High Fructose Corn Syrup, Mercury, and Autism - Is there a Link?

Heather A. Opalinski

Abstract

The purpose of this article is to review relevant background literature and research regarding the evidence linking high fructose corn syrup (HFCS), mercury, and the increased incidence of autism among the population in the United States. Results of review suggest that rigorous scientific studies need to be performed to conclusively identify the link between autism and HFCS containing mercury. In addition, if factories continue to use mercury to process HFCS, a warning label identifying mercury in foods containing HFCS is absolutely necessary. In terms of practice implications, parents are often in the position of deciding which foods their children will consume in their daily lives. Families need to be informed to the current and credible evidence to make healthy decisions for their children and themselves. Excellent high fructose corn syrup information as well as, mercury resources are available online.

High Fructose Corn Syrup, Mercury, and Autism - Is there a Link?

The purpose of this article is to review relevant background literature regarding the evidence linking high fructose corn syrup (HFCS), mercury, and the increased incidence of autism among the population in the United States. Consumption of mercury primarily from dietary sources, such as high fructose corn syrup (HFCS), is related to the increased prevalence of autism (Wallinga, Sorenson, Mottl & Yablon, 2009).This literature review provides information regarding the relationship between the raise of autism and the increase use of high fructose corn syrup (HFCS) in everyday foods. High fructose corn syrup is being consumed in massive amounts in everyday diets, particularly in children (Ray, 2008).

A brief review of the literature pertaining to the increase in autism, the increase of high fructose corn syrup (HFCS) found in foods, the effects of HFCS and addressing the finding of mercury in HFCS are included for examination (Dufault, Le-Blanc, Schnoll, Cornett, Schweitzer, Wallinga, Hightower, Patrick & Lukiw, 2009). For illustrative purposes, research is provided linking HFCS and mercury to the increase in neurological defects found in the brain, which are similar to those with autism (Default, Schnoll, Lukiw, LeBlanc, Cornett & Patrick, 2009).

Autism

What is autism? According to the American Psychiatric Association, autism is defined as, "Autism is the most severe developmental disability, involving impairments in social interaction—such as being aware of other people's feelings—and verbal and nonverbal communication" (American Psychiatric Association, 2000). Autism is a relatively low-

incidence developmental disability that results in impairments of socialization, communication, and imagination (Frith, 1991). People with autism often exhibit major language problems such as delayed or absent speech. Repetitious behaviors often occur, such as rocking (Wing, 1991). Rituals seem almost universal among individuals with autism (Dewey, 1991; Tsai, 1992). Most people with autism also have severe intellectual disabilities (Yeung-Courchesne & Courchesne, 1997).

The understanding of autism has dramatically increased over the past 50 years. In the early 1940s Leo Kanner and Hans Asperger independently used the term "autistic" to describe children who appeared to have unusual reactions to sensory stimuli, exhibit stereotyped and repetitive behavior, lack imitative responses, desire sameness, and develop strong attachments to objects rather than people (Wing, 1991). Is the autistic brain neurology structured differently than "normal" developing brains? MRI scans of autistic brains showed abnormalities in the medial temporal lobe, including the hippocampus. Other scientific studies show biochemical abnormalities or abnormities in the development of the cerebellum (Default, et al. 2009).

Some brain scans indicated that prenatal autistic brain development is abnormal. The scans also show evidence of regional cerebral blood flow abnormalities. These structural and biochemical abnormalities may account for the behavioral manifestations of autism and may also account for a psychological condition which prevents autistic people forming "theory of mind" (Default, et al. 2009). The person is unable "to predict and explain the behavior of other humans in terms of their mental states" (Carlson, 1994). Differences in neurological development can result in altered sensitivity to sound, touch, visual input, and movement (Default, et al. 2009).

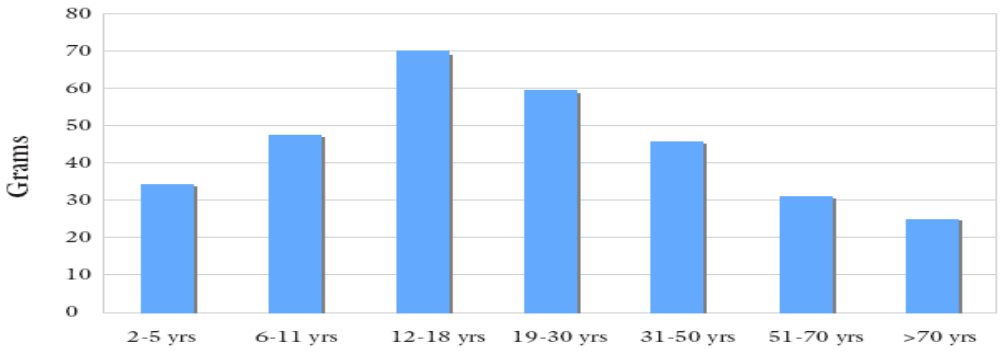
Children with developmental disabilities by definition do not develop along the same paths as nondisabled children (Goldberg, 1981). According to Courchesne and Townsend (1995) pervasive developmental disabilities affect the individual from infancy. Researchers suggest that difficulties with communication, social interaction, organization, and attention are symptomatic of damage to specific areas of the central nervous system (Default, et al. 2009). However they disagree on the exact site of the damage (Cox & Mesibov, 1995).

Furthermore, food allergies and sensitivities have been shown to produce a variety of neurological signs associated with autism (Default, et al. 2009). Neurons lacking in plasticity are a factor in neurodevelopment disorders such as autism and mental retardation. Nutritional deficiencies and mercury exposure have been shown to alter neuronal function and increase oxidative stress among children with autism (Default, et al. 2009). Mercury, either individually or in concert with other factors, may be harmful if ingested in above average amounts or by sensitive individuals (Default, et al. 2009). High fructose corn syrup has been shown to contain trace amounts of mercury as a result of some manufacturing processes, and its consumption can also lead to zinc loss, which is needed for the elimination of mercury from the body (Default, et al. 2009).

