. Those responses might have been due to chance or could have reflected a true sensitivity to sugars.

The bottom line on sugars is that few good studies—of sufficient duration, with sizable numbers of subjects, and employing child-by-child analyses—have been conducted.[79] The studies that have been done indicate that sugars may affect a small number of children, but not nearly as many or as dramatically as some people believe.

Parents could test their child by putting him or her on a low-sugar (and low-additive) diet for two weeks. They could then "challenge" their child on several different days with a sugar-sweetened (usually corn sugar) beverage or table sugar and on other days with an artificially sweetened drink and carefully monitor his or her behavior.

Of course, whether or not refined sugars affect behavior, most children should, on purely nutritional grounds, eat fewer sugary foods. Children (and many adults) are consuming an average of twice as much sugar as the U.S. Department of Agriculture recommends.[80]

Appendix 2: Studies of Diet and Behavior

Studies showing some effect of diet on behavior

◆ In the first controlled study (1976), C. Keith Conners and his colleagues at the University of Pittsburgh tested the Feingold diet (free of artificial colors, flavors, and certain foods) on 15 children (average age was eight years) diagnosed with hyperkinesis (the earlier term for ADHD).[81] The response over four weeks to that diet was compared to the children's response over an additional four weeks to a diet that was presented to them as another experimental diet, but that allowed foods with artificial colors and flavors. The average improvement on the special diet was about 15 percent. According to parents and teachers, four or five (27 to 33 percent) children improved on the diet. Two showed "dramatic results."

The study was criticized because the restricted diet appeared to have a greater effect in children who consumed it after, as compared to before, the unrestricted diet, though that difference, called an "order effect," was not statistically significant. The authors suggested that the placebo-first group, by chance, might have had more diet-responsive children.

◆ Conners and his colleagues subsequently conducted several studies in which children were challenged with food dyes only. One study started with placing 16 children between four and 11 years old and diagnosed with hyperactivity on a "modified Feingold diet" from which only dyes were eliminated."[82] That diet, introduced openly rather than in a double-blind fashion, appeared to reduce behavior problems by 34 percent (as rated by teachers) or 57 percent (as rated by parents). The researchers then challenged the children with chocolate cookies that contained (or lacked) a mixture of food dyes (26 mg per day). Parents and teachers did not identify any effect, but three of the children (six and seven years old) showed "a marked deterioration of performance" in an objective visual-motor attention task. The three children were affected only at about one hour after eating one cookie. The parents and teachers' failure to discern when children were consuming the dye, the authors conjectured, might have been because they rated the children not at the one-hour point, but only at the end of the day. Also, Conners has raised the possibility that several subjects dropped out of the study because of severe reactions to the dyes.

◆ In another study, Conners' team tested 13 children between the ages of three and nine.[83] Eight of the children were diagnosed as hyperactive, and five were considered borderline hyperactive. When put on a dye-free diet (not double-blind) for several weeks, the subjects demonstrated a 45-percent reduction in behavior problems, with 77 percent of the children appearing to respond. The children then ate two cookies made with or without dyes (13 mg each, one after breakfast, the other after dinner) for one week each. Parents rated their children's behavior for a three-hour period after dinner. For the group as a whole, children exhibited significantly more behavioral problems after they ate the dye-containing cookies. Four children (31 percent) displayed marked reactions. One girl was retested twice and showed repeated reactions to colors.

The authors conclude, "these data firmly establish that artificial colors may be particularly disruptive to younger children and that it will be important to ... examine the possible mechanisms whereby these chemicals act on the CNS [central nervous system]."

◆ Several studies were conducted at the University of Wisconsin and published in 1978. In one study, J. Preston Harley and his colleagues tested a diet free of artificial colors, flavors, and foods containing salicylates on ten hyperactive preschool boys.[84] Those researchers controlled the children's diets by replacing all foods at home (and at parties and special family get-togethers) with specially coded foods. For several weeks, those diets

either contained or lacked "ordinary" levels of dyes, flavorings, and salicylates. The families did not know when they were getting which diet. All ten mothers and four of seven fathers rated their children's behavior as improved when they were eating the additive-free diet.

◆ Harley's group also tested 36 school-age boys with the same kinds of diets as were provided to participants in their study on preschoolers.[85] The results were mixed: Laboratory tests and teachers' ratings did not find improvements when the children were on the Feingold diet, but "improved behavior [was] found on the experimental diet for the father [47 percent] and mother [36 percent] ratings ..." The parents especially noted improvement in the children who consumed the placebo diet before the Feingold diet. The same "order effect" seen in Conners *et al.*'s first study was also seen in this study. Regarding the order effect, Swanson speculated, "The fact that behavior remained improved when children were switched from the additive-free to the placebo phase of the experiment may simply reflect a carryover effect of the 4 weeks on the Feingold diet."[86]

◆ In a 1978 study, Jeffrey Mattes of the Long Island Jewish–Hillside Medical Center in Glen Oaks, New York, and Rachel Gittelman-Klein of the New York State Psychiatric Institute in New York City conducted a double-blind trial on a 10-year-old boy who had been diagnosed with hyperactivity.[87] His parents said that he responded well to a Feingold diet. In an 11-week study, the boy was given cookies with or without a mixture of food dyes (a baseline test used 5 mg or 10 mg daily for three days; the study phase used 10 mg on two days per week).[88] His overall diet was not described. In nine of the 11 weeks, the boy's mother correctly guessed whether or not he was eating the cookies with dye. That was statistically significant. However, the researchers concluded that their findings did not support the Feingold hypothesis because, while the dyes made the boy irritable and fidgety, the boy never exhibited true hyperactivity as judged by the Conners' scale. A larger, but negative, study by the same authors is discussed below.

◆ J. Ivan Williams and his colleagues at the University of Toronto tested 26 schoolchildren who had been diagnosed with ADHD and had been taking stimulant drugs.[89] In this 1978 study, the children were kept on a diet free of artificial colors and flavors, though at least seven of the children "cheated." The children were challenged with chocolate cookies containing or lacking a mixture of food dyes (26 mg per day) in the presence or absence of their medications. The children's teachers observed "clearly significant reductions [in hyperactive behavior] related to diet for approximately one-fourth [3 to 8] of the children." A detailed reanalysis by Weiss found that one child responded "sharply and consistently."[90] The authors concluded that while diet was sometimes effective, the stimulant drug was more effective, but that "drugs and diet provide the best treatment effect."

◆ In a 1980 study funded by the FDA and other agencies, Bernard Weiss of the University of Rochester School of Medicine and Dentistry and his colleagues tested 22 children between the ages of two and seven.[91] None of the subjects had been diagnosed as hyperkinetic, but their parents complained of their short attention span, habit of throwing and breaking things, whining, and acting as if driven by a motor. The parents believed that those problems were relieved when artificial colors and flavors were excluded from their children's diets.

The children were put on a diet free of artificial colors, flavors, and certain other additives and foods. For 77 consecutive days, each child drank a specially prepared beverage at a specified time. On eight randomly selected days, the drink concealed a mixture of seven dyes (35.3 mg). That amount represented the average consumption by children, as judged by dietary histories of 80 children who resembled the study population. One child, a 34-month-old girl, reacted "dramatically" on the days she received the colors. A three-year-old boy also displayed convincing evidence of sensitivity to the color challenge for two behaviors his mother considered typical of his outbursts: throwing things inappropriately, and biting, kicking, and hitting.

◆ In 1980, James Swanson of the Hospital for Sick Children in Toronto and Marcel Kinsbourne of the University of Toronto conducted a study using larger amounts of dyes.[92] They challenged 40 children, half of whom were considered hyperactive based on their responsiveness to stimulant medications. The other half responded adversely to those drugs and were presumed not to be hyperactive. After being put on a diet free of dyes, artificial flavors, BHT, BHA, and natural sources of salicylates (such as apples and tomatoes) for three days, the children were challenged on one day each with a mixture of dyes or a placebo. The researchers tested larger doses of dyes, 100 mg and 150 mg (the latter estimated by the FDA to be the 90th-percentile intake) than had been used in previous studies. Compared to the placebo, the dyes decreased the attention span of the hyperactive children but not the other children. Seventeen of the 20 hyperactive subjects suffered impaired performance in a learning test.

