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Latent labels:
Is corporate obfuscation surrounding synthetic and industrialized food chemicals leading to serious health safety issues for U.S. consumers?

Abstract: This paper explores findings linking a myriad of synthetic and industrialized food chemicals to serious adverse health consequences, and juxtaposes this with a theoretical construct suggesting label obfuscation and other actions by the chemical and food manufacturing industries as a primary reason these additives remain in the food sans label warnings to alert consumers. Also explored are potential obstacles behind the U.S. Food and Drug Administration's failure to require warnings on food labels for consumers alerting them about potential hazards of some of these synthetic and industrialized food chemicals, and the effect this has had on consumer confidence and behavior.

Many U.S. consumers rely on the government for health safety labeling about synthetic and industrialized food chemicals and to monitor corporate marketing of ingredients and healthy food claims on food products containing these chemicals, but is that a good idea? This paper presents evidence that suggests that marketing and label obfuscation, among other tactics from the chemical and food manufacturing industries, combined with the current lack of government required warnings and disclosures on food ingredients labels, leaves consumers unaware and unprotected and thereby vulnerable to potentially harmful synthetic and industrialized food chemicals that may pose a threat to their health and well-being.

SYNTHETIC AND INDUSTRIALIZED FOOD CHEMICALS AND ADVERSE HEALTH OUTCOMES

A number of commonly used synthetic and industrialized food chemicals (more specifically, food additives, colorings/dyes, and preservatives) in the U.S. have been linked in empirical studies and clinical trials to adverse symptoms and health consequences (Lau et al. 2006; Sasaki et al. 2002; Tuormaa, 1994; Parke and Lewis 1992). The same is true for animal antibiotics, animal growth hormones and other animal drugs which have been found in U.S. meat and dairy products (McEwen and Fedorka-Cray 2002), as well as with high residue content of pesticides which have been found in both produce and meat and dairy products in the U.S. (LeDoux 2011).

One group of synthetic and industrialized food chemicals extensively studied and sometimes linked with adverse health reactions include food dyes/food colorings (Ahearn and Weiss 2010; McCann et al.

2007; Lau et al. 2006; Sasaki et al. 2002; Conners 1980; Ceserani, Colombo and Robuschi 1978; Feingold 1977; Freedman 1977; Baer and Leider 1949). A recent review of the empirical studies on food dyes revealed: "The food industry dumps over 15 million pounds of the dyes studied into the food supply each year. Three of the dyes carry known carcinogens, and four can cause serious allergic reactions in some consumers. New studies show that seven of them contributed to cancer in lab animals, including brain and testicular tumors, colon cancer, and mutations" (Curran 2010). One such food dye in particular (commonly found in candy and cereals, among other processed foods) is Tartrazine (FD&C Yellow dye #5) which appears to cause the most adverse reactions of all azo dyes—especially to people with allergies and asthma (Elhkim et al. 2007; Arai et al. 1998; Dipalma 1990; Ceserani, Colombo, and Robuschi, 1978; Neuman et al.1978; Lockey 1977) and has been linked in empirical studies and clinical trials to behavioral problems in children, including ADHD and learning difficulties (Pelsser et al. 2011; Ahearn and Weiss 2010; McCann et al 2007; Bateman et al. 2004; Schab and Trinh 2004; Rowe and Rowe 1994; Pollock and Warner 1990; Weiss 1982; Swanson and Kinsbourne 1980; Weiss et al. 1980; Feingold 1977; 1976; 1975), respiratory problems, bronchospasms and asthma (Arai et al. 1998; Corder and Buckley 1995; Dipalma 1990; Hong et al. 1989; Van Bever, Docx and Stevens 1989; Settipane 1987; Freedman 1977; Stenius and Lemola 1976), urticaria/skin reactions (Dipalma 1990; Van Bever, Docx and Stevens, 1989; Settipane 1987; Juhlin 1981; Ceserani, Colombo, and Robuschi 1978; Settipane et al.1976), anaphylactic shock (Trautlein and Mann 1978) irritability, restlessness, and insomnia/sleep disturbances in some children (Bateman et al. 2004; Rowe and Rowe 1994). Animal studies have also found a link with Tartrazine and generalized toxicity/genotoxicity (Sasaki et al. 2002; Davis, Fitzhugh, and Nelson 1964), adverse immunosuppressive effects (Koutsogeorgopoulou et al. 1998), and cancer (Patterson and Butler 1982). The FDA's position on Tartrazine is that it prompts "minor adverse reactions in some people" (Henkel 1993). In 2008 the Center for Science in the Public Interest filed a regulatory petition with the FDA requesting that this

food dye be removed from the permitted food coloring list (Center for Science in the Public Interest 2008). To date, Tartrazine (FD&C Yellow dye #5) remains a permitted food dye in U.S. foods and while like other food dyes it is required to appear on ingredients listings, there are no warning labels on products containing it (Center for Food Safety and Applied Nutrition/U.S. Food and Drug Administration Color Additive Status List 2009a; U.S. Food and Drug Administration 2008a; 2003a).

A recent study on caramel food coloring suggests this food dye may pose serious health consequences for consumers. Caramel food dye is common in many processed foods such as soda. Synthetic caramel coloring is processed with the use of sulfites which are recognized by the medical and research community as potentially dangerous to people with asthma and other health conditions (Metcalfe, Sampson, and Simon 2008; Puglisi and Frieri 2007; Arai et al. 1998). Toxicological data from clinical trials and animal research studies indicate this food dye is an immunosuppressive and can trigger allergic reactions in some people (Greenhawt and Baldwin 2008; World Health Organization Technical Report 2001; de Heer et al. 1995; Thuvander and Oskarsson 1994; Houben et al. 1993). A recent study by Moon and Shibamoto (2011) linked this food chemical to cancer. Following the release of this study the Center for Science in the Public Interest (2011), along with five independent food science experts, filed a regulatory petition with the FDA requesting that caramel coloring be removed from the permitted food coloring list, citing FDA policy which allows the use of colors the agency believes have “a reasonable certainty of no harm" while color additives that have been found to cause cancer in animals or humans are disallowed in FDA-regulated foods and drugs.

Previous studies on other food dyes/colorings have been linked to neurobehavioral effects (Ahearn 2010; Ahearn and Weiss 2010; Weiss 2008; Elhkim 2007; Bateman et al. 2004; Schab andTrinh 2004; Rowe and Rowe 1994; Pollock and Warner 1990; Sarantinos, Rowe and Briggs 1990; Weiss 1982; Conners et al. 1980; Swanson and Kinsbourne 1980; Weiss et al. 1980; Goyette et al. 1978; Lockey 1977; Feingold 1968). A recent public information report presented a review of the study findings on

food dyes (Kobylewski and Jacobson 2010) revealing to consumers that clinical studies and laboratory research examining the link between several FDA-approved food colorings and adverse consequences has been taking place for decades (Moon and Shibamoto 2011; Ahearn and Weiss 2010; Schab and Trinh 2004; Ward 1996; Rowe and Rowe 1994**;** Pollock and Warner 1990; Rowe 1988; Chung et al.1981; Juhlin 1981; Swanson and Kinsbourne 1980; Weiss et al. 1980; Goyette et al. 1978; Price et al.1978; Honohan et al.1977; Feingold 1976; Michaelsson, Pettersson, and Juhlin 1974; Radomski 1974; Michaelsson and Juhlin 1973; Ryan, Welling and Wright 1969; Chafee and Settipane 1967; Radomski, and Mellinger 1962; Baer and Leider 1949). FD&C Blue #1 has been linked with triggering hypersensitivity reactions in some people (Juhlin 1981) and systemic toxicity and death when used in enteral feeding tubes (U.S. Food and Drug Administration 2003b). Animal studies on FD&C Blue #2 first indicated a statistically significant incidence of tumors as far back as three decades ago (Price et al. 1978) and has been determined by the World Health Organization to have toxicity risks in patient feeding tubes, "FD&C Blue No. 2, may have similar if not greater toxicity potential than Blue No. 1 and would not be appropriate replacements" (World Health Organization 2003). FD&C Red #40 has been linked with allergy-like hypersensitivity in a small number of adults and a potential trigger for hyperactivity in children (Bateman et al. 2004; Schab and Trinh 2004; Sarantinos, Rowe, and Briggs 1990; Conners et al. 1980; Conners, Petti, and Curtis 1978) and has been linked in animal studies to intrauterine developmental problems (Collins and Black 1980), behavioral and physical toxicity (Vorhees et al. 1983); genotoxicty (Sasaki et al. 2002) and colon DNA damage (Tsuda et al. 2001). FD&C Red #3 has been linked to cancer in animal studies (Lin and Brusick 1986), though the FDA has been clear that it does not agree that these findings are persuasive enough to reverse their position that these food dyes are safe for consumers (Blumenthal 1990). FD&C Yellow #6 (Sunset yellow) has been linked in a case study to anaphylactic shock (Trautlein and Mann 1978), in empirical research to allergic reactions and gastroenteritis (Gross et al,1989), adverse reproductive and neurobehavioral effects (Tanaka 1996) and cancer (National

Toxicology Program 1981). Despite the FDA's acknowledgement of the findings on FD&C Yellow #6: "Industry-sponsored animal tests indicated that this dye, the third most widely used, may cause tumors of the adrenal gland and kidney. In addition, small amounts of several carcinogens, such as 4-aminobiphenyl and benzidine (or chemicals that the body converts to those substances) may contaminate dye Yellow #6. However, the FDA reviewed those data and found reasons to conclude that Yellow 6 does not pose a significant cancer risk to humans. Yellow 6 may cause occasional and sometimes severe hypersensitivity reactions in some people," their final position is that this food dye is safe for public consumption (U.S. Food and Drug Administration 2007a;b).