High Fructose Corn Syrup (HFCS)

High fructose corn syrup has been announced as being a health danger, while the Corn Refiners Association shouts the additive is safe (Wallinga, Sorenson, Mottl & Yablon, 2009). The bottom line of the corn refiners' stance is the consumer who chooses not to use products with corn syrup is simply misinformed as to how safe corn syrup is, especially in moderation. Are children moderate in their intake of high fructose corn syrup? Are pregnant women moderate in their use of this substance? According to Fig. 2, the highest consumers of HFCS are two groups ages 12-18 and 19-30 years old, presumably the years when women reproduce the most often.

Figure 2: Estimates of Average Daily HFCS Consumption, by Age Grouping

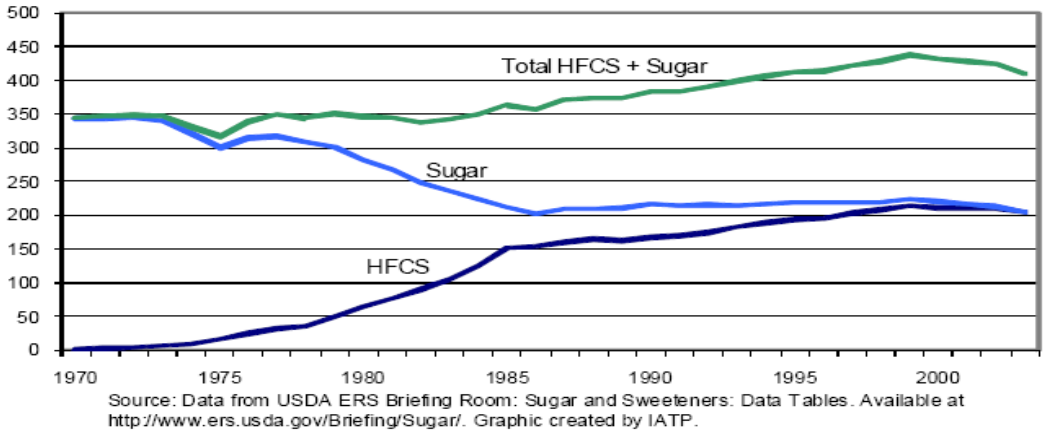


Adapted from data from Tables 1 and 3 in Vos M, Kimmons J, et al. Dietary fructose consumption among US children and adults: The third national health and nutrition examination survey. *Medscape J Med*. 2008. Figures assume: 1) 60% of fructose came from HFCS; 2) a 50% fructose/50% glucose combination in HFCS as a conservative measure; 3) calculation of HFCS content excludes fruit, fruit juices and vegetables.

Source: Fig. 2- Wallinga, Sorenson, Mottl & Yablon , 2009. Not so sweet: Mercury and high fructose corn syrup. Institute for Agricultural and Trade Policy.

Today, high fructose corn syrup is in almost everything you buy, from sodas to catsup (Ray J, 2008). It wasn't until the 1970's that high fructose corn syrup was created from the sugar in corn (Wallinga, Sorenson, Mottl & Yablon, 2009). This sweetener is certainly sweet, easy to make and cheaper than sugar. Many companies jumped on the high fructose corn syrup bandwagon, from sodas to pasta sauces to catsup to beer and even so-called health bars (Ray J, 2008). Take a look in your cupboard and start reading labels, you will be surprised at how many products contain this syrup. With regards to food allergies and intolerances, high fructose corn syrup is a major factor in behavior and intolerant reactions in both children and adults today (Wallinga, et al. 2009).

Figure 1: HFCS vs. Table Sugar (Sucrose) Consumption



Source: Data from USDA ERS Briefing Room: Sugar and Sweeteners: Data Tables. Available at http://www.ers.usda.gov/Briefing/Sugar/. Graphic created by IATP.

The diets of many today include daily sodas, which are filled with high fructose corn syrup. Juices and juice boxes are higher in HFCS. Snack bars, candy and many other snacks contain this syrup (Ray, 2008). You can even be consuming it unknowingly, while dining on spaghetti, adding some pizzazz with Worcester sauce, or dipping something into catsup (Wallinga, et al. 2009). How common is HFCS in everyday foods? Check any label and you're likely to find high fructose corn syrup listed as an ingredient. Not only is it an ingredient, but it is usually second or the third ingredient listed. Consumption of HFCS jumped 135% from 1977 to 2001(Wallinga, et al. 2009).

Corn syrup is found in everything from cereals to breads, frozen foods to condiments, especially in children's snack foods. Sometimes surprisingly, HFCS is a component in so-called "health" foods such as protein bars, granola, and sports drinks (Ray, 2008). Unfortunately, HFCS is most often the primary sweetener in juices and soft drinks, which children consume readily. Between 1978 and 1998, soft drink consumption among youth ages 6 to 17 years increased 48% (Ray, 2008).