◆ In 1985, Joseph Egger and his colleagues at the Institute of Child Health and the Hospital for Sick Children in London, England, studied 76 children (two to 15 years old) suffering from severe hyperactivity, neurological disorders, allergies, and other problems (those children were not typical of children with ADHD).[93] The researchers placed the children on a severely restricted "few food" ("oligoantigenic") diet that consisted of two meats, two carbohydrate sources (for example, potatoes and rice), two fruits (banana and apple), and variety of vegetables, as well as vitamins and minerals. That diet excluded dyes, milk, chocolate, citrus fruit, and other foods suspected of affecting behavior. Sixty-two of the subjects (82 percent) appeared to behave better on the modified diet, though because that part of the study was not double-blind some of that improvement may not have been due to diet. The researchers then challenged, not in a double-blind manner, those 62 children with various foods or additives and associated adverse reactions in every child with at least one, and usually to more than one, substance. The most common reactions were attributed to tartrazine, benzoic acid (a food preservative), milk, wheat, oranges, eggs, and chocolate. However, because of the non-blinded testing protocol, those observations are not reliable. Contrary to Feingold's hypothesis, few subjects appeared to react to cucumbers, peaches, and other salicylate-containing foods.

The next step was a double-blind trial of 28 of the children presumed to be diet-sensitive. Parents, a psychologist, and a neurologist all rated the children, as a group, as better behaved while eating the limited diet than when, for one to two weeks, each subject was covertly fed one substance to which he or she was thought to be sensitive. When the children were rated individually, depending on which researcher was doing the rating, 54 percent or 71 percent of the children behaved worse when exposed to the provocative food as compared to a placebo. However, 18 percent of the children behaved better when fed the food to which they were thought to be sensitive.

◆ In 1988, Katherine Rowe of the Royal Children's Hospital in Victoria, Australia, tested 55 preschool and school-age children who were hyperactive (15 children) or whose parents thought their behavior was affected by diet.[94] When those children were placed on a "Feingold diet" (largely free of synthetic additives, but not necessarily of salicylate-containing foods), 40 showed improved behavior. Fourteen of those children reacted adversely when they returned to a diet containing dyes, preservatives, and other synthetic additives. That first phase of Rowe's research was not double-blind.

In a second phase, eight of the children whose behavior improved on a Feingold diet were kept on that diet and challenged, double-blind, for two one-week periods with 50 mg per day of tartrazine (and another two weeks with carmoisine, a dye not used in the United States) or lactose (placebo). Two (25 percent) of the children reacted sharply to both dyes, as judged by daily behavioral checklists compiled from parents' reports. A seven-year-old girl responded with increased activity, irritability, sleeplessness, and other symptoms. Her symptoms disappeared within several days after she stopped consuming the dyes. Also, a 12-year-old boy reacted with increased activity,

irritability, short attention span, aggression, and other symptoms, which persisted for several weeks after he stopped consuming the dyes. Both responders suffered from asthma and other allergies. As in other studies that tested only dyes, additional children might have reacted if challenged with a wider range of food ingredients and additives.

◆ In 1989, Bonnie Kaplan and her colleagues at the University of Calgary enrolled into a total-diet study the entire families of 24 preschool boys diagnosed with ADHD.[95] Each family agreed to eat only the foods the researchers provided them during a seven-week period. During four of those weeks, the meals were free of artificial colors, flavors, and other substances, such as chocolate, MSG, preservatives, and caffeine, that parents thought might be affecting their children. During the other three weeks, the meals provided to the families were unrestricted but designed to resemble the experimental meals as closely as possible.

To keep the families in the dark about which diets they were getting, Kaplan and her colleagues misled the participants with false clues, such as designating some days as "corn" days or by limiting beverage consumption to no more than one cup per meal for three days.

Ten (42 percent) of the 24 boys improved an average of about 50 percent on the restricted diet, according to their parents' ratings, while four (17 percent) additional families reported a more modest 12-percent average improvement. The other ten boys did not respond.

◆ In 1990, I. Pollock and J.O. Warner of St. George's Hospital in London, England, studied 19 children between three and 15 years old.[96] The children, according to their parents, exhibited poor concentration, excessive fidgeting, and other behavioral problems after consuming foods that contained dyes, so they had been put on restricted diets.

During the study, the children were kept on their food-additive elimination diet. Every day for seven weeks, the children consumed a gelatin capsule with their breakfast. During two of those weeks the capsules contained 125 mg of a mixture of four food colors, including tartrazine. The other weeks the capsules contained a lactose (milk sugar) placebo. Seventeen of 19 sets of parents rated their children's behavior as worse—in several cases sharply worse—when their children were consuming the food colors.

◆ In 1993, Christine Carter and her colleagues at the Institute of Child Health in London, England, studied 78 children, three to 12 years old, who had been diagnosed with ADHD.[97] Though some were on special diets, they were not chosen for being food-sensitive. In an open (non-blinded) trial, the children were placed on a severely restricted "few-food" diet free of additives and certain foods. The parents of 59 children (73 percent) felt there had been worthwhile improvement in behavior. Two children became worse, and the remainder did not respond. When foods were reintroduced at a rate of one a week in a non-blind manner, half or more of the children who ate "additive-containing foods," chocolate, milk, and oranges were said to react.

The researchers then conducted a double-blind, placebo-controlled trial on 19 of the children who seemed to have improved in the open trial. For one-week periods, each child received either a placebo or a test food (like chocolate or milk disguised in other foods, or a mixture of food colors [six to 26 mg] in a capsule). During the weeks they were getting the test foods or food colors, the behavior of 14 (74 percent) of the children worsened, according to their parents' ratings. Parents reported that their children were more likely to be restless, to disturb others, to cry often, and to suffer temper outbursts. A psychologist also rated the children's hyperactive behavior as worse during the challenge weeks, especially for fidgetiness. The researchers stated that when the children avoided problem foods, "Many parents commented ... that their children had become more manageable and more amenable to reasoning rather than less active or better able to concentrate."

◆ In 1994, Katherine S. Rowe and Kenneth J. Rowe, of the Royal Children's Hospital in Victoria, Australia, followed up on the former's 1988 study by testing 200 children whose parents believed they were affected by diet.[98]

The parents of 150 children reported improvement in behavior with a diet free of dyes, but deterioration after exposure to dyes, in a non-blind test. On the basis of that research they developed a system that they felt was better for rating the behavior of children in their study than the Conners' scale.

The Rowes then studied 54 other children between two and 14 years old. The parents of 34 of those children said they were likely or possible reactors to dyes. Those children suffered irritability, sleep disturbances, and restlessness. All 34 had been suspected of having ADHD, but only two were so diagnosed using the Conners' scale. The other 20 subjects served as controls. The children were put on a dye-free diet and then each morning for three weeks given a capsule or orange juice containing either a placebo or one of six dosages (1 mg to 50 mg) of tartrazine. Each day, the parents evaluated their children's behavior using a 30-item checklist that was based on their children's past behavior.

On the days they consumed the dye, 24 of the children (including 19 of 23 [83 percent] likely reactors, three of 11 [27 percent] possible reactors, and two of the 20 [10 percent] control children) became more irritable, restless, and sleep-disturbed, according to their parents. All six dosage levels produced reactions, which increased in severity with dosage. The researchers concluded, "Behavioral changes in irritability, restlessness, and sleep disturbance are associated with the ingestion of tartrazine in some children." All of the children who reacted to the dye also had asthma, eczema, or other signs of allergy, although none of those symptoms was caused by tartrazine.