There have been numerous screenings, tests and reviews concerning the safety of a variety of food colorings over the years (Sasaki et al. 2002; Hayashi et al. 2000; Peiperl et al. 1995; 1993; Center for Food Safety and Applied Nutrition 1993; Blumenthal 1990; Flamm et al. 1985; Lagakos and Mosteller 1981; Haveland-Smith and Combes 1980; FAO/WHO Expert Committee on Food Additives 1969) and based on numerous research findings The Center for Science in the Public Interest filed a Citizens Regulatory Petition requesting that the FDA ban these food dyes (2008). The FDA however, has concluded that the evidence weighs in favor of determining the aforementioned food dyes safe for consumers (U.S. Food and Drug Administration 2009a; 2008a; 2007a;b; 2004; 2003a; 2000; 1988; 1987; 1986; 1985; 1983; 1982a;b;c; FDA Agency Review of Toxicology Information in Petitions for Direct Food Additives and Color Additives Used in Food 2007), maintaining that colors found to be potentially hazardous have already been purged from the list of permissible additives (Henkel 1993) but in March 2011 they announced a review of the link between food dyes and child hyperactivity (Gleason, 2011).

The food additive monosodium glutamate (commonly known as "MSG") has been linked in empirical studies and clinical trials to a myriad of adverse symptoms (Lau et al. 2006; Yang et al. 1997; Scher and Scher 1992; Olney 1987; 1984; Sauber 1980; Reif-Lehrer 1976; Rosenblum et al. 1971;

Morselli and Garattini 1970; Schaumburg et al. 1969) including headaches and migraines (Baad-Hansen et al. 2010; Scopp 1991; Merritt and Williams 1990; Raskin 1981; Schaumburg et al. 1969), diabetes/insulin resistance/impaired glucose tolerance (Roman-Ramos et al. 2011; Collison et al. 2010; Sasaki et al. 2009; Morrison et al. 2008; Nakanishi et al. 2008; de Campos et al. 2007; Nagata et al. 2006; Iwase et al. 1998; Cameron et al. 1976), brain lesions/abnormalities (Yu et al. 1997; Monno et al. 1995; Meister et al. 1989; Simson et al. 1977; Arees and Mayer 1970; Olney and Ho 1970; Olney 1969; Olney and Sharpe 1969), skin abnormalities, urticaria, angioedema and intestinal disturbances (Tarlo and Sussman 1993; Van Bever, Docx and Stevens 1989), developmental irregularities (Yu et al. 1997), changes in circadian rhythm (Manivasagam and Subramanian 2004), respiratory problems including bronchoconstriction, especially for people with asthma (Tarlo and Sussman 1993; Hong et al. 1989; Allen et al. 1987; Moneret-Vautrin 1987; Swan 1982), enhanced threat to people with vascular disease (Merritt and Williams 1990); reproductive problems (Rodriguez-Sierra et al. 1980; Pizzi, Barnhart, and Fanslow 1977), liver inflammation/ injury/pathology (Roman-Ramos et al. 2011; Collison et al. 2009; Nakanishi et al. 2008), cognitive impairment (Collison et al. 2010), growth irregularities in offspring of mothers given MSG (von Diemen and Trindade 2010), dyslipidemia/ hyperlipidemia (Collison et al. 2010; Iwase et al. 1998), hypertension (Iwase et al. 1998), endocrine dysfunction (Miśkowiak and Partyka 1993), burning sensations, pressure, and tightness or numbness in the face, neck, and upper chest and bronchospasm (Settipane 1987), and weight gain/obesity (Roman-Ramos et al. 2011; He, Staviglas, and Stamler 2009; Sasaki et al. 2009; He et al. 2008; Nakanishi et al. 2008; de Campos et al. 2007; Hermanussen et al. 2006; Nagata et al. 2006; Hermanussen and Tresguerres 2003; Gobatto et al. 2002; Guimarães et al. 2002; Balbo et al. 2000; Iwase et al. 1998; Yamamoto et al. 1998; Miśkowiak and Partyka 1993; Tanaka et al. 1978; Olney 1969). Scientists have known for some time about the link between MSG and weight gain; one of the most widely used models to induce obesity in laboratory rats and mice is by administering food additive-grade monosodium glutamate (Von Diemen,

Trindade, and Trindade 2006; Dawson et al. 1997; Caputo et al. 1996; Yoshida et al. 1994). And despite results calling the MSG-weight gain link into question, including those studies sponsored by the MSG industry (Kondoh and Torii 2008), a number of studies linking MSG with weight gain appear to support the position of The Glutamate Association, a government lobbying group comprised of corporations who use and produce MSG for foodstuffs (Samuels 1999), that eating foods containing MSG increases appetite (Hermanussen et al. 2006) in their suggested promotion of MSG for populations like the elderly who have difficulty gaining weight due to lowered appetites (Bellisle et al. 1996). Despite the findings linking MSG with weight gain, increased appetite, and obesity, there remains no warning stating this possibility on food products containing MSG, which could potentially complicate a number of health-related issues such as obesity for some consumers.

The U.S. Food and Drug Administration (FDA) which has the responsibility of aggregating consumer complaints and investigating potentially problematic ingredients in the food based on those consumer reports, has received numerous complaints about synthetic and industrialized food chemicals over the past several decades. MSG alone has seen its fair share including severe headaches—over 43 percent of reported reactions from MSG to the FDA's Adverse Reactions Monitoring System are for headaches (Samuels 1999) and breathing difficulties in asthmatics (U.S. Food and Drug Administration 1995). There is enough of a significant trend in clinical reports of adverse symptoms linked with MSG (including 41.2 percent of subjects in a glutamate industry-sponsored study; Kerr et al. 1979) that it has been assigned the name: "MSG symptom complex". According to the Mayo Clinic website:

> "Over the years, the FDA has received many anecdotal reports of adverse reactions to foods containing MSG. These reactions — known as MSG symptom complex — include: headache, flushing, sweating, facial pressure or tightness, numbness, tingling or burning in face, neck and other areas, rapid, fluttering heartbeats (heart palpitations), chest pain, nausea, weakness" (Zeratsky 2011).

Back in 1993 the FDA actually considered requiring food manufacturers to include the words "contains glutamate" on all products that contained protein hydrolysates with substantial amounts of glutamate (such as hydrolyzed soy protein) but rejected this possibility (U.S. Food and Drug Administration 1995). In 1994 the FDA received a Citizens Regulatory Petition concerning MSG. Based on the Petitioners' reports of debilitating and life-threatening sensitivities the Petitioners had to monosodium glutamate (MSG) the petition requested the FDA to make changes to the label requirements for food containing MSG and all related substances. More specifically, the petition requested mandatory listing of all food items that contain free glutamic acid with an additional requirement that food manufacturers list the amount of free glutamic acid (MSG) along with a warning that MSG may be harmful to certain people (U.S. Food and Drug Administration 1995).

The FDA failed to respond to the petition within 180 days of filing as required by law and in August, 1995, twenty-nine individuals (including physicians, scientists and parents on behalf of their children) filed suit in Federal Court asking the court to intercede on their behalf and require that all MSG in processed food, including foods containing substantial amounts of glutamate (such as hydrolyzed soy protein) be labeled with a warning that MSG may be present (Samuels 1995). To date the FDA has not taken such action.

Despite the body of evidence by independent researchers that MSG may be potentially harmful to some consumers (earlier estimates placed adverse reactions to MSG at between 25 and 30 percent of people; Reif-Lehrer 1976; 1977) the U.S. Food and Drug administration permits MSG to be present in the food without a warning to consumers. Of course in theory consumers can simply read the ingredients labels and if they are already aware that they experience adverse health symptoms from MSG they can abstain from purchasing that product and thereby avoid ingesting MSG. Unfortunately, searching the label for the words, "monosodium glutamate" is often not enough. Free glutamic acid

(monosodium glutamate) is frequently present in items that contain the ingredients listed as hydrolyzed vegetable protein, hydrolyzed protein, hydrolyzed plant protein, plant protein extract, hydrolyzed pea protein, sodium caseinate, calcium caseinate, yeast extract, textured protein and TVP, autolyzed yeast, hydrolyzed oat flour and corn oil, all the while the words "monosodium glutamate" or "MSG" may appear nowhere on the ingredients label (Federal Register 1977). As if that is not confusing enough for consumers, monosodium glutamate may also make an appearance in food that lists ingredients such as malt extract, malt flavoring, bouillon, broth, stock, flavoring, natural flavors/flavoring, natural beef or chicken flavoring, seasoning, spices, carrageenan, enzymes, soy protein concentrate, soy protein isolate and whey protein concentrate (Blaylock 1997), again, with no warning to consumers that the product may contain monosodium glutamate (MSG).