Addressing Mercury in HFCS

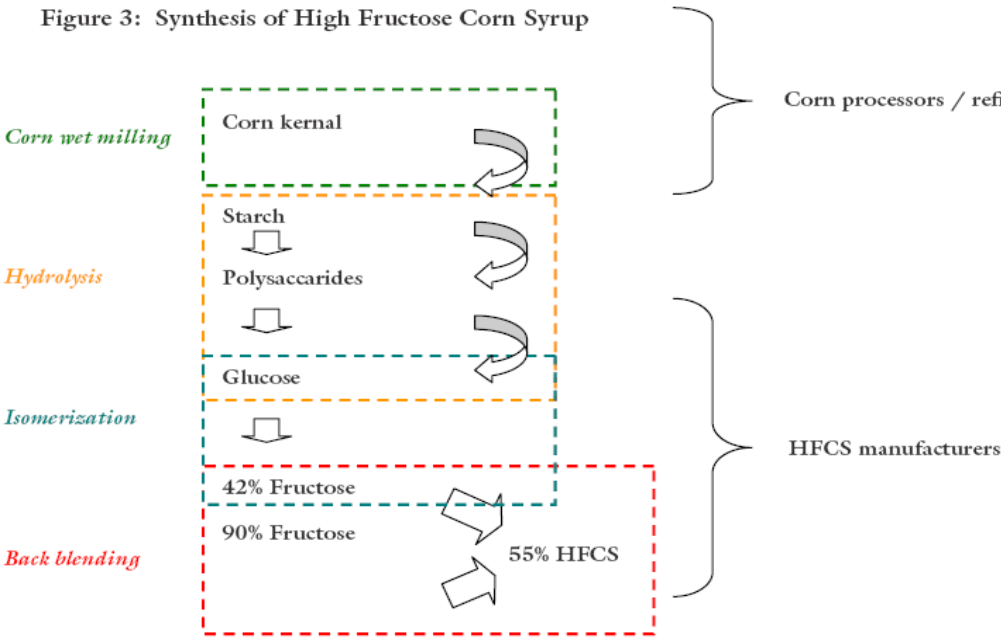
Mercury cell chlor-alkali products are used to produce thousands of other products including food ingredients such as citric acid, sodium benzoate, and high fructose corn syrup. High fructose corn syrup is used in food products to enhance shelf life (Ray, 2008). A pilot study was conducted to determine if high fructose corn syrup contains mercury, a toxic metal historically used as an anti-microbial. At *Environmental Health*, researchers studied high fructose corn syrup samples from three manufacturers, finding levels of mercury ranging from below a detection limit of 0.005 micrograms to detectable 0.570 micrograms mercury per gram of high fructose corn syrup (Default, et al. 2009). Average daily consumption of high fructose corn syrup is about 50 grams per person in the United States (Default, et al. 2009). With respect to total mercury exposure, it may be necessary to account for this source of mercury in the diet of children and sensitive populations since it is consumed so readily and in such large amounts (Default, et al. 2009).

Chlorine and caustic soda are produced at chlor-alkali plants using mercury cells or the increasingly popular membrane technology that is mercury free and more energy-efficient. Worldwide there are approximately fifty mercury cell chlor-alkali plants in operation (Oceana, 2010). Of those eight are in the United States (Environmental Protection Agency, 2009). In 2003 the EPA reported in the Federal Register that on average approximately seven tons of mercury were missing from each plant in the year 2000 (National Archives and Records Administration, 2000). These chlor-alkali plants have an average of fifty-six cells, each containing as much as 8,000 pounds of mercury (Natural Resource Defense Council, 2009) and, every year the chlor-alkali industry reports unaccounted for mercury losses to the EPA (United States Environmental Protection Agency, 2009).

Mercury is a danger to unborn children whose developing brains can be damaged if they are exposed to low dose microgram exposures in the womb (Goldman, 2001). Since mercury is a potent neurological toxin, these unaccounted for mercury losses from the chlor-alkali industry and the large amounts consumed daily through HFCS could be a source of exposure for fetuses, humans, wildlife, and the environment. An Environmental Health Officer (EHO) at the Food and Drug Administration (FDA) conducted an investigation to find the missing mercury in the chlor-alkali industry (Wallinga, et al. 2009). A representative of the Chlorine Institute confirmed in a telephone interview that the amount of mercury residue in mercury cell chlor-alkali products varies; depending on the manufacturing process at each plant (Gross, 2009).

Mercury grade caustic soda and hydrochloric acid are primarily used by the high fructose corn syrup industry (Wallinga, et al. 2009). HFCS industry uses both mercury grade caustic soda and membrane grade caustic soda in their manufacturing process to enhance product and indeed used as a sweetener by food manufacturers to stabilize food products and enhance product shelf life (Ray, 2008). Several chemicals are required to make HFCS, including caustic soda, hydrochloric acid, alpha-amylase, gluco-amylase, isomerase, filter aid, powdered carbon, calcium chloride, and magnesium sulfate (Tufts University, 2007). The caustic soda and hydrochloric acid are used throughout the milling process to adjust the pH of the product line (Krisberg, 2009). The product line starts with corn and the cornstarch molecule is then converted to different products by various methods that involve acids, bases, sodium hypochlorite and enzymes (Wallinga, et al. 2009).

Figure 3: Synthesis of High Fructose Corn Syrup



Source: Fig. 3- Wallinga, Sorenson, Mottl & Yablon, 2009. Not so sweet: Mercury and high fructose corn syrup. Institute for Agricultural and Trade Policy.

Should mercury grade caustic soda, hydrochloric acid, or sodium hypochlorite (derived from mercury grade chor-alkali chemicals) be used in the milling process? It seemed likely to the EHO that mercury may well end up in the final product – HFCS. A limited screening of HFCS samples for mercury was initiated by the EHO and researchers at NIST found low levels of total mercury (Default, et al. 2009).
To determine the extent of total mercury in HFCS products, the EHO then used additional government resources to collect HFCS samples from different manufacturers and collaborate with individuals outside of the federal government to analyze the samples for total mercury content. It should be noted that these activities occurred before the EHO retired in January 2008 (Default, et al. 2009).

A list of the foods that were recently tested for total mercury along with the results of the analyses may be found at the FDA website (Lurgi Life Science GmbH, 1999). In 2003, FDA tested 48 foods for mercury during the TDS and of those only three may have contained HFCS (Wallinga, et al. 2009). However, in January 2009 a study, "*Not So Sweet: Missing Mercury and High Fructose Corn Syrup*" reveals the presence of mercury in 17 of 55 brand-name food and beverage products that contain HFCS, or one-third of those selected products taken from store shelves in the fall of 2008 (Wallinga, et al. 2009). The average daily US consumption of HFCS for the year 2007 was approximately 49.8 g per person according to the US Department of Agriculture website (United States Department of Agriculture, 2007). High-end consumers of beverages sweetened with HFCS could easily be ingesting more HFCS than the average person. Results of a recent study of dietary fructose consumption among US children and adults indicate that

fructose consumption by Americans represents ten percent (10%) of calories consumed in a 24-hour period (Vos, et al. 2008).