◆ Also in 1994, Marvin Boris and Francine S. Mandel of the North Shore Hospital–Cornell Medical Center in Manhasset, New York, studied 26 children, ages three to 11, who had been diagnosed with ADHD and most of whom also suffered from allergies (asthma, hives, eczema, or other symptom). In a preliminary non-blinded phase, 19 (73 percent) of those children showed marked improvement when placed on a severely restricted diet that excluded artificial colors, preservatives, and foods such as dairy products, wheat, corn, yeast, soybeans, citrus fruit, eggs, chocolate, and peanuts.[99] In open (non-blind) challenges, all of the children appeared to react to three or more items.

Those 19 children then participated in a double-blind, placebo-controlled study, which 16 children completed. Each day for seven days, the children ate lentil soup or apple-cranberry sauce. On one to three days, concealed in the soup or sauce were small amounts of the one food or mixture of dyes (100 mg of six dyes) thought to provoke the strongest reaction. The parents rated their children's behavior on each day. Eleven of the 16 children (69 percent) had much worse behavior (Conners-scale scores were doubled) during the challenge period than when consuming the placebo.

◆ A whole-diet study was conducted in 1997 by M.H. Schmidt and his colleagues on inpatients at the Central Institute of Mental Health in Mannheim, Germany.[100] They studied in a double-blind manner the effects of diet on 49 schoolchildren who suffered from severe hyperactivity and disruptive behavior. Unlike the subjects in most other studies, the children had not previously been suspected of being diet-sensitive. The children were fed special diets for nine days each. When they ate a diet free of potentially provoking additives and foods, including tartrazine, cereal proteins, and citrus fruit, 12 (24 percent) children showed a clear improvement in behavior, while two children's behavior deteriorated.

The researchers then tested methylphenidate on 36 of the same children. Sixteen children (44 percent) showed improvement when eating a typical diet, while the behavior of four children worsened. Interestingly, three children who responded to diet did not improve with the drug. The degree of improvement was about the same with diet and drug. The limited response to methylphenidate suggests that many of the subjects did not have ADHD, but suffered from other problems unaffected by the drug.

"Although only effective in a minority of children," concluded the authors, "dietary treatment cannot be neglected as a possible access to treating hyperactive/disruptive children and merits further investigation."

Studies showing limited or no effect on behavior

■ Conners' team tested 30 children, 22 of whom were diagnosed as hyperkinetic.[101] The children were between three and 12 years old. Children on a dye-free diet consumed 26 mg of dyes hidden in two chocolate cookies per day. Conners concludes: "It is obvious from the data that there was no effect whatsoever of the challenge..." (Conners notes that when initially put on the special diet, not in a double-blinded manner, half of the children showed a reduction of symptoms by 50 percent or more, with another seven children showing 25 percent to 50 percent improvements.)

■ Conners and his colleagues tested nine hyperactive schoolchildren who had previously appeared to improve on the Feingold diet.[102] The children were put on a Feingold diet and then challenged on one day each with either 0 or 26 mg of artificial colors. When eating the dyes incorporated into cookies, they did not make significantly more errors on a learning task, and no differences were seen with regard to physical activity. Conners later regretted not using more subjects, larger amounts of dyes, and a visual-motor tracking task.

■ Harley and his colleagues tested seven boys who in previous research behaved better on a diet free of artificial colors and flavors.[103] (Two other boys were put back on medication for part of the study.) Inexplicably, the researchers tested school-age boys even though they had found that preschool boys had responded better to a modified diet. The boys were put on a diet free of artificial colors, flavors, and foods high in salicylates and then challenged for two- or three-week periods over the next nine weeks with snacks that provided 0 mg or 27 mg per day of a mixture of food dyes. The researchers found that, on average, the children did not respond to diet. But they acknowledge: "[O]ne subject displayed a behavioral profile . . . that even approximated the predicted on-off effect of the challenge and placebo materials." Weiss has questioned this study on the basis of diagnostic and measurement criteria.[104] (Interestingly, the mothers, but not the fathers or teachers, of all nine boys reported improved behavior when the boys were initially put on the restricted diet.[105] Presumably, at least part of that improvement was due to the Hawthorne effect.)

■ In 1981, Mattes and Gittelman, whose study of one hyperactive boy was discussed above, tested the effect of up to 52 mg to 78 mg of a mixture of food dyes on 11 children between four and 12 years old.[106] Most of the children were considered as having ADD or ADHD. Parents claimed that each child was sensitive to food additives and adhered to the Feingold diet. In this study, with the children remaining on their ordinary (Feingold) diet, eating cookies containing increasing amounts of dyes each day for one week did not appear to affect the children's behavior. Parents reported that three children reacted to cookies with dyes and three to cookies without dyes. Whether the children might have been sensitive to substances excluded by the Feingold diet other than dyes was not tested.

■ In 1987, T.J. David of the University of Manchester in England, tested only tartrazine and benzoic acid on 24 children, six of whom had ADHD.[107] Parents said that all of the children suffered behavioral reactions within two hours of consuming tartrazine, six were said to be sensitive to benzoic acid, and all were on restricted diets. In a hospital setting, the children were challenged in this double-blind, placebo-controlled study on one day with tartrazine and on one other day with benzoic acid. None reacted after consuming a large dose of tartrazine (50 mg) followed several hours later by a huge dose (250 mg). Similar amounts of benzoic acid also had no effect. The author conceded that the negative result might be attributable to the unfamiliarity of the ward environment. One girl, for instance, had "gross, prolonged, and frequent temper tantrums," making it difficult to detect any effect of the additives. Five other children displayed abnormal behavior, such as aggressive behavior or pronounced overactivity.

■ Nicola Wilson and Alex Scott of the Hammersmith Hospital in London, England, tested four children whose parents had put them on additive-free diets to avoid behavioral effects.[108] (An additional five children refused

to follow the study's guidelines or dropped out early.) The children were challenged at home for 12 days each with a placebo, 17 mg of dyes (tartrazine and sunset yellow [Yellow 6]), or preservatives (sulfites, benzoic acid). Parents of the four children whose behavior was thought to be affected by diet did not see any effects. This study is limited by the many dropouts. (Fifteen other children with various allergies also were tested. One two-year-old boy, whose eczema was suspected of being caused by dyes, displayed "extremely abnormal behavior" after consuming preservatives.)

Non-blind studies

Several studies were not double-blind, so they cannot be considered reliable indicators of sensitivity to diet. Following are summaries of several such studies.

- Over a five-year period, Joan Breakey and colleagues tested 516 children.[109] The percentage of children who had ADHD was not indicated. A positive response to a low-additive, low-salicylate diet was observed in a total of 80 percent of the children, with 55 percent of children considered "good responders." Some children also were reported to have benefited from avoiding milk, grains, or chocolate.

- In 1992, Egger, whose 1985 study was described above, conducted another study that began with placing 185 hyperactive patients on the same "few food" diet without additives for four weeks.[110] One hundred sixteen (63 percent) patients improved enough that they would no longer be diagnosed as hyperactive, according to the Conners' scale. (Some of the responders then participated in a double-blind study that tested the effectiveness of a desensitization technique.)

- In 1997, T. Uhlig and his colleagues in Australia and Germany reported an association in children with ADHD between the consumption of provoking foods and electrical activity in the brain.[111] Forty-five school-children were placed on a "few-food" diet, and 71 percent improved significantly, with their Conners scores falling below the cutoff level for ADHD. Various foods were then reintroduced (again, not in a double-blinded manner) into the children's diets. If a food caused symptoms during three separate attempts, a child was considered to be affected by it. Those foods included beet sugar, artificial colorings, wheat, milk, and others. In a third phase, the researchers used EEG to study 12 children who showed marked improvements in behavior when they did not eat provoking foods, though it is unclear if the children knew when they were eating such foods. The researchers found a significant increase in beta-1 activity in the frontotemporal areas of the brain after the children ate sensitizing foods but not other foods. The EEG recordings were interpreted by two researchers, one of whom was blind to the order of treatment.

Appendix 3: The Conventional Wisdom on Diet and ADHD

Many public and private health and professional organizations, as well as some prominent experts, largely dismiss the notion that diet can affect children's behavior.