A number of other food additives, especially preservatives, have also been linked to potential adverse health outcomes for some people (Kaplan 2010; Stevenson et al. 2010; Lau et al. 2006; Schab and Trinh 2004; Weiss 1982) including Sodium Benzoate. Empirical studies and clinical trials indicate sodium benzoate may be linked in sensitive individuals to skin reactions including urticaria, pruritus and atopic dermatitis, and intestinal disturbances such as gastritis (Asero 2006; Schaubschläger et al. 1991; Van Bever, Docx and Stevens 1989; Juhlin 1981), nasal polyps, rhinitis, migraine headaches and arthralgia (Pacor et al. 2004; Juhlin 1981), shortness of breath, broncoconstriction, asthma *(*Arai et al. 1998; Petrus et al. 1996; Hong et al. 1989; Juhlin 1981; Freedman 1977), and with behavioral, mood and psychiatric disorders (El-Nouby et al. 2009; McCann et al 2007; Bateman et al. 2004; Schab and Trinh 2004; Juhlin 1981). While food items containing sodium benzoate must list its presence, there are no required warnings for consumers.

Sulfites (several forms of sulfites exist and are allowed for use in foods: sulfur dioxide, sodium metabisulfite, potassium metabisulfite, sodium bisulfite, potassium bisulfite, and sodium sulfite) have been linked with several idiosyncratic and allergic reactions including respiratory tract irritation,

bronchospasm, oculonasal symptoms, skin reactions including urticaria and angioedema, flushing, hypotension and intestinal disturbances in sulfite-sensitive individuals and those with asthma (Environmental Health and Safety 2008; Arai et al. 1998; Corder and Buckley 1995; Lester 1995; Atkinson, Sim, and Grant 1993; Tarlo and Sussman 1993; Hong et al. 1989; Van Bever, Docx and Stevens 1989; Settipane 1987; Towns and Mellis 1984; Freedman 1977). The FDA banned the use of sulfites on fresh produce in 1986 and required listing of sulfites on some food labels, but there remains no requirement for explicit warnings on processed or packaged food labels of the potential dangers from sulfites.

Salicylates are another group of additives that have been linked with respiratory problems and bronchoconstriction, and can be especially hazardous for people with asthma (Corder and Buckley 1995; Hong et al. 1989; Towns and Mellis 1984; Stenius and Lemola 1976) and have also been linked with allergic reactions and cross-reactions (Park et al. 1991) skin reactions and intestinal disturbances (Van Bever, Docx and Stevens 1989). Other common food additives such as EDTA have been linked with allergic reactions in some people (van Laar et al. 1998). TBHQ (tert-butylhydroquinone) has also been linked with allergic reactions (Aalto-Korte 2000) and possible toxicity (van Esch 1986). And Nitrates/Nitrites have been linked with the formation of carcinogenic nitrosamines (Parke and Lewis 1992), chronic liver disease (Freedman et al. 2010), as well as respiratory, skin and intestinal disturbances (Juhlin 1981), and Alzheimer's disease, diabetes mellitus and Parkinson's disease (de la Monte et al. 2009). Again, while these additives are required to be listed on food ingredients labels there are no required warnings.

While U.S. consumers may be hard pressed to find anything obvious about it on the label, the food additive[1] Formaldehyde is used in preserved foods, medicines and vitamins (Agency for Toxic Substances and Disease Registry 2008), sugar production, as a preservative for grain and seed dressings and as a disinfectant for seeds (Product Stewardship Summary 2010), has been detected in beer and

soft drinks (Lawrence and Iyengar 1983), as well as being present in the artificial sweetener Aspartame (Abegaz and Bursey 2009; Trocho et al. 1998), and when tested on products outside the U.S. has been detected in sources that can leach or migrate into food such as food packaging (Bradley et al. 2005), tableware and cooking utensils (Lund and Petersen 2006). According to a recent report from the National Toxicology Program (2010), ingestion of food can be a significant source of exposure to formaldehyde—in addition to low levels of formaldehyde occurring naturally in a variety of foods such as fruit, food may contain small amounts of formaldehyde from its use as a fumigant, fertilizer and preservative (Agency for Toxic Substances and Disease Registry 2008). Much of the research on formaldehyde has centered on inhalation and it has been linked to a variety of adverse reactions including respiratory problems for people with asthma (McGwin, Lienert, and Kennedy 2010), migraine headaches (Abegaz and Bursey 2009), insomnia, memory loss, mood alterations, nausea, fatigue (National Toxicology Program 2010) and leukemia/cancer (National Toxicology Program 2010; Zhang et al. 2009). The International Agency for Research on Cancer (IARC 2004) has determined that formaldehyde may reasonably be anticipated to be a human carcinogen. The FDA position on formaldehyde is that "The Food and Drug Administration (FDA) do not believe that the very low levels that are used in food and cosmetics present a significant safety concern," (Scheuplein 1985, 245).

The preservatives BHT and BHA are commonly used in food items such as breakfast cereals. The oxidative characteristics and/or metabolites of BHA and BHT have been found to contribute to carcinogenicity or tumorigenicity as tumor promoters (Kahl and Kappus 1993). (It should be noted that there exist some evidence suggesting that under certain conditions these additives may also have the opposite effect in that they may be anti-carcinogenic, Williams et al. 1999; Lindenschmidt et al. 1986.) Additionally, there is evidence that certain persons may have difficulty metabolizing BHA and BHT, resulting in health and behavioral changes, respiratory, skin and intestinal disturbances (Juhlin 1981). Of note, in animal studies BHT (Butylated hydroxytoluene) has been linked to having a toxic effect on

the lungs (Kahl and Kappus 1993), having a significant adverse effect on body weight to developing fetuses and later during the lactation period (Meyer and Hansen 1980), and adverse effects to adipose cells (Simán and Eriksson 1996), as well as acting as a developmental neurobehavioral toxin (Butcher et al. 1981) including promoting behavioral abnormalities during pregnancy, as well as to offspring, leading to severe deficits in learning, decreases in sleeping, as well as increases in aggression and social isolation (Stokes and Scudder 1974), promoting liver abnormalities and toxicity (Safer and al-Nughamish 1999; Simán and Eriksson 1996), and promoting cancerous tumors (Malkinson 1999; Parke and Lewis 1992). To date, BHT continues to be used as a food additive/preservative in the U.S. BHA (Butylated hydroxyanisole) has been linked in animal studies as a developmental toxin (Butcher et al. 1981), and as promoting decreases in sleeping, orientation reflex and learning (Stokes and Scudder 1974) and is now considered as "reasonably anticipated to be a human carcinogen" (National Institutes of Health Report on Carcinogens, Public Health Service National Toxicology Program Report on Carcinogens 2002; U.S. Department of Health and Human Services' Report on Carcinogens (BHA), Eleventh Report on Carcinogens; Parke and Lewis 1992). Citing numerous animal studies, Glenn Scott, M.D. filed a Citizens Regulatory Petition with the FDA back in 1990, asking the agency to prohibit the use of BHA in food. To date BHA continues to be used as a food additive/preservative in the U.S. While these additives are required to appear on the ingredients listings, there are no explicit warnings required on food products that contain these additives to alert consumers (Code of Federal Regulations - BHT 2010; Code of Federal Regulations - BHA 2010; U.S. Food and Drug Administration 2003a).

The same is true for an absence of warnings on high pesticide residues on or in certain foods such as produce, meat and dairy products (LeDoux 2011; Environmental Working Group 2009; Rutherford et al. 2000). Neither the FDA nor the USDA have required warning labels for consumers on foods tested to contain high pesticide levels despite the fact that many pesticides have been linked in empirical

studies with maternal and developmental toxicity (Farag et al. 2011), dysfunctional development during puberty (Roy et al. 2009; Wolf et al. 2008), neurobehavioral changes (Lim et al. 2011), ADHD in children (Shaw 2009), adverse effects on semen quality (Hauser et al. 2006; Swan et al. 2003), anti-androgenic potency effects; blocking androgens/ male hormones (Cone 2011; Orton et al. 2011), and other endocrine-disrupting effects (Schilirò 2011) leading to reproductive disorders and testicular and breast cancer (Prins 2008). Human studies have linked exposure to PCB (Polychlorinated Biphenyls) mixtures for instance, with numerous adverse health consequences including immunological, reproductive, and dermatological effects, as well as cancer (Faroon, Smith-Simon, and De Rosa 2005). The same holds true for animal antibiotics/antimicrobials present in meat and dairy products (McEwen and Fedorka-Cray 2002) for which the FDA estimates livestock receives 29 million pounds per year (FDA Summary Report 2009) and for which the U.S. Centers for Disease Control and Prevention (2011) cited studies that have correlated the use of antibiotics [cepholosporins] on food animals with higher rates of drug-resistant Salmonella infections in *humans* (U.S. Food and Drug Administration Draft Report 2010c; U.S. Food and Drug Administration Report 2004), and other drugs and animal growth hormones in meat and dairy products **(**Toldrá and Reig 2006; Chrièl and Dietz 2003**;** Anadón and Martínez-Larrañaga 1999**;** Epstein 1996; 1990; Prosser, Fleet, and Corps 1989) which have been linked in studies to increased risks of breast, colorectal, prostate, bladder, and other cancers (Rohrmann et al. 2007; Moorman and Terry 2004; Malawa 2002; Epstein 2001; Manousos et al. 1999; Bohlke et al. 1998; Chan et al. 1998; Hankinson et al. 1998; Outwater, Nicholson, and Barnard 1997; Peyrat et al. 1993; Epstein 1990). A Citizens Regulatory Petition was filed in 2007 by Dr. Samuel Epstein and others requesting that the FDA withdraws approval of Recombinant Bovine Growth Hormone (rBGH). The petition reads in part:

> "This petition is based on scientific evidence of increased risks of cancer, particularly breast, colon, and prostate, from the consumption of milk from cows injected with Posilac®, the genetically modified recombinant bovine growth hormone (also known as rBGH, sometribove, recombinant bovine somatotropin, or rbST). Posilac® is the trademark for Monsanto's rBGH product, registered with the U.S. Patent and Trademark Office, and is approved for marketing by the Food and Drug Administration (FDA). This petition is also based on abnormalities in the composition of rBGH milk, resulting from the recognized veterinary toxicity of rBGH, particularly increased levels of IGF-1." (Epstein 2007, 1)

While some manufacturers of milk and dairy products have voluntarily stopped selling products containing recombinant bovine growth hormone (rBGH) in recent years, this remains an approved substance in food products in the U.S. and the FDA (2010b) does not require rBGH food products to carry warnings on the labels for consumers.

Another chemical that has been linked in numerous studies to a variety of adverse health outcomes is bisphenol-A, otherwise known as BPA. BPA, like the other food additives[1] examined here, makes an appearance on U.S. grocery shelves with no packaging warnings to consumers. BPA, developed in 1891 as a synthetic estrogen, came into widespread use in the 1950's when scientists realized it could be used to make and strengthen polycarbonate plastic and some epoxy resins to line food and beverage cans. In recent years BPA has been found to leach into food by way of cans (canned food) (Schecter et al. 2010; Environmental Working Group 2008[2]), the lids of canning jars and plastic food and drink containers (Schecter et al. 2010; Wang and Schnute 2010) including baby bottles and toddler sippy-cups (Nam et al. 2010; Wang and Schnute, 2010; Maragou et al. 2008), and has been detected in infant formula and baby food (Gibson 2007; Houlihan and Lunder 2007; Biles, McNeal, and Begley 1997) as

well as dental fillings (von Goetz et al. 2010). BPA is a reported endocrine-disrupting chemical (Leranth et al. 2008; Takeuchi et al. 2004; Markey et al. 2003; Rubin et al. 2001) and numerous peer-reviewed studies conducted by independent scientists have linked exposure to BPA to a variety of adverse health consequences (Lang et al. 2008; Vom Saal et al. 2007) such as an increased risk for endocrine-related cancers (Prins 2008), including breast cancer (Jenkins et al. 2009; Dairkee et al. 2008) and prostate cancer (Prins et al. 2008a;b; Ho et al. 2006), heart disease (Melzer et al. 2010; Lang et al. 2008), abnormalities in liver function (Vom Saal et al. 2007), low sperm counts in men (Li et al. 2011), metabolic abnormalities, weight gain and increased serum cholesterol levels (Hugo et al. 2008; Miyawaki et al. 2007; Rubin et al. 2001), neurological damage/altered brain development (Palanza et al. 2008) including a link with schizophrenia (Brown 2009), puberty advances/disruptions/abnormalities (Wolf et al. 2008; Wadia et al. 2007; Howdeshell et al. 1999), insulin resistance and diabetes (Lang et al. 2008), and adverse reproductive and developmental effects (Benachour and Aris 2009; Rubin and Soto 2009; Honma et al. 2008; Lenie et al. 2008; Leranth et al. 2008; National Toxicology Program-CERHR 2008; Susiarjo and Hunt 2008; Dolinoy, Huang, and Jirtle 2007; Newbold, Jefferson, and Banks 2007; Richter et al. 2007) including recurrent miscarriages (Sugiura-Ogasawara et al. 2005). BPA appears to be pervasive in the bodies of people living in the U.S. It was found to be present in the urine of over 90 percent of Americans tested, in the breast milk of nursing mothers (Lang et al. 2008; Kuruto-Niwa et al. 2007; Ye et al. 2006), and with prenatal exposure, where testing detected BPA in the biological fluids and placenta, as well as the urine and umbilical cords of newborns (Völkel et al. 2011; Braun et al. 2009; Calafat et al. 2008; Ikezuki et al. 2002; Schönfelder et al. 2002).

BPA is another food additive in which the FDA has failed to take action that would potentially protect the health and safety of consumers (U.S. Food and Drug Administration, FDA Draft Assessment of Bisphenol A for Use in Food Contact Applications). In 2010 the National Resource

Defense Council (NRDC) filed a lawsuit against the U.S. Food and Drug Administration for its failure to act on a 2008 Citizens Regulatory Petition to ban the use of bisphenol-A (BPA) in food packaging, food containers, and other materials likely to come into contact with food (Environmental Working Group 2008). Among other things, the petition argues that BPA exposure has been associated in primate and other empirical animal studies with a wide range of adverse effects, including reproductive defects, chromosomal damage, nervous system harm, increased rates of breast and prostate cancer, and metabolic changes including obesity and insulin resistance (a condition that commonly precedes the development of diabetes) and studies in human tissue link BPA exposure with breast cancer and diabetes. The petition further states:

> "In light of the data suggesting that BPA is harmful to human health, and in response to the well-founded concerns of experts in the field, FDA must prohibit BPA from use in human food and food packaging, including in can linings and in beverage containers like baby bottles. The FDA must further revoke all regulations permitting the use of any food additive that results in BPA becoming a component of food," and that FDA's Approval of BPA for 'Use in Food Contact Substances' violates the Federal Food, Drug, and Cosmetic Act" (National Resource Defense Council 2008, 3).

Several states have taken the issue of BPA in children's products under consideration, and some states, cities and counties have decided to take the matter of public health and safety into their own hands and have banned BPA in baby bottles in their communities (Koch 2010). In March, 2011 the Environmental Protection Agency said it would consider adding BPA to its list of chemicals of concern (Szabo 2010a). In a change from its 2008 position on BPA, the U.S. Food and Drug Administration has since expressed that it has "some concern" and shares the National Toxicology Program's concerns

that BPA may alter the brain, behavior and prostate gland in children both before and after birth (U.S. Food and Drug Administration 2010a; 2008b; Szabo 2010b;). While encouraging manufacturers to look for safer materials for baby feeding products, baby formula and to line metal cans, as well as reporting plans to conduct a new review of this chemical, to date the FDA has not recommended discontinuing use of products that contain BPA and has taken no action to recommend a complete or partial ban or to require warning labels on food that may contain BPA.

U.S. food consumers rely on governmental agencies like the FDA and USDA to oversee the safety of their food and to alert them when foods contain ingredients that may be hazardous for some people. For instance, approximately 11 percent of U.S. food consumers read the allergen labeling on food packaging while searching for potentially problematic ingredients (International Food Information Council Foundation 2010). This begs the question: Why are there no required warnings on food products that contain ingredients linked with adverse symptoms like free glutamic acid (MSG), Tartrazine/yellow dye #5, sodium benzoate, Formaldehyde, BHT/BHA, BPA or other synthetic and industrialized food chemicals that may pose a health risk for some people?

Other Countries' Reactions to Research Findings about Potentially Dangerous Food Chemicals

The U.S. government agencies may consider many of these synthetic and industrialized food chemicals safe enough for consumers that they do not warrant a warning on the ingredients labels or packaging, but other countries do not always share this level of confidence. Outside of the U.S. many countries either require warning indicators for their consumers to be placed on food labels containing

some of these synthetic and industrialized food chemicals or they have banned them all together.