Table 2.	No. of Samples	No. with detectable mercury (above LOD)	Mercury detected
Beverages	19	3	15.8%
Dressings and condiments	10	4	40.0%
Dairy products*	5	3	60.0%
Snacks and desserts	8	3	37.5%
Soups and entrees	3	1	33.3%
Syrups and jellies	10	3	30.0%
Total	55	17	30.9%
* Two of three dairy products with detectable mercury were chocolate milk, which also could easily be categorized as beverages.			

Source: Table 2- Wallinga, Sorenson, Mottl & Yablon, 2009. Not so sweet: Mercury and high fructose corn syrup. Institute for Agricultural and Trade Policy.

According to Table 2, mercury is detected in everyday items that contain HFCS. Mercury in any form, either as water-soluble inorganic salt, a lipid-soluble organic mercury compound, or as metallic mercury, is an extremely potent neurological toxin (Wallinga, et al. 2009).

Organic mercury compounds such as methyl mercury that are fat-soluble and readily cross the blood brain barrier are especially damaging to developing nervous tissues (Langford & Ferner, 1999) and (Castoldi, Johansson, Onishchenko, Coccini, Roda, Vahter, Ceccatelli & Manzo, 2008). For example, prenatal exposure as low as 10 mg/kg methyl mercury, as measured in maternal hair growing during pregnancy, may adversely affect the development of the fetal brain (Castoldi, et al. 2008) and (Myers & Davidson, 2000) . Confounding associations and concerns with various stages of brain development related to cumulative early life exposure to mercury include the following sources of mercury: maternal fish consumption during pregnancy, the thimerosal (sodium ethylmercurithiosalicylate, approximately 49% mercury weight) content of certain vaccines and dental amalgam (Oken & Bellinger, 2008).

There has never been a blinded, placebo, controlled study published giving humans mercury or methyl mercury, nor would this kind of study be ethically considerable. Quantitative information on long-term effects of inorganic mercury compounds on humans does not exist. Inorganic mercury compounds react with DNA and are clastogenic, which can causes breakages of chromosomes (World Health Organization, 2009). Because the mechanisms of these reactions remain unknown, it is currently impossible to establish a safe level of mercury for humans. The implications for mercury in ingested HFCS are not known and clearly more epidemiological and neurotoxicological studies are required (Wallinga, et al. 2009).

An EHO at the FDA conducted an investigation of the chlor-alkali industry in 2004 and found mercury residue in all of the mercury cell chlor-alkali products including caustic soda, chlorine, potassium hydroxide, and hydrochloric acid. Mercury is widely accepted

to be a neurotoxic heavy metal (Agency for Toxic Substances and Disease Registry). The American Academy of Pediatrics has recommended that minimizing any form of mercury exposure is essential for optimal child health and nervous system development (Goldman & Shannon, 2001). Current international food processing standards allow 1.0 μg mercury/g caustic soda (Institute of Medicine: Food Chemicals Codex, 2003) and (World Health Organization) and there is no standard for mercury in food grade hydrochloric acid. Both of these chemicals may be used to make HFCS (Wallinga, et al. 2009).

Linking Mercury, HFCS, and Autism

Mercury contamination of food products as a result of the use of mercury contaminated HFCS seems like a very real possibility (Wallinga, et al. 2009). With daily per capita consumption of HFCS in the US averaging about 50 grams and daily mercury intakes from HFCS ranging up to 28 μg, this potential source of mercury may exceed other major sources of mercury especially in high-end consumers of beverages sweetened with HFCS (Gross, 2009). Food products that contain a significant amount of HFCS should be tested for mercury contamination in the end product and the public should be informed of any detections.

In 2004, a study led by Raymond F. Palmer, et al. of the University of Texas Health Science Center in San Antonio compared the rate of special education programs in Texas and the amount of mercury found in the environment and the results were alarming: "On average, for each 1000 lb of environmental mercury released, there was a 43% increase in the rate of special education services and a 61% increase in the rate of autism" (Palmer, Blanchard, Stein, Mandell & Miller, 2009). He conducted a second study from February 2008 that took into account the proximity to sources of mercury output -- like coal-fired utility plants, which account for 33% of the 158 tons of mercury spewed into the atmosphere annually, municipal/medical incinerators, which account for 29%, commercial/industrial boilers, which account for 18%. This second study found that "for every 10 miles from industrial or power plant sources, there was an associated decreased autism Incident Risk of 2.0% and 1.4%, respectively" (Palmer, et al. 2008). In other words, the study found the more mercury in the environment of a child or woman of childbearing age, the more likely for the child to develop autism (Oken & Bellinger, 2008).

The reason that HFCS contains mercury is so alarming is two-fold: First, the FDA had evidence of this in 2005 and did absolutely nothing. No testing, no warning the companies using the tainted HFCS to produces their ketchup, chocolate syrup, cereal bars and soda (Krisberg, 2009). Therefore, more time has passed when mercury could bio-accumulate in humans. Second, there has been a previous association made between diet and autism, and particularly HFCS has been singled out as a cause for worsening the disorder (Wallinga, et al. 2009). This means that there has been a growing body of evidence relating mercury to autism for some time, in which HFCS is only a new development (Langford & Ferner, 1999). This could amount to one of the worst scandals by our government, which has been sitting on the evidence of mercury's relationship to

our health for too long, and if this is not true, could be testing HFCS further to dispute the findings of mercury found.