U.S. Food and Drug Administration (FDA)—International Food Information Council (IFIC)

The FDA is the federal agency responsible for ensuring that synthetic food colors and other additives are properly tested for safety. In 1993, the FDA published "in cooperation" with IFIC a pamphlet entitled "Food Color Facts." Actually, the pamphlet was written by IFIC and only edited by the FDA.[112] IFIC is an organization directed by officials of, and funded by, many makers of food additives and processed foods, such as General Mills, Kraft, Procter and Gamble, Pepsi-Cola, Coca-Cola, Monsanto (maker of aspartame), and Ajinomoto (maker of monosodium glutamate).[113]

The pamphlet states:

> Q. Do food color additives cause hyperactivity?
>
> A. Although this theory was popularized in the 1970s, well-controlled studies conducted since then have produced no evidence that food color additives cause hyperactivity or learning disabilities in children. A Consensus Development Panel of the National Institutes of Health concluded in 1982 that there was no scientific evidence to support the claim that colorings or other food additives cause hyperactivity. The panel said that elimination diets should not be used universally to treat childhood hyperactivity, since there is no scientific evidence to predict which children may benefit.

The pamphlet has rewritten history. As noted earlier, the NIH panel concluded that controlled studies "did indicate a limited positive association" between diet and hyperactivity and that dietary treatment may be worth trying. Moreover, the one study (by Weiss, Williams, Margen, *et al.*) funded by the FDA found an effect of diet on behavior.

Endorsement by the FDA—its name and logo are on the back cover—confers great credibility on a pamphlet that, from beginning to end, is a one-sided argument in favor of color additives. (Not mentioned is that colors usually are used in foods with little nutritional value; that artificial colors and flavors often replace more valuable ingredients, such as fruit; and that numerous colors have been banned because they caused cancer, liver damage, or other problem in laboratory animals.[114])

National Institute of Mental Health (NIMH)

NIMH, a division of NIH, supports research on the brain, mental illness, and mental health. In 1994, the NIMH published a pamphlet titled "Attention Deficit Hyperactivity Disorder" that dismissed "restricted diets" as an example of "the types of treatment that have not been scientifically shown to be effective in treating the majority of children or adults with ADHD."[115] A few anecdotal success stories, said the NIMH, cannot substitute for scientific evidence. "Until sound, scientific testing shows a treatment to be effective, families risk spending time, money, and hope on fads and false promises." Elsewhere, though, the pamphlet acknowledges that the 1982 NIH consensus panel found that dietary treatment could "help about 5 percent of children with ADHD, mostly either young children or children with food allergies." (The basis of that "5 percent" statement is unclear.) It is true that diet may not be effective in "the majority" of children with ADHD, but that does not mean it should not be employed by the minority.

Children and Adults with Attention Deficit/Hyperactivity Disorder (CHADD)

CHADD, the largest self-help group concerned with ADHD and one that assists a

great many families, dismisses any role of food additives:

> Dietary intervention has long been claimed to be a useful treatment for an array of children's learning, behavior, and attention problems. Advocates claim that removing food additives, such as preservatives and colorings, from the diet will improve most or all of a child's learning and attention problems. Numerous studies have debunked the notion of an additive-free diet as a treatment for ADD.[116]

CHADD has been a vigorous proponent of drug treatment for ADHD. To make methylphenidate less expensive and more available, the group petitioned the DEA to reclassify it as a less risky controlled substance.[117] CHADD has been criticized for failing to disclose a conflict of interest that might have influenced its advice on treatments. About 20 percent of the organization's budget in some years reportedly was underwritten by Ciba-Geigy (now Novartis), the maker of Ritalin.[118] CHADD was reported to have received from drug companies more than $1 million in grants and services. The DEA charged, "The relationship between Ciba-Geigy and CHADD raises serious concerns about CHADD's motive in proselytizing the use of Ritalin."[119] CHADD in a recent year received about $30,000 from Novartis and ten percent of its income overall from the drug industry.[120]

National Center for Learning Disabilities; Learning Disabilities Association of America

The National Center for Learning Disabilities states: "... in spite of some claims, ADHD has not been proven to result from too much TV, food allergies, excess sugar intake ..."

Another organization, the Learning Disabilities Association of America, grants a little credence to diet's potential effect: "Several nutritional approaches have been proposed. The Feingold Diet appears to work at best for 1-2 percent of children with ADHD. Too much refined sugar can increase hyperactivity in some children." No evidence for either statement is provided.

Nutrition Foundation

The Nutrition Foundation sponsored some of the early research on the Feingold hypothesis, and it created a National Advisory Committee on Hyperkinesis and Food Additives. In 1980, the foundation issued its final report, which concluded:

> Instead, the evidence that the total Feingold diet produces improvement in the behavior of hyperactive children is equivocal. The mild and entirely subjective changes that have been reported are not, in our opinion, clinically important.... It is our opinion that the studies already completed provide sufficient evidence to refute the claim that artificial food colorings, artificial flavorings, and salicylates produce hyperactivity and/or learning disability.[121]

The committee did acknowledge that one child in each of three studies may have been affected by colorings, but said those effects were not definitely proven. The committee consistently tried to explain away positive findings, but failed to address weaknesses in studies said to have negative findings. The Nutrition Foundation described itself as "a public, non-profit institution ... dedicated to the advancement of nutrition knowledge," but it was financed largely by makers of processed foods. (The Nutrition Foundation was subsequently absorbed by the International Life Sciences Institute, another industry group.)

American Academy of Pediatrics

The leading organization of physicians who specialize in children's health problems dismisses any link between diet and hyperactivity. In its *Pediatric Nutrition Handbook* for physicians, the academy states: "Double-blind controlled studies of the Feingold diet, which eliminates all artificial colorings and flavorings, have not supported the thesis that additives are a significant causative factor."[122] On its web site, the academy states:

> Special diets. These are based on the unproven idea that certain foods cause ADHD... While there is scientific evidence that these diets do not work, many parents strongly believe they help.... Remember, no special diet alone can solve the problems of ADHD and should not be used as the only treatment for your child's behavior.[123]

William Klish, the former chairman of the academy's Committee on Nutrition, wrote: "Foods do not appear to be related to ADHD even though the concept has persisted for many years."[124] Whenever the hypothesis that diet affects hyperactivity "is tested in well designed blinded placebo-controlled clinical studies," wrote Klish, "the results are negative."

American Medical Association

In 1998, the American Medical Association's Council on Scientific Affairs reviewed the treatment of ADHD without discussing diet.[125] On its KidsHealth web site, the AMA states:

> In addition to drug and psychosocial therapies, there also exists a long history of other treatments, including herbs, vitamins, minerals, biofeedback, and dietary solutions. Many of these therapies, although appealing, have not been proven in therapeutic trials to be effective.[126]

American Academy of Child and Adolescent Psychiatry

This professional organization states:

> Since the mid-1970s, the advocates of dietary treatment of behavioral problems have been remarkably persistent despite the lack of scientific evidence. Families who insist on trying a diet should be permitted to do so, provided the diet is nutritionally sound, because initial attempts to dissuade them may disrupt the therapeutic alliance.[127]

A working group of that organization stated:

> Given the minimal evidence of efficacy and the extreme difficulty of inducing children and adolescents to comply with restricted diets, they should not be recommended.[128]

Sugar Association—American Academy of Family Physicians Foundation

A pamphlet on hyperactivity published by the Sugar Association, an industry group, was "favorably reviewed" by the American Academy of Family Physicians Foundation (AAFPF).[129] "Questions Most Frequently Asked About Hyperactivity," published in the early 1990s, dismisses any notion that diet affects behavior. In response to the questions "Is there a dietary relationship to hyperactivity? Should I restrict certain foods from my child's diet?" the pamphlet states:

> The answer to both questions is "No." Folklore linking certain foods such as food additives, colorants and refined sugars with hyperactivity in children began in the early 1970s.... In over 20 studies, including those supported by the Food and Drug Administration, science has been unable to support these claims. Results of the most recent research indicate there is no dietary connection to increased incidence of ADHD or intensity of symptoms in children already affected with the disorder. Restricted diets for the purpose of manipulating behavior problems are not recommended.