Several food dyes either require consumer warnings on food labels or have been banned outright in some countries. Following the European Food Safety Authority's request that food manufacturers voluntarily remove six food dyes back in 2008, a European Union-wide mandatory warning is now required to appear on food and drink labels that contains any of these food dyes: quinoline yellow (E104), carmoisine (E122), allura red (E129), Tartrazine (E102), ponceau 4R (E124), sunset yellow FCF (E110). The label must carry the warning 'May have an adverse effect on activity and attention in children'. This became mandatory across the European Union as of July, 2010 (Food Standards Agency, U.K. 2010) and was based in part on the findings from empirical research conducted by Cragg, Ross, and Dawson Qualitative Research Report (2007). Additionally, in March, 2011, the European Food Safety Authority's panel on food additives and nutrient sources revised the Acceptable Daily Intakes (ADIs) levels for a group of caramel food dyes (E150a, E150c, E150d) used in food production (The European Food Safety Authority 2008; 2011). One of the food dyes required by the UK to carry a warning label is allura red (E129) (FD&C Red Dye 40) which is banned in Denmark, Belgium, France, Germany, Switzerland, Sweden and Austria (CBC 2010), Green Dye #3 is illegal throughout the European Union (Official Journal of the European Communities 1994) and Tartrazine (Yellow dye #5; E102), which is also on the EU list requiring consumer warning labels, is banned in Sweden and Finland, the latter banning Tartrazine (Yellow Dye #5) and sunset yellow (Yellow Dye #6) back in 1981 (Perera 1986). (It should be noted that Norway previously banned food dyes/additives containing coal tar and coal tar derivatives back in 1978, as well as nitrates/nitrites, but in 2001 agreed to reverse the bans in order to abide by the rulings of the European Economic Area.) Under public pressure spurred on by the findings of the EU study, Nestle Corporation announced in late 2008 that it would phase out six dyes from its foods produced in Australia: quinoline yellow (E104), carmoisine (E122), allura red (E129), Tartrazine (E102), ponceau 4R (E124), sunset yellow FCF (E110) (Burke 2009) and in 2009

some grocery retailers in Australia implemented a voluntary ban of the same six food dyes (Macey 2009).

Some countries also handle other food additives and preservatives differently than the U.S. For example, the preservative Sodium Benzoate is a commonly used preservative in foods, drugs and other products in the U.S. But parabens such as benzoic acid and Ethyl para-hydroxybenzoate, a derivative of benzoic acid, is banned in Australia, and methyl p-hydroxybenzoate and benzoic acid are banned for use in food in Taiwan, Canada and Europe (Food Safety Net 2010). Sulfites/Metabisulfites (E223) are listed in the U.K. as a preservative that may cause allergic reactions, particularly skin irritation, gastric irritation and asthma, and back in the 1980's the U.K. banned bromates (such as potassium bromate) in baked goods after animal studies found they increased the incidence of kidney tumors (Food Standards Agency, U.K. 2010; Murphy 1997). Formaldehyde is banned as a food preservative in China, Vietnam and Hong Kong (Flynn 2010; Ma 2010; Tang et al. 2009; The Centre for Food Safety 2009; The Standard 2008). The Chinese health ministry's 2008 list of banned food additives (including boric acid as an emulsifier and sodium thiocyanate, used as a preservative in milk and dairy products) was expanded in 2011 when China's officials banned the production of two new food additives, benzoyl peroxide and calcium peroxide, commonly used to bleach flour (Global Food Law 2011).

The growth hormone rBGH in milk/dairy and hormones in meat is also handled differently in some countries outside the U.S. There is a European ban on the marketing and sale of rBGH milk. Since January 2000 the growth hormone (rBGH) has been banned in milk and dairy products in all twenty-seven countries of the EU (European Commission Report on Public Health Aspects of the Use of Bovine 1999) as have hormones in meat (Stephany 2001; European Commission Report: Assessment of Potential Risks to Human Health From Hormone Residues in Bovine Meat and Meat Products 1999). Canada, Australia, New Zealand, and Japan have also prohibited the drug's use (American Public Health Association 2009; Food Standards Australia and New Zealand 2006; Japan Ministry of

Health, Labour and Welfare 2004; Health Canada Report 1998).

And BPA (bisphenol-A), a permitted food additive in the U.S., is banned (at least in baby bottles) in several countries across the globe. Among them are Canada, France, Denmark, Australia, Germany and New Zealand (Food Safety Net 2011). Malaysia's ban on BPA in baby bottles becomes effective March, 2012 (Food Safety Net 2011) and in March, 2011 China created draft regulations to ban BPA in baby bottles and children's products (Feiran 2011). The European Union banned BPA from being manufactured in plastic baby bottles in all EU countries effective March, 2011 and a BPA ban on all plastic baby product sales and imports in EU countries became effective June 2011 (European Commission 2010; USA Today 2010). The United Arab Emirates (UAE) in also banning BPA in baby bottles and all children's products (Emirates News 2010). In late 2010 Environment Canada placed bisphenol-A (BPA) on the country's list of toxic substances. The Canadian government first banned polycarbonate baby bottles back in April 2008 (Global Food Law 2011).

Beyond other countries requiring warning labels for consumers or banning certain synthetic or industrialized food chemicals that are permitted by the U.S. Food and Drug Administration, many countries outside the U.S. have developed systems for determining and assuring consumer food safety that varies dramatically from that of the U.S. For example, in India the Supreme Court recently banned food industry representatives from being a part of the food safety advisory committee. The Indian Food Safety and Standards Authority (FSSA) blocked representatives from the food and beverage industry from being included on an advisory scientific panel on food safety and standards. The Indian Supreme Court found that involvement of food industry figures breached the Food Safety and Standards Act because such panels could not be said to be manned by independent experts (Food Production Daily 2011; Global Food Law 2011).

AN ASSESSMENT OF THE NEED FOR LABELING

As the preceding section describes, there is considerable evidence of at least the potential for harm from a number of synthetic and industrialized food chemicals. However, at the same time there also exist studies that do not find evidence of harmful effects. And in fact, the FDA has categorized many of the additives discussed here as "Generally Recognized As Safe" (GRAS). For example, regarding BHA and BHT, the FDA's Select Committee on GRAS Substances (SCOGS) concludes that, "While no evidence in the available information on BHA/BHT demonstrates a hazard to the public when it is used at levels that are now current and in the manner now practiced, uncertainties exist requiring that additional studies be conducted." And regarding MSG and sulfites, the SCOGS concludes that, "There is no evidence in the available information on MSG/sulfites that demonstrates a hazard to the public when used at levels that are now current and in the manner now practiced. However, it is not possible to determine, without additional data, whether a significant increase in consumption would constitute a dietary hazard."[3]

This leads to two questions: (1) How can the evidence of potential harm cited be reconciled with the conclusions of the FDA? ; (2) What does this suggest about what public policy should be regarding labeling?[4] There are a number of possible interpretations regarding the FDA's position on the substances discussed here. One is that the FDA has acted as an objective evaluator of all possible scientific information and is making optimal, unbiased, rational decisions regarding the safety of these additives. Therefore, it would follow that an objective reading of the current state of research on each individual food additive would conclude that the evidence of harm is strongly outweighed by other studies showing no harm. A second possibility is that the FDA is trying to act as an objective evaluator but for some reason comes out with biased conclusions. A third possibility is that decision-

makers are not even attempting to be objective and instead are operating under 'regulatory capture'—a process in which decision-makers serve industry interests rather than the public interest. The idea that regulatory capture has been taking place at the FDA is not a new one, though most of the evidence presented publicly has been in the area of drug approval (Egilman et al 2007; Abraham 2002; Olson 1995).

But even if FDA decision-makers are not consciously steering decisions to favor industry interests, the second possibility—that bias in decisions is present—could still occur for a number of reasons. One explanation would be that the selection process leads to hiring decision-makers who have certain leanings, and even if they try their best to make objective decisions they have a tendency to favor a particular viewpoint. Another source of bias could be incentives that favor certain conclusions, either within the FDA, or through career paths that involve interchange with industry (either being directly employed by industry or being employed at third party institutions with research funded by industry) that unconsciously influence perspectives. A third source of bias could simply be the substantial resources available to industry to produce material and results that favors one set of conclusions; this factor, combined with decision-makers who fail to adequately discount biased input, can influence their decisions. This could occur if decision-makers from the FDA attempt to judiciously weigh the evidence for or against a substance's safety but fail to fully discount how the quantity of evidence on a particular side and the strength of its conclusions may be influenced by the source of that study. For example, decision-makers may be too influenced by numerous studies funded by industry that show additives cause no harm. A judicious decision-maker may discount this evidence for a number of reasons. First, as described by Michaels (2008), the powerful and well-funded product defense industry has evolved for defending potentially unsafe products and chemicals; it has been developed with the sole goal of creating science that is considered credible, but that is biased and unreliable and inevitably favors the interests of its funders. Industry has also adopted the practice of ghostwriting

research articles on behalf of allegedly objective scientists to gain regulatory approval of products and substances (Fugh-Berman 2010; McHenry and Jureidini 2008). Even aside from the alleged creation of a product defense industry and ghostwriting of research, health-related research results have been shown to be correlated with the source of funding (Bourgeois et al. 2010; Tereskerz et al. 2009). The magnitude of differences in results by funding source can be striking in its size. For example, Lexchin et al. (2003) found that industry sponsored research was four times more likely to reach conclusions favorable to industry, while Friedberg et al. (1999) found that non-sponsored research was seven times more likely to report unfavorable qualitative conclusions. Research results that are compiled into reviews of health-related issues may also be influenced by reporting bias, with industry-funded studies failing to report results that are contrary to their interests (Smyth et al. 2011; Kirkham et al. 2010). Samuels (2010) gives an account of the approval of one of the chemicals discussed here, MSG, that implicates both industry bias and information suppression, as well as bias in the FDA's actions as causing the continued presence in U.S. food products of a substance many have argued to be harmful to consumer health. And Barbee (2004, 13) points out that conflicts of interest occur frequently in FDA approval committee meetings, concluding that when it comes to the FDA, "if you have the money and the influence, you can frequently get what you want".