In 2005, Robert F. Kennedy, Jr. saw the correlation between autism and childhood vaccines (Mickleborough, 2009). It became clear to him that the parents of autistic children who blamed the vaccines for their child's disorder were onto something. He stumbled onto a report from a conference in 2000 called Simpsonwood, where high-level officials from the FDA and Center for Disease Control (CDC), the top vaccine specialist from the World Health Organization in Geneva, and representatives of every major vaccine manufacturer, including GlaxoSmithKline, Merck, Wyeth and Aventis Pasteur gathered to discuss a new study that linked a mercury-based preservative in vaccines to increasing rates of autism (Myers & Davidson, 2000). This group, instead of changing direction, and assessing the data, decided to cover up the research to presumably save the companies' bottom line.

Mercury is a potent brain toxin that we know accumulates in fish and seafood, although diet is not the only route by which we are exposed (Wallinga, et al. 2009). When babies are exposed to elevated mercury in the womb, their brains may develop abnormally, impairing learning abilities and reducing IQ. For these youngest children, the science increasingly suggests there may be no "safe" level of exposure to mercury (Weiss, 1994). Yet for decades an increasingly common ingredient in processed foods, HFCS, has been made using mercury-grade caustic soda. "Mercury-grade," also known as "rayon grade" caustic soda, comes from chlorine plants still using an outdated 19th century technology that relies on the use of mercury (Wallinga, et al. 2009). While most chlorine plants around the world have switched to newer, cleaner technologies, some still rely on the use of mercury. These mercury cell plants may rival coal-fired power plants as sources of mercury "leaked" to the environment. What has not been publicly recognized is that mercury cell technology can also contaminate all the food grade chemicals made from it, including caustic soda, as well as hydrochloric acid. It was unrecognized, that is, until the lead author of the *Environmental Health* study, a longtime environmental investigator of the Food and Drug Administration (FDA), thought to look into it (Wallinga, et al. 2009). What was found was that possible mercury contamination of these food chemicals was not common knowledge within the food industry despite the availability of product specification sheets for mercury- grade caustic soda that clearly indicate the presence of mercury (as well as lead, arsenic and other metals) (Vos, et al. 2008). Through this public scientist's initiative, the FDA learned that commercial HFCS was contaminated with mercury (Wallinga, et al. 2009). The agency has apparently done nothing to inform consumers of this fact or to help change industry practice (Wallinga, et al. 2009).

Consumers probably are not the only ones in the dark. While HFCS manufacturers certainly should have been wary of buying "mercury-grade" caustic soda in the first place, the food companies that buy finished HFCS and incorporate it into their processed food products may be equally unaware of how their HFCS is made, i.e., whether or not it is made from chemicals produced by a chlorine plant still using mercuy cells (Potts & Bellows, 2006). The HFCS isn't labeled "Made with mercury," just like contaminated pet foods, chocolates and other products have not been labeled "Made with melamine."

Under current regulations, that information is not made available to either consumers or to companies further down the food supply chain.

Study Found Mercury in Common Everyday Foods

In a January 2004 report from the Institute for Agriculture and Trade Policy, researchers detected mercury in almost one-third of 55 brand name food and beverage products in which the first or second labeled ingredient was HFCS (Wallinga, et al. 2009). The study included some of the most recognizable brands on supermarket shelves: Quaker, Hunt's, Manwich, Hershey's, Smucker's, Kraft, Nutri-Grain and Yoplait. Mercury was not detected in the majority of beverages tested (Wallinga, et al. 2009). That may be important since sweetened beverages are one of the biggest sources of HFCS in our diets.

Table 1: U.S. HFCS Consumption by Type of User Industry (thousand short tons)

Industry	2002	Percent
Beverages (mostly soft drinks)	5270.2	57.0
Canned, bottled, and frozen foods	685.7	7.0
Bakery, cereals and allied products	513.1	6.0
Ice cream and dairy products	258.5	3.0
Confectionery and related products	83.0	1.0
Total	9294.0	

Source: Beghin JC, Jensen HH. Farm policies and added sugars in US diets. Working Paper 08-WP 462. 2008. Iowa State University. Calculated from U.S. Census Bureau data available as of February 2008.[4]

Source: Table 1- Wallinga, Sorenson, Mottl & Yablon, 2009. Not so sweet: Mercury and high fructose corn syrup. Institute for Agricultural and Trade Policy.

On the other hand, mercury was found at levels several times higher than the lowest detectable limits in some snack bars, barbecue sauce, sloppy joe mix, yogurt and chocolate syrup. Although closer to the detection limit, elevated mercury levels were also found in some soda pop, strawberry jelly, catsup and chocolate milk. The top products containing mercury are summarized in Table 3.

Table 3 indicates the food products for which total mercury was detected, highest to lowest.

Table 3.

Product Name	Total Mercury	Limit of Detection (ppt)
Quaker Oatmeal to Go	350	80
Jack Daniel's Barbecue Sauce (Heinz)	300	100
Hershey's Chocolate Syrup	257	50
Kraft Original Barbecue Sauce	200	100
Nutri-Grain Strawberry Cereal Bars	180	80
Manwich Bold Sloppy Joe	150	80
Market Pantry Grape Jelly	130	80
Smucker's Strawberry Jelly	100	80
Pop-Tarts Frosted Blueberry	100	80
Hunt's Tomato Ketchup	87	50
Wish-Bone Western Sweet & Smooth Dressing	72	50
Coca-Cola Classic	62	50
Yoplait Strawberry Yogurt	60	20
Minute Maid Berry Punch	40	30
Yoo-hoo Chocolate Drink	30	20
Nesquik Chocolate Milk	30	20
Kemps Fat Free Chocolate Milk	30	20

Source: Table 3- Wallinga, Sorenson, Mottl & Yablon, 2009. Not so sweet: Mercury and high fructose corn syrup. Institute for Agricultural and Trade Policy.

"Mercury is toxic in all its forms," said David Wallinga, MD, a co-author of both the report and article and director of the Food and Health Program at the Institute for Agriculture and Trade Policy. "Given how much high fructose corn syrup is consumed by children, it could be a significant additional source of mercury never before considered. We are calling for the Food and Drug Administration to help stop this avoidable mercury contamination of the food supply" (Wallinga, et al. 2009).