The AAFPF's review was done by Esther H. Wender, professor of pediatrics at Albert Einstein College of Medicine. Wender did a study, supported in part by the Sugar Association, that actually found that sucrose (table sugar) reduced attention to tasks in children with ADHD, but not other children.[130]

In a second pamphlet, "Fast Facts About Hyperactivity," that also was "reviewed favorably" by the AAFPF, the Sugar Association states:

> It used to be thought that ADHD could be caused or made worse by food additives and/or sugar in the diet. **The truth is...** Scientific studies do not support any connection between diet and ADHD. Forbidding children with ADHD to eat certain foods will not change their behavior, and is not recommended.

The American Academy of Family Physicians, a respected medical organization, diminishes its credibility by endorsing self-serving industry propaganda.

American Council on Science and Health (ACSH)

In a 1979 report titled "Diet and Hyperactivity: Is There a Relationship?" ACSH stated:

> The current evidence indicates that a few hyperkinetic children, on the order of a fraction of one percent, may experience adverse reactions to one or several of the large number of artificial food colors and thousands of artificial flavors...[131]

Returning to the topic a decade later, another article in ACSH's newsletter called the Feingold diet "now-disproven."[132]

ACSH calls itself a nonprofit "consumer education association," but it is funded largely by food and chemical companies and consistently defends those companies' practices and products. Sponsors include Kraft, Anheuser-Busch, Monsanto, Pfizer, PepsiCo, Procter and Gamble, the National Soft Drink Association, and many others.

Researchers

One of the best known and most widely quoted researchers on ADHD is Russell A. Barkley, director of psychology and professor of psychiatry and neurology at the University of Massachusetts Medical Center in Worcester, Massachusetts. In his popular book *Taking Charge of Hyperactivity*, Barkley largely dismisses the link between additives or foods and hyperactivity:

> Most of the substantial amount of research done over the next decade was simply unable to support Feingold's claim. In fact, only a very small number (5% or less) of mainly preschoolers showed a slight increase in activity or inattentiveness when consuming these substances.... In 1983, Drs. Kenneth Kavale and Steven Forness with the University of California published a review of 23 studies investigating the Feingold diet. They concluded that diet modification was not effective for treating hyperactivity.[133]

The authoritative-sounding study by Kavale and Forness is flawed, because it averages together the reactions of all the children, rather than looking at the effect on each child's behavior. The benefits experienced by subgroup of responders are masked when they are averaged in with a larger group of non-responders

Alan J. Zametkin, a leading NIMH researcher on the neurobiology of ADHD, stated in the *Journal of the American Medical Association*:

> Many carefully controlled studies have failed to find any substantive link between food additives and ADHD. Support for this finding is well summarized in Barkley's definitive textbook ... as well as in the 1980 report of the National Advisory Committee on Hyperkinesis and Food Additives.[134]

It is puzzling that Zametkin chose to cite that advisory committee, which was sponsored by the food industry, and not the NIH's own 1982 consensus conference, which concluded that some children are affected by diet.

Josephine Elia (University of Pennsylvania School of Medicine), Paul J. Ambrosini (MCP-Hahnemann University), and Judith Rapoport (NIMH) authored in the *New England Journal of Medicine* a major review of the treatment of ADHD and focused entirely on drugs, dismissing other approaches in a single sentence: "Controlled studies have not proved the effectiveness of ... restrictive or supplemental diets."[135]

The drumbeat of statements from naysayers, some with vested interests, has created a conventional wisdom that diet has no effect on behavior and that Feingold's hypothesis has been disproved. As early as 1986, Bernard Weiss, a neurotoxicologist at the University of Rochester who has studied the effect of diet on behavior, observed that "most clinicians and scientists remain unaware of the evidence supporting [Feingold's] claims, because of an effective publicity campaign by the Nutrition Foundation and because of their unfamiliarity with the pertinent literature."[136] Whatever the underlying reason, it is clear that many authorities appear to be unfamiliar with evidence that some children are adversely affected by diet.

Appendix 4: Is Your Child Sensitive to Food Ingredients?

Some children with ADHD or other behavioral problems are sensitive to one or more substances in food. Testing different diets on your child may be rewarded with improvements in behavior, without the potential side effects (and costs) of stimulant drugs. Preschool children and children who suffer from asthma, hives, hay fever, or similar symptoms might be the most likely to benefit from dietary changes.

Numerous studies have demonstrated that some children are sensitive to artificial colorings, which are listed on food and vitamin labels with names like Red 40 and Yellow 5. The simplest experiment you could try would be for several weeks to eliminate foods that contain artificial colorings and see if your child's behavior improves. Those foods are relatively easily avoided and usually not very nutritious.

If you are more ambitious, you could put your child on the Feingold diet, which eliminates not only artificial colorings, but also artificial flavorings, artificial sweeteners (acesulfame-K, aspartame, saccharin, sucralose), and several preservatives (BHA, BHT, and TBHQ). Those additives sometimes are used in vitamin supplements, toothpastes, and drugs—including Ritalin. The Feingold diet also excludes foods that contain salicylates, such as apples and oranges (see box below). Almost no research has been done to investigate the behavioral effects of either additives other than artificial colorings or salicylate-containing foods, but many parents believe that eliminating some or all of those ingredients has helped their children. (You can obtain practical assistance for keeping your child on the Feingold diet, lists of acceptable brand-name foods, and other information from the Feingold Association, whose address is on page 14.)

After you've decided which foods you will eliminate, you should start a notebook to keep track of your child's behavior before and after you change his or her diet. Prepare a score sheet based on common characteristics of ADHD (see box on page 2), but modify it to include your own child's most troubling behaviors, which may include sleep disturbances and aggressiveness. Note when behavioral problems arise and which foods your child recently had eaten. For each day, rate the various behaviors on a scale of 0 (no problem) to 3 (severe problem). You also can ask your child's teacher if he or she has noticed any improvement in behavior, but don't say that you're changing your child's diet unless you need his or her assistance to provide your child with special snacks. Considering how erratic most children's behavior is, correctly linking improved or worsened behavior to diet is not an easy task.

If those first changes do not improve your child's behavior, you can try more restricted diets. Several studies indicate that certain foods—including wheat, eggs, milk, chocolate, corn, and soybeans—adversely affect some children's behavior. You could eliminate one food at a time for a week or two each, or you could try eliminating several simultaneously (also continue to exclude the artificial colorings and perhaps other additives). If your child appears to

Salicylate-containing Foods (partial list)*

almonds	coffee	peaches
apples	cucumbers and pickles	peppers (bell, chili)
apricots	currants	plums, prunes
berries (all)	grapes, raisins	tangerines
cherries	nectarines	tea
cloves	oranges	tomato

aspirin (acetyl salicylate) and medications that contain it

oil of wintergreen (methyl salicylate; mint flavoring)

**Reactions to these foods are based on unconfirmed reports, not controlled studies.*

be sensitive to a certain food, try reintroducing it into his or her diet. Your child is probably sensitive to it if he or she reacts adversely to it repeatedly. You should only undertake an elimination diet with assistance from an allergist, especially if your child has eczema or other allergies (severe reactions might occur when a food is reintroduced). If your child is sensitive to milk or other major source of nutrients, you should consult a dietitian to get suggestions of other foods that will provide your child with all the necessary nutrients. If the food does not trigger symptoms, a different food or something other than diet might be the problem. It is also possible that your child might be able to eat a provoking food in smaller quantities or infrequently.

The Feingold Association suggests that, if its basic diet does not improve behavior, corn sugar (glucose or dextrose) and corn syrup, MSG (monosodium glutamate) and HVP (hydrolyzed vegetable protein), and sodium nitrite (in luncheon meats) also should be eliminated. Again, those changes are based on reports from parents, rather than from controlled studies.