The evidence that decisions regarding what is considered to be a harmful substance vary considerably across developed countries casts further doubt on the regulatory process. The variance could be interpreted as decision-makers not making an objective reading of the evidence on the substances discussed here. Or, an alternative inference is that interpretations of the evidence can vary considerably among knowledgeable decision-makers holding different perspectives.

This leads us to the second question posed, 'What does this suggest regarding public policy?' If either objectivity is open to reasonable questioning or there is considerable variance in interpretation of the evidence, then it suggests that consumers should be provided with the information to make such

decisions themselves. The public appears to agree with this perspective. According to an International Food Information Council Foundation (2010) survey, 77 percent of U.S. food consumers believe that insuring food safety is the responsibility of the government, with 70 percent claiming it is also the responsibility of the food industry. Approximately 31 percent believe food safety is a shared responsibility among five or more stakeholder groups including the government, farmers, food producers, retailers, and consumers.

Of course, a balance must always be attempted between information overload of the consumer and providing beneficial information. While it is sometimes useful to utilize government regulatory expertise as a way to distill complex information into labels that the consumer can easily digest, extra care must be taken when there is a known wide range of consumer beliefs regarding the importance of product properties. In the realm of synthetic and industrialized food chemicals, a growing portion of the U.S. population will pay a significant premium to buy organic products or to otherwise avoid certain food chemicals (U.S. purchases of organic foods have increased 70 percent over the past four years, Chase 2011). This suggests that rather than government bodies alone, some level of consumer sovereignty should prevail with adequate information on the label to allow consumers to reach their own conclusions in terms of whether a substance is safe or not.

Food chemical safety conclusions reached by the FDA also tend to be focused on the most serious health consequences (such as cancer and birth defects) and focus on an individual of "average" sensitivity. For example, in concluding that MSG is "generally recognized as safe" the FDA noted that a portion of the population is known to experience adverse symptoms from its consumption. This portion of the population is so large in fact, as to exert enough economic influence to cause numerous Chinese restaurants across the U.S. to make explicit mention of the fact that they do not use MSG. Additionally, several conventional food manufacturers have begun to promote their soups, sauces and other food items by advertising that they contain "No MSG". Yet, according to the FDA, the

percentage of people with adverse reactions to this food additive is not large enough to counter the conclusion that the substance is generally recognized as safe, despite the fact that the FDA acknowledges that some consumers can have strong adverse reactions to minute quantities. As previously noted, reactions of sensitive individuals (such as asthmatics) can be serious and life-threatening. This raises a question as to why if we label peanut residue in food for the sake of a small portion of sensitive individuals with serious adverse consequences, do we not also warn of hidden and inconsistently labeled substances that can also lead to severe consequences?

Labeling is not just for the average consumer who seeks to avoid life-threatening health consequences. Consideration must also be given to empowering those known to be sensitive to synthetic/industrialized food chemicals, as well as empowering those who do not yet know they are sensitive so they and their healthcare providers can learn about the connection through experience. Our food supply system should consider the needs of all consumers—including individuals who have sensitivities to synthetic and industrialized food additives. Additionally, it should consider the needs of not only those who wish to avoid the potential of serious health problems, but also those who wish to avoid foods that consistently cause them to have headaches, nausea, edema, and a variety of other known short-term adverse consequences.

A Behavioral Economic Model of Consumer Confusion

This section uses theoretic behavioral economic principles to describe how consumer biases and cognitive limits can cause consumer confusion and how the directed actions of industry that seeks to capitalize on this can enhance this consumer confusion, increasing the need for intervention by regulators in providing consumers with systematic, consistent information about potential harm.

In addition to issues surrounding food additives and potentially harmful chemicals discussed here, there are numerous cases where consumer confusion exists regarding food characteristics. There has been confusion over labeling of eggs as well as other animal products with higher animal care standards (Frank 2006; Paulson 2006; Fulmer 2001), confusion over the presence of genetically modified organisms (Scandizzo 2002), confusion over what it means for something to be natural or organic (Eng 2009), and confusion over the healthy qualities and benefits of food (Labiner-Wolfe, Jordon, and Verrill 2010), among many other issues. In some cases, efforts seem to have been made by some in the food industry to intentionally label products that add to consumer confusion, while in other cases it is less clear whether the confusion to consumers is intentional.

The fact that confusion can be beneficial to a firm that seeks to seize on a trend in demand (such as the growing market for organic food) by changing a label without changing their production process or ingredients, is self-evident and does not require further explanation. But what may be less clear is why confusion among consumers is so prevalent. Sometimes the information search costs required to make the proper choices are quite modest. Limited resources and cognitive capacity can explain part of it, but we postulate that something more is going on. In particular, when threatened with unpleasant realities that conflict with current habits, a desire for denial (or dissonance reduction) may work to enhance confusing messages, causing the consumer to ignore the issue entirely. In addition, other behavioral factors such as *satisficing* (to be discussed later) may also play a role.

While the applicability of the main ideas presented in this section may extend to many other products beyond food, food is also special in the way we respond to it for a number of reasons, some of which are discussed in Frank (2007):

1) Few habits are as deeply ingrained or as often repeated as our eating habits. Therefore existing food preferences may be particularly hard to change based on rational health or ethics-based arguments.

2) Food consumption is embedded in important ways into our social interactions. When changing food preferences threatens to disrupt current social interactions (such as by limiting restaurant options or requiring special dietary requests when one meets with friends or coworkers), there may be a strong resistance to changing preferences.

3) Existing choices may be reinforced culturally and socially causing further resistance to change (note: this is subtly distinct from the issue of disrupting social interactions. An example would be even if the restaurant we regularly attend with our friends has foods that accommodate our new diet so that there is no disruption of social interactions, the fact that our new choice of food differs obviously from the choices of our reference group may still exert pressure to deter change).

4) Food holds a special place in the law. There are unusual subsidies to food production and laws governing what can even be said about food. This creates an unusually strong institutional context with powerful actors seeking to prevent disruption of current markets.

5) Some of our behavioral responses to food may have developed through biological evolution and be partially hardwired in our brains. We may also have a limited reinforcement horizon with food, such as reacting instinctively to short-term digestive problems from food sources, but being less inclined to connect long-term adverse effects with certain foods. Humans may also be less inclined to connect

food to problems related to modern chemical additives rather than to the toxic reactions that we have encountered throughout our evolutionary history.

Let us begin by assuming that a consumer gets utility of Ua from a current food consumption choice. But the consumer learns of a cost to this food consumption behavior that causes a utility cost of Ca. Assume that this cost also has the features of a credence good (Darby and Karni 1973). In other words, it is an intangible cost that cannot be observed at the time of consumption. Some examples of this include an ethical good (Frank 2006) such as humane treatment of animals in production or a health outcome that can be short-term but beyond the time of consumption (weight gain, headaches, etc.) or long-term (cancer, obesity or heart disease risk). The consumer can switch to good B which is a substitute for good A and yields utility Ub, and has no associated ethical or health cost (Cb=0). We assume that in the absence of the cost, A is preferred to B (Ua > Ub) but that in the presence of the cost, B is preferred to A:

(1) $Ua - Ca < Ub$

For the sake of simplicity, in some scenarios it may be helpful to generalize Ua and Ub as utilities net of price. In particular this may be a useful simplification when utilities from consumption are the same, but monetary costs differ. An example is A is a regular food product while B is the same product but produced using organic (or some other) methods. It may be the case that the same utility is received from both products (aside from Ca), but that B has a higher selling price than A. But rather than introducing separate price variables, if Ua and Ub are utilities net of selling prices, the assumptions above can remain unchanged. A rational consumer with perfect information would simply choose B over A given the added cost.

However, let us assume that the company producing B can legitimately label their product as not having the potential for adverse health costs, while the company producing A can easily obfuscate that

information by making their label appear similar or otherwise hide the source of the potential health costs of their food product. For example, foods known to cause adverse reactions in a large percentage of the population (25-42 percent, Kerr et al. 1979; Reif-Lehrer 1977) such as monosodium glutamate (MSG) may be hidden despite the consumer checking the labels. While consumers who know they have adverse reactions to MSG can avoid this particular ingredient if they recognize it on food labels, by using a variety of pseudonyms such as "natural flavoring" or not stating that it is present within other ingredients such as hydrolyzed vegetable protein, the food manufacturer can attempt to keep this ingredient hidden from the consumer on their food labels.

Even if intentional obfuscation takes place, consumers may be able to make optimal decisions in some cases if they take some effort to learn what to look for or avoid. This information cost is labeled I. For a rational consumer, it would be worth it to make the effort to differentiate A from B if:

(2) $Ua - Ca < Ub - I$

However, this is where the consumer is hypothesized to deviate from rational behavior. Before the obfuscation, the consumer was confronted by the fact of Ca, and therefore with the inevitability of switching their choices, even if their myopic preference is for A. If the mind is viewed from a dual process theory (Kahneman 2003), "System 1" would prefer product A, while "System 2" would reason that product B is preferable. When obfuscation takes place, it creates a plausible opportunity for denial or motivated reasoning. In other words, if a consumer at some level wants A to be the right answer, they can ignore the opportunity for obtaining information and simply rationalize that there is no way to avoid Ca and therefore they might as well ignore the potential adverse health cost. In other words, it becomes an excuse to ignore the adverse health consequences of our choices, even if these costs are avoidable. The opportunity to seek out information may be ignored, or the cost, "I" may be unreasonably exaggerated in the mental calculus.