In response to the reports, the Corn Refiners Association said the findings were "based on outdated information of dubious significance," adding that the mercury levels found in the supermarket food products were "far below levels of concern" set by federal agencies (Gross, 2009). However, Wallinga noted that while the *Environmental Health* findings were based on samples taken in 2005, they are the only such high fructose corn syrup samples available. He said that if the "corn refiners or anyone else" has more recent samples of the food additive, in the form a food company would receive it before it is added to the final product, he urges them to make such samples available for study. He added that any level of mercury contamination should be viewed as undesirable. The U.S. Food and Drug Administration has long recognized that HFCS is safe. In 1983, the FDA listed HFCS as "Generally Recognized as Safe" for use in food, and reaffirmed that ruling in 1996 after a thorough review. However, the FDA did not conduct further testing despite the evidence of mercury found everyday common foods found in the supermarket (Gross, 2009).

Comments Regarding HFCS and the Corn Refiners Association

HFCS has made headlines before. The additive has been criticized by nutrition, whole-food and parent-advocacy groups for the correlation between increased consumption and rising obesity and diabetes rates in children. The Corn Refiners Association has staunchly disputed claims of the detrimental health effects of HFCS. It's released a slew of pro-HFCS advertisements touting the substance's "natural" origins (Gross, 2009).
Products have not yet been removed from grocery store shelves because the origins and legitimacy of the IATP study results are still being questioned by *corn* industry groups and implicated manufacturers. The researchers and scientists who compiled the IATP report suggest that the work in the study was "never intended to take the place of a full-scale safety test by the FDA." But they caution that the findings have serious implications for public health, since the U.S. consumes so many HFCS-containing products (Gross, 2009).

In a February 2009 press release, Corn Refiners Association (CRA) President Audrae Erickson said, "The article's authors and the IATP engage in unfounded claims and speculations based on scant data of questionable quality. High fructose corn syrup is safe for use in foods and beverages. To imply that there is a safety concern based on this incomplete and flawed report is irresponsible. The article and the report are based on outdated information of dubious significance" (Gross, 2009). The CRA questions the legitimacy of the IATP report because it is based on Food and Drug Administration (FDA) data from 2005. Former FDA researcher Renee Default and a team of scientists found that nine out of 20 products contained mercury, or 45% of the samples. But not until Default retired from the FDA in March 2008 were the findings made public (Gross, 2009).

Despite mercury contamination, HFCS continues to be used widely in the U.S. because it is significantly less expensive than table sugar. Sugar farmers do not receive subsidies in the U.S., which is why prices have generally been higher than those of corn. Most manufacturers switched to HFCS in the 1970s and 1980s, as corn subsidies made the sweetener extremely cheap as food manufacturers sought a less-expensive alternative to sugar (Zmuda & York, 2010). However, increased ethanol production in recent years has boosted the price of corn, and consequently corn sweeteners. According to the USDA, the average price of HFCS during fiscal 2009 was 31¢ a pound, while sugar prices averaged 36¢ a pound. Yet sugar prices have spiked dramatically in 2010, 53¢ per pound in February, compared with 27¢ for HFCS (Zmuda & York, 2010).

In response to consumer concerns with HFCS, the Corn Refiners Association has mounted a massive advertising and PR offensive to dispel the myth that corn sweeteners are less healthy than sugar. The organization's research underscores that the body processes all sweeteners the same, be they processed or natural. Working with the ad agency DDB and a team at Ogilvy Public Relations, the Corn Refiners Association has plowed more than $30 million over the last two years into an ad campaign called; "*Sweet Surprise*" that highlights what it says are vague and unsubstantiated opinions (Gross, 2009). In one of the TV ads, a woman at a picnic stares critically at her friend who is

pouring a drink containing high-fructose corn syrup. "Wow, you don't care what the kids eat, huh?" she asks. When the mom can't identify why the syrup is so bad, she awkwardly changes the subject, announcing, "Love that top!" (Gross, 2009).

Among the numerous spoofs of the campaign, one of the more outrageous recreates the picnic scene with a man in drag playing the syrup-loving mom, though this time she is also defending lead from China, female genital mutilation ("It's safe in moderation") and K.K.K. cross-burning. Two Los Angeles comedians created the YouTube video, which has been watched more than 225,633 (YOUTUBE- HFCS Spoof, 2010). Clearly, there are still many who are not in favor of HFCS despite the Corn Associations efforts.

Ms. Erickson says she has heard of the spoofs but has not bothered to watch most of them. "We're really focused on trying to correct the record since a lot of the information consumers have is incorrect," she says. "High-fructose corn syrup is a case of mistaken identity." And as for those mercury studies that spread like wildfire last year, Ms. Erickson says that there is no reason to believe that the mercury detected in various foods was coming from high-fructose corn syrup. In a further attempt to improve its image, the Corn Refiners Association has petitioned the Food and Drug Administration to allow a name change to the simpler, "corn syrup" (Gross, 2009). In January, the FDA issued a letter to the Corn Refiners giving its thumbs-up to the name change. However, after an objection from the Corn Refiners' rival, the Sugar Association, FDA officials sent another letter saying that they needed to give the matter further thought (Gross, 2009).

The Quaker Oatmeal To Go Bar was one product found to contain mercury in its HFCS. Quaker Oats Company Public Relations Manager Candace Mueller says, "Based on our initial observations of the environmental health study, we are concerned that the methodology and assumptions relied on in the study are critically flawed and that their purported findings are insufficient to support their claims and to warrant alarm." Quaker will continue to sell the bars (Gross, 2009). The FDA suggests that the IATP report does not provide any specific information about "any appreciable risk from this potential exposure from mercury," saying, "The authors provide no information as to what form of mercury the total is comprised of. It is very probable that the total mercury level represents mostly inorganic mercury; this represents no health hazard since it is so poorly absorbed when ingested. In addition, the potential levels of exposure are extremely low" (Gross, 2009).