Some research suggests that a severely restricted diet, called the "few-food diet," improves behavior in high percentages of children. That diet excludes all food additives (including artificial colorings, flavorings, and sweeteners, MSG, and preservatives) plus:

- ✔ caffeine (colas and other soft drinks, coffee, tea)
- ✔ chocolate
- ✔ corn products (and corn sugar and corn syrup)
- ✔ dairy foods
- ✔ eggs
- ✔ nuts
- ✔ oranges, grapefruit
- ✔ soybeans/tofu
- ✔ wheat

The few-food diet also eliminates other foods that an individual child is suspected of being affected by.

On this diet, children can eat fresh meat and poultry, any vegetable (except corn and soy foods), fruits and fruit juices (including pineapple and pear, but not orange and grapefruit), rice, and oats. If you see an improvement in behavior after your child has been on that diet for one or two weeks, reintroduce one food every few days to identify as many foods as you can to which your child is not sensitive.

Adhering to a severely restricted diet for even a short while requires a tremendous commitment from both parents and children and may be more appropriate in a research setting than for typical families. If a highly restricted diet does appear to help your child, and your child remains on it for an extended period of time, you'll need to work with a dietitian to ensure that your child is getting all the necessary nutrients.

Finally, if your child does not seem to benefit significantly from any restricted diet, then you should discuss with your pediatrician other treatment options, including behavioral counseling and/or medications.

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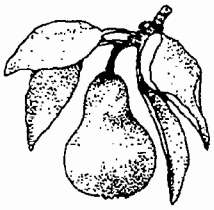
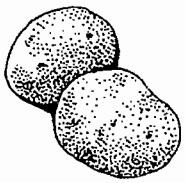
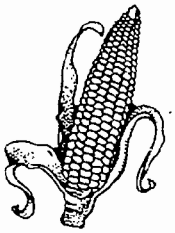
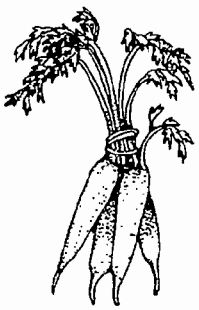


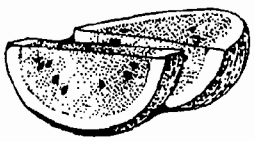


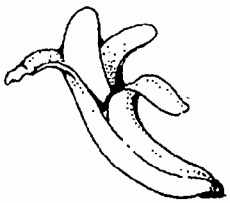


A Parent's Guide to

Diet, ADHD & Behavior







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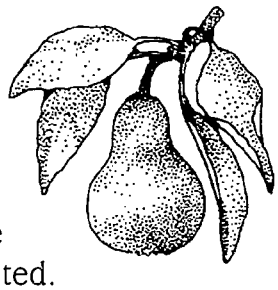
Center for Science in the Public Interest

A Parent's Guide to Diet and ADHD*

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common behavioral problems in children. It not only bedevils children, but also affects their siblings and parents. It can be treated, but not cured. A key question for parents is how to treat their children.

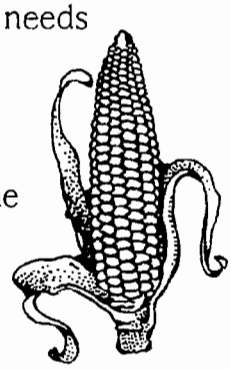
ADHD—also called hyperactivity or attention-deficit disorder—has been diagnosed in millions of American children and adults. The main symptoms in children are reduced attentiveness and concentration, excessive levels of activity, distractibility, and impulsiveness. Before concluding that your child has ADHD, consult a doctor or psychologist who is qualified to make the diagnosis. Many children whose parents think they have ADHD are merely very active or spirited. Besides ADHD, some children exhibit other types and degrees of inappropriate behavior.



Exactly how many children suffer from ADHD is not known. The usual estimates are 3 to 5 percent of school-age children. Using broader diagnostic definitions, some surveys find that the percentage is as high as 20 percent in

* This pamphlet is adapted from *Diet, ADHD & Behavior*, published by the Center for Science in the Public Interest. That report is available from CSPI or its Internet site (www.cspinet.org).

certain subgroups of the population. ADHD is two or three times more common in boys than in girls. On average, at least one child in every classroom in the United States needs help for ADHD.



Researchers generally agree that ADHD has genetic roots. Thus, if one child has the syndrome, his or her siblings have a greater risk of developing it. Because doctors cannot yet diagnose ADHD by using blood analyses, brain scans, or other laboratory tests, ADHD is usually diagnosed by observing a child's behavior, interviewing parents and teachers, and by using a checklist of behaviors, such as those included in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM)-IV published by the American Psychiatric Association. (See box on next page.) Researchers are working hard to develop more reliable diagnostic tools and have found subtle differences in brain structure and metabolism between children with and without ADHD.

ADHD takes an enormous toll on children and their families. The child falls behind in school, loses self-esteem, and needs extra help. A family must cope daily with the need to focus the child's attention on essential activities or restrain his or her impulsive behavior, while dealing with the unsettling fact that the child is not always welcome in other people's homes, in play groups, or on teams. Siblings may suffer because their needs are not as acute, and many marriages suffer from the constant stress

Signposts of ADHD

The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* describes three patterns of behavior that indicate ADHD. People with ADHD may show several signs of being consistently inattentive. They may have a pattern of being hyperactive and impulsive. Or they may show all three types of behavior.

Signs of inattention include:

- becoming easily distracted by irrelevant sights and sounds
- failing to pay attention to details and making careless mistakes
- rarely following instructions carefully and completely
- losing or forgetting things like toys, or pencils, books, and tools needed for a task
- avoiding tasks that require sustained mental effort

Signs of hyperactivity and impulsivity include:

- feeling restless, often fidgeting with hands or feet, or squirming
- running, climbing, or leaving a seat, in situations where sitting or quiet behavior is expected
- acting as if driven by a motor
- blurting out answers before hearing the whole question
- having difficulty waiting in line or for a turn

Because everyone shows some of those behaviors at times, the DSM contains specific guidelines for determining when they indicate ADHD. The behaviors must appear early in life, before age seven, and continue for at least six months. In children, they must be more frequent or severe than in others the same age. Above all, the behaviors must create a real handicap in at least two areas of a person's life, such as school, home, work, or social settings. So someone whose work or friendships are not impaired by those behaviors would not be diagnosed with ADHD. Nor would a child who seems overly active at school but functions well elsewhere.

(Adapted from *Attention Deficit Hyperactivity Disorder*, National Institute of Mental Health, 1994.)

of dealing with an affected child.

Many children outgrow or learn how to control their symptoms. But symptoms sometimes persist into adulthood, making it more difficult to succeed in careers, to start and maintain families, and to become involved in community activities. Adults with ADHD have higher rates of alcoholism, drug use, and imprisonment. Thus, early treatment is crucial.

The Feingold diet

In the early 1970s, Dr. Benjamin Feingold generated a firestorm of excitement and controversy by asserting that certain foods and food additives could trigger ADHD. Feingold, who was Chief Emeritus of the Department of Allergy at the Kaiser Foundation Hospital and Permanente Medical Group in San Francisco, reported that when he prescribed dietary changes for patients with hives, asthma, or other allergic reactions, their behavioral problems (if present) sometimes diminished. He claimed that 30 percent to 50 percent of his hyperactive patients benefited from diets free of artificial colorings and flavorings and certain natural chemicals (salicylates in apricots, berries, tomatoes, and other foods).

Thousands of beleaguered families, eager for drug-free relief for their hyperactive children, tried Feingold's diet. Many reported improvement in their children's behavior. That spurred the formation of Feingold-diet support groups throughout the country to share information and provide assistance to families. For more information contact the

Feingold Association of the United States (P.O. Box 6550, Alexandria, VA 22306; 800-321-3287; www.feingold.org).

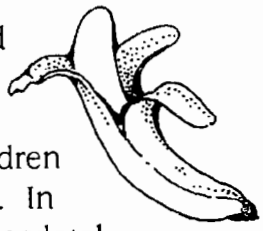
But not everyone was impressed by Feingold's claim. The processed-food industry, many child-behavior experts, and many pediatricians reacted to Feingold's claim with skepticism bordering on derision, pointing out that it was based solely on his and parental observations and was not backed by any controlled studies. The reported successes of his diet could be due to something else the families were doing or simply to their wishful thinking, they said, and not necessarily to the absence of certain chemicals in the food.