This is consistent with the considerable evidence on motivated reasoning and mechanisms to reduce cognitive dissonance. The case for motivated reasoning is well established, both theoretically (Kunda 1990) and empirically (Agrawal and Maheswaran 2005; Chernov 2001; Jain and Maheswaran 2000). Kunda in particular argues that though people are more likely to arrive at conclusions that they want to arrive at, they are constrained in their ability to do so by their ability to construct seemingly reasonable justifications for these conclusions. This is tied closely to what is hypothesized here. Namely, by expending a small amount of effort, food companies can enhance the ability of consumers to construct reasonable justifications for their conclusions, even if they are wrong (or unhealthy) conclusions. In other words, consumers who would prefer to discount from consideration an intangible or long-term health cost of a particular food item are enabled by the food manufacturer to do so. In particular, the firms create some degree of uncertainty about an adverse health cost (Ca) or the effectiveness of mitigating a cost. A consumer who would at some level prefer to myopically make choices in ignorance of this cost can then seize on this uncertainty and cognitively exaggerate its importance to the decision-making process. For example, competing ethical claims allows consumers to throw up their hands and rationalize that they are powerless to mitigate the ethical costs by making responsible consumption choices. The same is true for confusing claims about food products being 'natural', 'organic' or otherwise free of unwanted synthetic and industrialized food chemicals. Confused consumers who would rather not confront issues like how their personal food choices may adversely affect their long-term health can easily justify not even trying to make healthier food choices. Using motivated reasoning, weak evidence that counters inconvenient but strong findings regarding a health cost can likewise be seized upon as a source of uncertainty.

Introducing complexity into the food marketplace through intentional obfuscation may also play into what is called, "satisficing" (Simon 1957). Simon originally conceived of satisfying to explain the behavior he observed of managers who, when faced with too many decisions to make, did not optimize

their choices but simply settled for a 'good enough' decision that met some minimum standard, and then they moved on to focus their limited cognitive attention on other issues. Consumers likewise are often faced with too many options and decision points and may resort to satisficing. That is, when consumers are faced with confusing or contradictory information via marketing or product defense industry obfuscation, consumers may default to the "good enough" choice. This stems in part because there is information-overload on what is good and bad to eat. If experts overwhelmingly speak on one side of a debate, consumers may have little trouble incorporating a change in their behavior. However, when a claim is contested, consumers with limited resources to research the credibility and motivations of both sides will often simply satisfice. The "good enough" solution in this case may be to simply continue eating what one has already been eating if there is no perceived clear tangible and immediate harm. Since the cost Ca is assumed to be long-term, intangible, or otherwise hard to connect directly to the consumption behavior, it will likely be ignored in the satisficing decision.

What does all this mean for food consumption choices? It implies that established consumer consumption patterns may be hard to change even when evidence exists that challenges these choices. This is particularly true when food manufacturers have a vested interest in continuing current consumption patterns. Conventional food manufacturers will not need to have the weight of evidence on their side about potential health risks that may or may not be associated with food additives in their products. A little effort to confuse the issue can go a long way in keeping consumers from changing their behaviors.

Does Industry Intentionally Obfuscate Food Content?

If it takes little effort on the part of industry to thwart consumer intentions for changing their consumption behavior, is their evidence that intentional deception on the part of the food manufacturer takes place? In some cases there is. But far more prevalent is evidence that labels are misleading, while the intention of the producer remains open to interpretation. As already discussed, MSG can make an appearance under a large number of aliases, most of which give no indication of the presence of this food additive. In some cases it is possible that labeling of MSG by other names may be unintentional (for example when MSG is a byproduct rather than added to the final food product). However, it is a possibility that at least in some cases, if not many, additives containing MSG appear on the label with no mention of it to the consumer, and that this occurs with the full recognition of the manufacturer. While that inference can certainly be disputed, what it is indisputable is that including MSG in products labeled "No Added MSG," "No MSG Added," and "No MSG" is an intentional obfuscation. Yet, according to Samuels[5], this does in fact happen. Placing "No MSG," "No MSG Added," or "No Added MSG" on food labels has been deemed by the FDA to be false and misleading under the U.S. Federal Food, Drug and Cosmetic Act—especially when the label also lists any hydrolyzed protein as an ingredient since it always contains MSG. According to Samuels (1999), at one time, the FDA responded to the illegal use of the term "No MSG Added," with both a Regulatory Letter and threat of seizure and injunction in case of non-compliance. But over time the FDA began to look the other way (as did State Attorneys Generals who previously had prosecuted these cases), leading the deceptive and misleading practice of labeling products "No MSG" and "No Added MSG" to once more proliferate.

To make things even worse for consumers, while the FDA announced in 1995 that it considers food labels stating, "No MSG" or "No Added MSG" to be misleading if the food contains ingredients that are sources of free glutamates, the United States Department of Agriculture (USDA) took no such action. The USDA actually approves labels of meat and poultry products that claim "No MSG," "No MSG Added," or "No Added MSG" despite the presence of sources of free glutamates such as hydrolyzed vegetable protein (Samuels 1999).

Unfortunately, label confusion for consumers does not stop there. Many other potentially harmful additives discussed in this paper can come under a variety of names. For example, sulfite preservatives may be listed on food labels as Sulfur Dioxide, Sodium Sulfite, Sodium Bisulfite, Sodium Metabisulfite, Potassium Bisulfite, and Potassium Metabisulfite. Or even worse for consumers, it may come with no label at all. For example, sulfites without any label are not uncommon in some dried fruit and wine, among other foods. This absence of a label on a food additive known to cause adverse reactions may or may not be an example of intentional obfuscation. Either way, the consumer loses. Another example of labeling that may be intentionally confusing to consumers is BHA/BHT on cereal boxes which sometimes does not appear in the ingredients listing but is noted elsewhere on the box with a statement that it was 'added to the packaging'. For consumer information purposes, it is not relevant at what stage in the process the preservative was added—the fact is that it ends up in the final food product which is consumed, and therefore should be labeled in the place consumers expect to find such information.

But the problem of consumers being intentionally misled can go well beyond the food ingredients label. Corporate obfuscation (such as funding bias and ghostwriting) can occur not only at the product labeling level but also in the science defining the risk of the product—a practice that requires complicit cooperation from others in the chain of the approval process. Samuels (1999) lays out a particularly compelling and damning case regarding industry influence on the risk assessment of MSG. In addition

to industry involvement, Samuels also presents evidence that personnel at government institutions such as the U.S. Food and Drug Administration (FDA) and National Institute of Health (NIH) have been complicit in this influence. The American Medical Association (AMA) has also had a role in maintaining public ignorance regarding synthetic and industrialized food chemicals like MSG in food. At the AMA 1991 annual meeting the organization refused to implement a resolution passed by its own membership to encourage all appropriate regulatory agencies, including the FDA, to mandate labeling of all foods containing even small amounts of MSG (American Medical Association 1991).

The FDA has acknowledged that MSG holds the potential to cause some people to have serious adverse health outcomes which is the reason they require MSG to be listed on food ingredients labels (U.S. Food and Drug Administration 1995). But requiring MSG to be listed on the label is meaningless to the consumer if the food industry lists MSG under other names and then fails to require warnings on the food label that MSG is or may be present. If the FDA acknowledges the potential for adverse health consequences from MSG in some people, it begs the question, 'Why do they permit food corporations to obfuscate the fact that their products contain monosodium glutamate or free glutamic acid?' It also remains unclear why there are no required warnings on food products that contain other additives linked with adverse health reactions such as Tartrazine, caramel food dye, sodium benzoate, formaldehyde, BHT, BHA, BPA, and so on.

Yet another method of corporate obfuscation can come in the form of promoting consumer information overload. Information overload is a legitimate concern in food labeling. However, while industry often argues that labeling of legitimate health risks will overload the consumer, at the same time food manufacturers often overload the consumer with irrelevant or misleading information on food labels (Laskawy 2010). These can include meaningless claims of being "natural" without being USDA certified organic or complying with USDA requirements for organic foods, or claims of "no transfats/no added sugar" on products for which these claims are irrelevant. Information overload can

also come in the form of scientific studies overload (sometimes industry-sponsored), which may affect experts and reporters, as well as the consumer. Research overload can come in the form of overwhelming or confusing evaluators with the sheer volume of contradictory scientific information (Lengle 2008). This can often lead the evaluator (or consumers who read news articles on the subject) to conclude that the harm or benefit of certain food products or additives are completely unknown. Consumer doubt of scientific evidence may lead to the continued use of products even when there is arguably evidence of potential harm, simply because the seeds of doubt have been sown. As previously discussed, the scientific defense of industry's interests has become an industry in itself—one that has the resources to fulfill the objective of confusing and complicating evaluation of the science on a topic—including synthetic and industrialized food chemicals.