David R. Brown, Sc.D., director of public health toxicology at Environment and Human Health, Inc. and professor of environmental ethics at Fairfield University in Fairfield, Connecticut said, "Currently, under FDA guidelines, the products (listed in the IATP report) are not 'contaminated' but 'adulterated,' meaning that mercury is not meant to be there. It's not right to have mercury in Quaker Oats (bars) or any other food," he adds. Although many companies with products on the list have questioned the merits of the IATP report, the presence of mercury in any food sources leaves Brown concerned. "It's a situation that warrants more than passing attention," he says. "The major question is how in the world did we have mercury in food sources and nothing was done about it?" (Gross, 2009).

Saying Goodbye to HFCS

According to a recent article, "*Major Brands no Longer Sweet on High-Fructose Corn Syrup,*" consumers are demanding major brands are removing high fructose corn syrup from some of their products in favor of sugar. Few, however, are shouting it from the rooftops as it would cast a shadow on those products that still contain HFCS (Zmuda & York, 2010). As a result, sales of the ingredient have fallen in the United States were down 9 percent in 2009, compared with 2007. A further decline is expected this year (Zmuda & York, 2010). According to the NPD Group, a market research firm, more than half of all Americans, 53 percent, now say they are concerned that high fructose corn syrup may pose a health hazard, up from 40 percent in 2004 (Zmuda & York, 2010). Hunt's ketchup, Gatorade and Wheat Thins are all permanently ditching corn syrup for sugar. Heinz has created a sugar-sweetened version of its iconic ketchup, while Pepsi and Mountain Dew launched limited-time, sugar-sweetened versions of their colas. But with all of these reformulations, only Pepsi and Mountain Dew have made any noise to date (Zmuda & York, 2010). "We know moms don't like it, and they don't want to feed it to their kids," said supermarket expert Phil Lempert, who has pushed for HFCS removal for a decade. "As a result, the brands that lead the pack to get rid of it, they're going to see an uptick in sales." He added that the sugar shift is an easier one for consumers than say fat-free cheese. Most consumers either don't notice a taste difference or prefer the sugar version (Zmuda & York, 2010).

"We know HFCS was of interest to some of our consumers, but not all," a Wheat Thins spokesman said. The brand chose not to broadcast its shift to sugar, though it did market the broader product overhaul, focusing on the benefits of whole grains. New packaging references the lack of HFCS in the product, but it's "not a core message in our marketing," the spokesman said (Zmuda & York, 2010). Gatorade declined to share specifics of its marketing plans around the reformulation of Gatorade and G2. But a spokeswoman said that targeted communications are planned to address audiences who have expressed concerns about HFCS, namely moms and health professionals. "Removing HFCS is part of our long-term strategy to reinforce the functional benefits and quality of Gatorade and G2," she said. "Through our research and understanding of athletes, we have learned many have a negative perception of HFCS" (Zmuda & York, 2010).

Hunt's is planning to market its ketchup overhaul, hitting shelves in May. "We made the decision to take it out due to consumer's desire for shorter, simpler ingredient lists," a spokeswoman said, adding, "Consumers preferred the taste" (Zmuda & York, 2010). Kraft products that don't include the sweetener include the Back to Nature product line; Nabisco Oreo 100 Calorie Pack Chewy Granola Bars; Lunchables Pizza and some Kraft Salad Dressings. "We know some consumers are interested in items without high-fructose corn syrup, so we have eliminated it in some of our products," says a spokeswoman for the food maker. Kraft says it has no plan to eliminate HFCS entirely from its product line (Zmuda &York, 2010).

Further Action

On February 16, 2009 (ENS, 2009), the Obama administration reversed the former U.S. position on limiting mercury pollution worldwide. According to The United Nations Environment Programme Governing Council (UNEP) Executive Director Achim Steiner, "It covers reducing demand in products and processes - such as high intensity discharge vehicle lamps and the chlor-alkali industry - to cutting mercury in international trade," Steiner said. "Other elements include reducing emissions to the atmosphere, environmentally-sound storage of stockpiled mercury and the cleaning-up of contaminated sites." Steiner also stated that the mercury policy framework is the result of seven years of intense discussions spearheaded by UNEP and it represents the first, coordinated global effort to tackle mercury pollution (ENS, 2009).

The U.S. Environmental Protection Agency has determined that mercuric chloride and methyl mercury are possible human carcinogens and exposure to high levels of mercury can permanently damage the brain, kidneys, lungs, and developing fetus (ENS, 2009). "The Obama administration has clearly shown a new day has dawned for U.S. leadership and engagement with the rest of the world," said Michael Bender, director of the U.S.-based Mercury Policy Project, and a coordinator of the international Zero Mercury Working Group. "And the momentum created by the U.S. appears to be galvanizing other governments around the world to step up to address the global mercury crisis" (ENS, 2009).

Conclusion

Clearly, more research is needed to determine the extent of mercury exposure in contaminated HFCS in food products. Research is still unsure as to the exact cause or causes of autism in general. A thorough review of the literature indicates, among other things, that some researchers believe children's diets including high fructose corn syrup and mercury are a contributing cause of the increase of autism (Wallinga, et al. 2009). Dietary exposure to mercury can pose life-threatening risks to adults, children, and developing fetuses by attacking the nervous system (Default, et al. 2009). News reports and research that indicate mercury, whether present in fish, vaccines, high fructose corn syrup, proximity to coal-burning power plants or occurring naturally in the environment may be linked to increasing incidents of autism (Default, et al. 2009). Rigorous scientific studies need to be performed to conclusively identify the link between autism and HFCS containing mercury.

In addition, if factories continue to use mercury to process HFCS, a warning label identifying mercury in foods containing HFCS is absolutely necessary. Parents are often in the position of deciding which foods their children will consume in their daily lives. Families need to be informed to the current and credible evidence to make healthy decisions for their children and themselves. Most importantly, informing the population, especially families, on the possible dangers of HFCS is critical and the public must stop buying and consuming products that contain high fructose corn syrup until further action and research are taken.