Slowly, researchers began testing Feingold's claim. The first study, conducted by C. Keith Conners and his colleagues at the University of Pittsburgh and published in 1976, found that at least four of 15 children diagnosed with ADHD improved on a diet free of artificial colors and flavors. Over the next two decades, almost two dozen more controlled trials followed, most of which focused on food dyes. In some cases, children were put on a diet that lacked many food additives and then "challenged" with dyes. In other cases, the behavior of children was monitored after they were switched to a diet free of foods that might cause a reaction (dyes, wheat, egg, chocolate, and others) and then challenged with those foods. Most—but not all—of those studies

> *"I would rather be different because of what I eat than because of how I behave."*
>
> Chris, 11 years old, Waldorf, MD

found that some—but not all—children were affected by diet. Some of those "responders" were affected by diet slightly, others dramatically.

In 1982 the National Institutes of Health (NIH) convened a "consensus development conference" on diets and hyperactivity to review the early scientific research and advise health professionals and the public. That NIH panel concluded that food additives and certain foods do, indeed, affect a small proportion of children with behavioral problems. In addition to noting that anecdotal reports claimed "dramatic improvements" in some hyperactive children, the panel concluded that controlled studies "did indicate a limited positive association between defined [Feingold-type] diets and a decrease in hyperactivity." It pointed out that a major limitation of the research was that most studies tested the effect only of dyes and not of other additives and foods that also might promote hyperactivity. It recognized "that initiation of a trial of dietary treatment . . . may be warranted" for hyperactive children. The conference recommended that additional research on diet and behavior be conducted, but over the next decade and a half only scattered research was done. The failure to conduct a broad range of research means that little is known about the percentage of children who respond to dietary therapy, to what degree they respond, which children are likeliest to be affected, the additives and foods that cause problems, and the best ways to use diet therapy.



Concerns about stimulant drugs

Once pediatricians, psychologists, and psychiatrists have concluded that a child has ADHD, they usually prescribe parenting-skills training for parents and behavioral counseling and stimulant drugs for the child. The drug most frequently prescribed is methylphenidate, the most popular brand of which is Ritalin. Other behavioral problems may be treated with other drugs.

Ritalin is often highly effective in reducing the symptoms of ADHD, and millions of children have been treated with it. In recent years, Ritalin's use has increased greatly, with a 2.5-fold increase occurring just between 1990 and 1995.

One reason to consider alternatives to Ritalin is that it and other drugs have troubling side effects. Ritalin and amphetamines (Adderall, Dexedrine) may cause reduced appetite and weight loss, stomachaches, and insomnia. More seriously, those drugs occasionally may cause or exacerbate tics and Tourette's syndrome. Another drug, pemoline (Cylert), has been associated with fatal liver failure, and the Food and Drug Administration (FDA) urges doctors not to use it to treat ADHD. Furthermore, until long-term studies are done, it will not

"Our belief that medication should only be a last resort spurred us into action and we began the Feingold program. Within ten days my husband and I agreed that on a scale from 0 to 10, Hannah's behavior had improved from a 0 to about 8.5."

Mother of Hannah, 7 yrs old, South Pomfret, VT

be known whether years-long treatment in childhood (or adulthood) with stimulant drugs affects the nervous system or other parts of the body later in life.

Adding to the concern about Ritalin is that a study conducted by the federal government's National Toxicology Program (NTP) found that methylphenidate caused liver tumors in mice. Unlike studies in which animals developed tumors only after being fed extraordinarily high dosages of a chemical, the dose of methylphenidate that caused tumors was only several times higher than the maximum recommended dose in humans. (In a separate study, amphetamines did not cause cancer.)

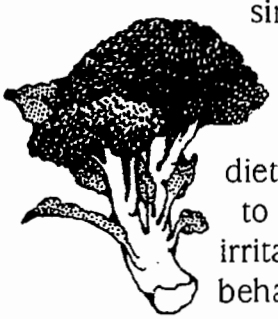
Samuel Epstein, a cancer expert at the School of Public Health at the University of Illinois, says, "The NTP study sends a powerful warning that Ritalin may cause cancer—in the liver or other organs—in humans. Millions of young children take Ritalin for years on end, and children may be especially susceptible to a carcinogen's effects."

The FDA acknowledges that the NTP study indicates "a weak signal of carcinogenic potential," but still considers the drug to be safe. The FDA noted that it did not cause cancer in rats and that the strain of mouse used was especially susceptible to developing liver tumors. There is no evidence that Ritalin causes cancer in humans, but no studies have followed large numbers of Ritalin-users for four or five decades. After all, large numbers of children have been consuming Ritalin for only the past one or two decades, and cancer might not occur until the children reach their 60s or 70s.

Deciding on a treatment

Until some preventive method or cure is developed, parents of a child with ADHD need to determine what therapies to try. On th asis of their concerns about medications, the effectiveness of different approaches, and their child's personality and diet, parents may choose to test their child on a restricted diet, to use stimulant-drug therapy, to use only counseling and behavior-modification techniques, or some combination of those methods.

Many parents have qualms about treating their child with a drug to make him or her behave more appropriately at home and in school. Those drugs are simple to use and often effective, but may have side effects. One possible alternative is a dietary approach, which seeks to identify and remove irritants in foods that cause behavioral symptoms. That approach entails eliminating certain foods from the (unmedicated) child's diet for several weeks to see if his or her behavior improves. In some cases, dietary changes by themselves may adequately reduce behavioral problems. If not, amphetamines or another medication could be tried in addition to, or instead of, a restricted diet.



Treating your child with diet

Numerous studies have demonstrated that the behavior of some children improves when they avoid certain foods. Those children may react to any of a variety of different foods and

ingredients, and some may be affected by more than one. Your goal is to identify the specific foods or additives, if any, that affect your child. What makes that task especially challenging is that children's behavior ordinarily is so variable.

Needless to say, controlling the diets of young children can be difficult, especially once children go to school. Foods containing dyes and other potentially provoking ingredients are advertised aggressively and available everywhere: at supermarkets, restaurants, schools, vending machines, parties, theaters, and the homes of friends and relatives. Many young children are already "hooked" on the very foods that may cause problems, though it is getting easier to find acceptable alternatives. And children who do not eat what all their friends eat may feel left out or stigmatized.

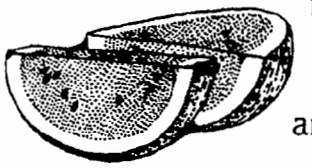
Some parents who have put their children on special diets, though, say that their children willingly cooperate in making dietary changes, especially after they discover that those changes make them feel better. Some older children avidly read labels to avoid certain ingredients.

Some studies suggest that the children who respond best to dietary therapy are young (preschool) and those who suffer from asthma, eczema, hives, hay fever, or similar symptoms. Children who still have significant problems after taking stimulant medications might also be good candidates. But, no matter the age of your child or the exact nature of his or her behavioral problem, it could be

worth trying diet. It is certainly safer and cheaper than using stimulant drugs, and, if your child has been eating a lot of artificially colored foods, it may also be more nutritious. At worst, a modified diet won't help and you've delayed for several weeks trying another option.

Trying a modified diet

Finding a diet that will help your child will require time, patience, and experimentation. We discuss diets that involve varying degrees of change, starting with eliminating only dyes. The most restricted diets begin by eliminating numerous common foods and then add them back one by one to identify any that cause problems.



Numerous studies have demonstrated that some children are sensitive to dyes. Thus, you might start by eliminating only foods (and vitamins, drugs, and toothpastes) that contain artificial colorings.