Obstacles to Achieving Bans or Label Warnings for Potentially Dangerous Synthetic/Industrialized Food Chemicals

One of the problems fueling consumer skepticism about the healthiness and safety of their food may be perpetuated by the obstacles governmental overseer agencies like the FDA and USDA must deal with. Governmental oversight agencies' efforts are often challenged by powerful lobbying groups representing the chemical and food industries, making any attempted changes a game of tug-of war. Some U.S. political representatives must fight these same obstacles when presenting legislation that is counter to the interest of the chemical and food industries. For example, Senator Dianne Feinstein has gone on record as stating that the chemical industry, namely The American Chemistry Council

(formerly known as the Chemical Manufacturers Association) was behind the failure of the recent legislative bill to ban BPA in the U.S. (USA Today 2010). Some of the largest chemical companies in the world including BASF, Dow, and DuPont, among other plastics manufacturers, make up the members of the American Chemistry Council (ACC)—an organization that has spent millions of dollars working to defeat efforts to restrict the use of bisphenol-A in infant formula, baby food, baby bottles and sippy-cups at the state level (Rosenberg 2010; Kissinger and Rust 2009; Layton 2009; Rust and Kissinger 2008). Also working to fight against changes in food labeling that would offer consumers warnings and more information about synthetic and industrialized food chemical ingredients is the Grocery Manufacturers Association (GMA)—another powerful organization with well-orchestrated and well-funded lobbying efforts to protect their interests. While having less at stake than the chemical industry, the GMA nonetheless reportedly teamed up with major food corporations and the ACC and made strident efforts to help defeat the bill that would restrict the use of BPA in the U.S. (Rosenberg 2010; Kissinger 2009).

Funding limitations is another obstacle faced by governmental overseers of food safety, causing these agencies to prioritize their focus on only those issues deemed an immediate threat or public health problem. An FDA advisory panel of outside experts reportedly concluded that the U.S. Food and Drug Administration is "so underfunded and understaffed that it puts U.S. consumers at risk when it comes to food and drug safety" (Weise and Schmit 2009). Much needed structural changes to permit agencies like the FDA to function effectively with modern-day issues and challenges are also in order. Outdated policies causing bureaucratic entanglement have tied the hands of administrators and created bottlenecks in the process of implementing critical policies in agencies like the FDA. When the financial and human resource limitations of the governmental overseeing body are coupled with industry-funded studies and the well-orchestrated efforts of the product defense industry, the consumer may suffer.

Also at issue is the sheer amount of chemical substances that are being registered every day in the U.S.—far more than agencies like the FDA can properly evaluate, say some scientists. According to Patricia Hunt, a professor in the Washington State University School of Molecular Biosciences, "…things get rapidly into the marketplace and the testing of them is tending to lag behind." Hunt is the author of an open letter to the FDA and EPA on this very topic published in the journal *Science:*

> "…eight societies from the fields of genetics, reproductive medicine, endocrinology, developmental biology and others note that some 12,000 new substances are being registered with the American Chemical Society daily...top federal regulators, the U.S. Food and Drug Administration and the Environmental Protection Agency, often lack information about the hazards of chemicals produced in high volumes.
>
> "Scientific societies representing 40,000 researchers and clinicians are asking that federal regulators tap a broader range of expertise when evaluating the risks of chemicals to which Americans are being increasingly exposed." (Hunt 2011; Layton 2011).

The Effect Corporate Obfuscation and Governmental Inaction Has on Consumer Confidence and Behavior

Reports about empirical research findings linking food chemicals to adverse health consequences have affected perceptions of U.S. food consumers in recent years as they continue to lack confidence in the safety of their food. A 2009 survey conducted by Survey Sampling International (SSI) and sponsored by IBM reported that "Consumers are increasingly wary of the safety of food purchased at grocery stores, and their confidence in – and trust of – food retailers, manufacturers and grocers is declining." The survey results found that less than 20 percent of consumers trust food companies to develop and sell food products that are safe and healthy. The survey also found that 60 percent of consumers are concerned about the safety of food they purchase, and 63 percent of consumers reported being knowledgeable about the content of the food they buy. The survey also found that there is a significant gap between consumer expectations and what retailers/manufacturers are providing. For example, 77 percent of consumers reported that they want more information about the content of the food products they purchase, and 76 percent would like more information about the food ingredients' origins. Another 74 percent are willing to do research and seek more data on their own about how the food products they are considering are grown, processed and manufactured. The survey also found that "consumers are spending more time pouring over food labels to know which ingredients were used, questioning supermarkets and product manufactures about product detail…and doing more in depth background checks on specific food brands and their origin" (IBM 2009,1).

CONCLUSION

There is a critical and immediate need to stop corporate obfuscation of food product labels and to develop a system whereby the FDA can swiftly and efficiently act on protecting consumers from potentially dangerous synthetic and industrialized food chemicals. People are exposed to multiple chemicals each day—many of which have been theorized to have cumulative and synergistic adverse effects (Lau et al. 2006) and deciphering whether and which substances may be linked to or perpetuating their illness is a tricky process that can take months or even years to determine. Since 1999 the U.S. Center for Disease Control and Prevention (CDCP) has measured 219 chemicals in blood and urine samples from thousands of study participants and their 2005 study found that study participants living in the U.S. had traces of more than 60 toxic chemical compounds in their blood and urine (2005). Additionally, The CDC tested over 2,500 urine samples from people over the age of six and found nearly 93 percent of samples contained BPA metabolites (Calafat et al. 2008). The construct of people having a 'chemical body burden'—the level of accumulated toxins one has in the body—has become something the general public is starting to attend to (Moyers 2010). Given the pervasiveness of synthetic and industrialized chemicals in the food, personal care products, household products and general environment and the potential hazards some of these chemicals carry, consumers in the U.S. have the right to know what is in their food without having to conduct arduous research on their own to uncover it. This is especially true given that food additives are likely to be consumed by nearly all segments of the population, including infants and children (potentially over the full course of their lifetime) as well as those people with health conditions and the elderly. This increased likelihood of exposure requires a more conservative approach to assessing safety for food additives (Lars 1999). It is incumbent upon political leaders on both sides of the aisle to work together in a united, bipartisan fashion to overhaul, update and modernize the agencies overseeing food safety for consumers and

streamline the process for requiring and reviewing empirical evidence about synthetic and industrialized chemicals in the food, and then of course, the agencies themselves to carry the ball and make that happen.

Another step of significant value in taking consumers out of the dark would be the development of a government-run national food chemical public database. The database could be live and searchable on the internet and constructed to function in much the same way the recent product safety database does (U.S. Consumer Product Safety Commission 2011), allowing for health-related reactions and complaints to be registered by consumers and permitting consumers to search the database by food ingredient name/name of synthetic or industrialized chemical used in food for more detailed information as well as offering links to empirical research findings about the synthetic/industrialized chemicals used in food ingredients. Such a publicly-accessed, centralized database could also allow for streamlining of the current FDA complaint and symptom/adverse reaction reporting system as well as a more efficient way to aggregate and report data on each food chemical.

And finally, political leaders must work together to develop and encourage an updated, fluid and transparent system whereby the governmental overseeing agencies like the FDA return to focusing on a single primary goal: to watch out for the consumer by actively investigating and taking action on every ingredient that may affect the health safety of our food. The milieu that permits turning a blind eye or helps facilitate obfuscation of food labels by members of the chemical and food industries should be replaced with one of transparency and the FDA and USDA should be broadly shielded from any overt or covert pressure by corporate entities that benefit from keeping the consumer in the dark.

ENDNOTES

1. The Federal Food, Drug, and Cosmetic Act (FFDCA) defines "food additive" to mean "any substance the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food (including any substance intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food)." 21 U.S.C. §321(s).

2. According to the Environmental Working Group, "The FDA has not tested food for bisphenol A contamination since the early 1990s, when it tested select canned vegetables purchased in Washington D.C. *See* FDA, *Draft Assessment of Bisphenol A for Use in Food Contact Applications* (August 14, 2008). The FDA tested only six samples (three canned mushrooms, and one sample each of artichokes, tomatoes and mixed vegetables). Bisphenol A levels in those samples ranged from 5 to 39 ppb, with an average of 16 ppb. In its draft assessment, the FDA also considers a study conducted by Brotons et al., published in 1995, that tested 10 samples and found an average level of contamination of 22 ppb. *Id*. The FDA concluded that a "conservative estimate" of exposure from canned food was therefore 22 ppb, but this is not in fact a conservative estimate, and is much lower than the average found by EWG for consuming tomato based products (63.5 ppb).

3. FDA GRAS Substances (SCOGS) Database: http://www.fda.gov/Food/FoodIngredientsPackaging/GenerallyRecognizedasSafeGRAS/GRASSubstancesSCOGSDatabase/default.htm

4. While optimal public policy on banning substances is also a valid question, it goes beyond the scope here. Our goal is to focus on the issue of labeling and provision of information to consumers.

5. From http://www.truthinlabeling.org/hiddensources.html

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