References

Adams, L., & Conn, S. (1997). Nutrition and its relationship to autism. *Focus on Autism and Other Developmental Disabilities*, 12(1), 53-58. doi:10.

Agency for Toxic Substances and Disease Registry [http://www.atsdr.cdc.gov/toxprofiles/tp46-c1-b.pdf]

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental Disorders* (4th edition, text revision). Washington, D.C.

Brodnax, M., Wisenor, D., & Roberts, G. (2004). Autism: consequences of mercury toxicity. *Journal of Continuing Education Topics & Issues*, 6(3), 120-127.

Castoldi, A., Johansson, C., Onishchenko, N., Coccini, T., Roda, E., Vahter, M., Ceccatelli, S., & Manzo, L. (2008). Human developmental neurotoxicity of methylmercury: Impact of variables and risk modifiers. *Regul Toxicol Pharmacol*, 51:201-214.

Dufault, R., Le-Blanc, B., Schnoll, R., Cornett, C., Schweitzer, L., Wallinga, D., Hightower, J., Patrick, L., & Lukiw, W.J. (Jan 2009). Mercury from chlor-alkali plants: measured concentrations in food product sugar, *Environmental Health 8*: 1-6.

Dufault, R., Schnoll, R., Lukiw, W., LeBlanc, B., Cornett, C., & Patrick, L. (2009). Mercury exposure, nutritional deficiencies and metabolic disruptions may affect learning in children. *Behavioral and Brain Functions*, 5doi:10.

Environment News Service (ENS). (2009). *Obama shifts U.S. policy to back blobal mercury control treaty.*

Food and Drug Administration 2007 [http://www.cfsan.fda.gov/~comm/tds-food.html]

Food and Drug Administration [http://www.cfsan.fda.gov/~dms/foodlab.html]

Galef, J. (2010). Uncertainty in science. *Humanist*, 70(1), 10-13.

Gaugh, L. (2007). Nutrition and diet: Alternative interventions for autism spectrum disorders. *Dissertation Abstracts International*, 67.

Goldman, L., & Shannon, M. (2001). American academy of pediatrics technical report: Mercury in the environment: Implications for pediatricians. *Pediatrics*, 108:197-205.

Gross, A. (2009). Eating mercury. *E - The Environmental Magazine*, 20(3), 19-22.

Hightower, J. (2008). *Diagnosis mercury: Money, politics, and poison*. Washington DC: Island Press.

Institute of Medicine (2003). *Food Chemicals Codex* (5th edition). Washington DC: National Academies Press.

Ip, P., Wong, V., Ho, M., Lee, J., & Wong, W. (2004). Mercury exposure in children with autistic spectrum disorder: Case-control study. *Journal of Child Neurology*, 19(6), 431-434.

Krisberg, K. (2009). Findings: Everyday food sweetener poses mercury contamination risk. *Nation's Health*, 39(3), 6.

Langford, N., & Ferner, R. (1999). Toxicity of mercury. *J Hum Hypertens*, 13:651-656.

Lurgi Life Science GmbH. (1999). High Fructose Syrup Production-Process and Economics. In *Proceedings of International Conference on Value-* Added Products for the Sugar Industry.

Mickleborough, T. (2009). Should I worry about high-fructose corn syrup? *Triathlete*, (299), 138-142.

Myers, G., & Davidson, P. (2000). Does Methylmercury have a role in causing developmental disabilities in children? *Environ Health Perspec*, 3:413-420.

New Findings Bitter, Sweet for Fructose Fans (2007). *Tufts University Health & Nutrition Letter*, 25(7), 5.

Oken, E., & Bellinger, D. (2008). Fish consumption, methylmercury and child neurodevelopment. *Curr Opin Pediatr*, 20:178-183.

Palmer, R.F., Blanchard, S., Stein, Z., Mandell, D., & Miller, C. (2009). *Environmental mercury release, special education rates, and autism disorder: An ecological study of Texas*. R.F. Palmer/ Health and Place. University of Texas Health Science Center, San Antonio Department of Family and Community Medicine.

Palmer, R.F., Blanchard, S., & Wood, R. (Feb 2008). *Proximity to point sources of environmental mercury release as a predictor of autism prevalence*. University of Texas Health Science Center, San Antonio Department of Family and Community Medicine.

Phetrasuwan, S., Miles, M., Mesibov, G., & Robinson, C. (2009). Defining autism spectrum disorders. *Journal for Specialists in Pediatric Nursing*, 14(3), 206-209.

Potts, M., & Bellows, B. (2006). Autism and diet. *Journal of Epidemiology & Community Health*, 60(5).

Ray, J .(2008). Is HFCS a health danger? *J. American Dietetic Assoc*., 103, Is 10, p1326-31.

State of California [http://www.oehha.ca.gov/prop65/law/pdf_zip/andersonseafood.pdf]

United States Department of Agriculture [http://www.ers.usda.gov/briefing/sugar/data/table52.xls]

Vos, M., Kimmons, J., Gillespie, C., Welsh, J., & Blanck H. (2008). Dietary fructose consumption among U.S. children and adults: The third national health and nutrition examination survey. *Medscape J Med*, 10:160.

Wallinga, Sorensen, Mottl, & Yablon. (2009). *Not so Sweet: Missing mercury and high fructose corn syrup. Institute for Agriculture and Trade Policy* (IATP).

Weiss, B. (1994). *The developmental neurotoxicity of methyl mercury. Prenatal exposure to toxicants: Developmental consequences* (pp. 112-129). Baltimore, MD US: Johns Hopkins University Press.

World Health Organization (2009). [http://www.who.int/ipcs/publications/cicad/en/cicad50.pdf]

Zmuda & York. (2010). Major brands no longer sweet on high fructose corn syrup. *Advertising Age,* 81(11), 8.