The Feingold diet, which is based mostly on unconfirmed reports from parents and doctors, eliminates additional additives, as well as "salicylate-containing" foods. That diet eliminates:

- artificial colorings (look for names like Red 40 and Yellow 5 on labels)
- artificial flavorings (including vanillin, used in synthetic vanilla)
- artificial sweeteners (acesulfame-K, aspartame, saccharin, sucralose)
- BHA, BHT, and TBHQ preservatives

One study suggests that sodium benzoate and benzoic acid should also be on that list. The Feingold diet also excludes certain fruits and vegetables, though, again, studies have not demonstrated that they cause problems (see box on the next page for lists of excluded and permitted foods). While that diet excludes many common foods, later you can add back any to which your child is not sensitive.

> *"We began the Feingold diet last Thursday and find it relatively easy to do . . . what was holding me back before??"*
>
> Monica, Williamsville, NY

Once you have decided which foods and additives you will eliminate, check all the foods in your refrigerator, pantry, and cupboards. Remove or discard any foods that contain banned ingredients. Learn about the ingredients used by the restaurants you frequent, though during the test period it may be best to stick mostly to foods you prepare at home. Major fast-food chains offer lists of the ingredients in their products; ask servers or call their consumer-affairs offices. The Feingold Association publishes lists of selected packaged and chain-restaurant foods that fit into the diet, but you'll have to become a careful label reader and inquisitive restaurant-goer to learn the ingredients in your children's favorite foods.

Once you are set to go, put your child (and the rest of the family, if possible) on the modified diet for two or three weeks. Stick to the diet as carefully as you can. If your child mistakenly eats a prohibited food, don't get upset, just get him or her back on the diet.

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Foods Not Allowed on the Feingold Diet (partial list)*

almonds	cucumbers and pickles	peppers (bell, chili)
apples		
apricots	currants	plums, prunes
berries (all)	grapes, raisins	tangerines
cherries	nectarines	tea
cloves	oranges	tomatoes
coffee	peaches	

aspirin (acetyl salicylate) and medications that contain it

oil of wintergreen (methyl salicylate; mint flavoring)

**Reactions to these foods are based on unconfirmed reports, not controlled studies.*

Foods Allowed on the Feingold Diet (partial list)

Fruits

banana	honeydew	papaya
cantaloupe	kiwi	pears
dates	lemons	pineapple
grapefruit	mangoes	watermelon

Vegetables

bean sprouts	cauliflower	peas
beans (all types)	celery	potatoes
beets	kale	spinach
broccoli	lentils	squash
Brussels sprouts	lettuce	sweet corn
cabbage	mushrooms	sweet potato
carrots	onions	zucchini

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You should use a notebook to keep track of your child's behavior before and after you put your child on the diet. Prepare a score sheet (see box on next page) based on common characteristics of ADHD, but modify that to include your own child's most troubling behaviors. Use a separate page for each day. Note when behavior problems arise and which foods your child had eaten recently. You also can ask your child's teacher if he or she has noticed any improvement in behavior, but don't say that you're changing your child's diet unless you need his or her assistance to provide your child with special snacks.

Improvements in behavior should serve as great positive feedback to stay on the diet. However, it might just be a coincidence that a child's behavior improved when the diet was introduced. Parents should try to be objective and not let their expectations color their views of their child's behavior.

> *"My 11-year-old son finds great joy in reading labels and discovering a new food that we can try."*
>
> Tricia, Eldorado Hills, CA

To try for even greater improvement, you can try eliminating more of the additives or foods that are suspected of affecting behavior. Likewise, if your child's behavior did not improve on the initial diet, it could mean that your child is not affected by foods at all or is sensitive to other foods. It is also possible that prohibited ingredients are sneaking into your child's diet.

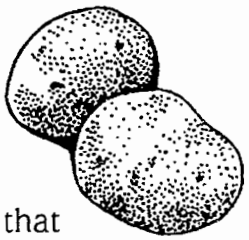
Behavior Scoresheet

Date:____

Behavior	Good - 0	Mild - 1	Moderate - 2	Severe - 3	Possible food cause
Easily distracted by irrelevant sights and sounds					
Not paying attention to detail, making mistakes					
Losing or forgetting toys, pencils, etc., necessary for tasks					
Restless, fidgety					
Running around when quiet behavior or sitting is expected					
Difficulty waiting in line or for a turn					

Adapt this form for your child's behaviors.

Try, and try again



If the initial dietary changes had little or no benefit, and you excluded only dyes, try putting your child on the complete Feingold diet. If that doesn't help, the Feingold Association, recommends, based on parents' experiences, eliminating:

- corn syrup, high-fructose corn syrup, and corn sugar (in soft drinks and other sweetened foods)
- MSG (monosodium glutamate) and HVP (hydrolyzed vegetable protein, which contains some glutamate)
- sodium nitrite (in luncheon meats)
- calcium propionate (in baked goods)

After several weeks, if your child's behavior has improved, every few days you could add back one eliminated food or ingredient at a time to see if it causes a problem. You'll need to repeat that two or three times to confirm that the food is really a culprit. Knowing which foods do not pose problems allows your child to eat a wider range of foods.

The "few-foods" diet

If your child's behavior did not improve on the Feingold diet you could try a "few-foods" diet, which involves more extensive restrictions. Studies indicate that some children are sensitive not just to food additives but also to such foods as:

- wheat
- eggs

- milk and other dairy foods
- chocolate
- soybeans/tofu
- corn products (including corn sugar and syrup)

On this diet, you would eliminate as many of those foods as you can, plus artificial colorings and other additives. Children can eat fresh meat and poultry, any vegetable (except corn and soybeans), fruits and fruit juices (but not citrus fruit/juice and not beverages normally consumed daily), rice, and oats. You should seek assistance from an allergist if you undertake an elimination diet, especially if your child has eczema or other allergies (severe reactions might occur when a food is reintroduced).

The more foods you try to eliminate, the more complicated it will be to provide healthy meals and win your child's cooperation. Fortunately, most of the restrictions will be temporary, because you will be trying to identify the foods that do not cause problems, as well as those that do.

Keep your child on the few-foods diet for two weeks, tracking his or her behavior until you notice two consecutive days of significantly improved behavior. Again, we note that it can be difficult to distinguish an effect of diet from your child's normal fluctuations in behavior. If you do not notice any improvement, you can end your experiment.

If you have noted improved behavior, add back to your child's diet one of the eliminated foods or additives at a time. After your child has eaten that food for several days in a row, note in your diary

any symptoms that develop. If that food did not affect your child, then consider it safe to eat. If your child's behavior deteriorated, leave that food out of the diet or retest it again later. Every few days add back another food and keep track of how your child reacts. Gradually, you may be able to identify foods that do and do not affect your child.

If your child stays on a sharply restricted diet for more than a few weeks, you should work with a dietitian to plan a diet that provides all the nutrients your child needs. Also, your child should take a daily vitamin-and-mineral supplement, which makes sense regardless of what diet he or she is on.

Another approach is to feed your child the few-foods diet until you see an improvement. Then add back *everything* —dyes, wheat, the works—for several days to see if *anything* triggers a reaction. If your child's behavior worsens, return your child to the special diet and add back foods one by one until you find the problems.

Finally, don't expect diet to bring about miraculous improvements in behavior. Even in kids who are affected by food ingredients, eliminating the culprits often yields only a partial improvement. But even partial improvements could be most welcome. If your child does not benefit significantly from a restricted diet, you should discuss with your pediatrician other treatment options, including medications and behavioral counseling.

Good Nutrition

Whether or not your child has ADHD or other behavioral problem, he or she should eat a nutritious diet. Most children eat far too many fatty, salty, and sugary foods—from burgers, fries, cheese, and ice cream to soft drinks, potato chips, and candy. And few children get the vitamins, minerals, fiber, and phytochemicals they need from fruits, vegetables, and whole grains. It is important to your child's current and future health to eat a really healthful diet (and that may mean that *you* need to improve your own diet to set a good example!). First steps include getting rid of the junk foods in your home, putting fatty and sugary foods off-limits when eating out, and turning off television shows riddled with junk-food ads. Also, give your child a daily vitamin-and-mineral supplement.

CSPI is a nonprofit health-advocacy organization. The contents of this pamphlet are not intended to provide personal medical advice, which should be obtained from a qualified health professional.

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