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Advertising, Empty Calories, and the
Endogenous Determination of Dietary Preferences

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THE McDONALD'S EQUILIBRIUM

Advertising, Empty Calories and the Endogenous Determination of Dietary Preferences*

Abstract

A comparison of accepted nutritional advice with actual American dietary practice suggests that many people fail to eat well in spite of well-documented health consequences. Popular culture often labels the worst offenders as lacking in “self-control,” and many blame the aggressive advertising campaigns of the fast-food and snack-food industries for manipulating consumers into poor diets, but these conclusions are not easily reconciled with a neoclassical approach to economic decision theory. This essay considers the consumer’s “diet problem” in light of emerging evidence from a number of behavioral sciences. In particular, it is argued that human evolution in the distant past resulted in an elegant solution to this problem (of search for a suitable diet in an uncertain environment), which any neoclassical economist would recognize. In modern environments, however, the signals that formerly provided information in the consumer’s search problem are subject to manipulation by food-producing firms. Confirmation by molecular biologists that many human responses to these signals are firmly encoded in our genes suggests a need to re-evaluate the welfare economics of the food industry.

Key Words: Self-Control, Health, Evolution, Consumer Protection

JEL Classification System codes: B4, D6, D18, D91, D83

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1. Introduction: The Diet Problem

1.1 *Deciding What to Do*

Economics, which has traditionally been concerned with what decisions are made rather than how they are made, has more and more reason to interest itself in the procedural aspects of decision.

--Herbert A. Simon (1978a, p. 494)

Economic search theory is often used to model consumer choice when product quality and/or price is uncertain. In such models, the consumer might, for example, engage in sequential search for the lowest-price product. Typically, search is costly, and the consumer uses prior knowledge of the price distribution to derive a “stopping rule” which specifies the conditions under which search will be terminated (i.e., what constitutes a satisfactory price).¹

Herbert Simon and others have noted that the information processing requirements of even the simplest search problems can be formidable, suggesting that cognitive constraints ought to be modeled directly. The resulting theories of *bounded rationality* posit that consumers in fact use relatively simple decision rules to solve search problems. In the simplest situations, a stopping rule derived without cognitive constraints can be observationally equivalent to the so-called *satisficing* behavior of the boundedly rational consumer, but certain peculiarities of consumer behavior have led some to argue that the latter approach has more descriptive power.²

This essay is an attempt to further delve into the question posed by Simon in the opening quotation. By asking *how* consumers choose products of uncertain quality and making use of the growing body of knowledge on the subject in fields outside the traditional purview of economics, it is my hope that new insights will result that lend both descriptive power and parsimony to consumer theory. It is within this larger context that I focus attention here on a very narrow class of the consumer’s decision problem. Specifically, I ask how people choose foods.

¹ See, for example, Stigler (1961), McCall (1965, 1970), or Hirshleifer (1973).

² See Simon (1978b) and recent survey by Conlisk (1996).

1.2 Choosing Foods

As an individual decision problem, dietary choice can be dauntingly complex. All but the poorest of the poor have a wide variety of foods available for inclusion in daily meals, each of which has unique nutritional and gustatory characteristics. In addition to the obvious constraints of cost and availability, the chosen diet must meet basic nutritional requirements. These requirements are age- and gender-specific, are not fully understood by modern science, and include many more compounds than can be found on product labels.³ And—as if it were not enough that nutritional information is incomplete, complex, and sometimes contradictory—the foods that *taste* best are often reportedly the *least* nutritious.

1.3 Human Nutritional Requirements

There is no question that diet has consequences for health and quality of life. Deficiency in any one of a long list of essential micronutrients (see Table 1) can quickly cause illness or death, and there is growing evidence that the proportion of macronutrients such as dietary fiber can be important determinants of health outcomes. For example, a 10-year prospective study of 75,000 women showed that those with the highest intakes of dietary fiber (in the form of 2.5 servings of whole grain foods per day) were 30% less likely to develop heart disease (Liu *et al.*, 2000); similarly, a 6-year prospective study of 65,000 women showed that those with the highest intakes of dietary fiber were 30% less likely to develop type 2 diabetes (Salmeron *et al.*, 1997); both of these diseases can be debilitating and/or deadly. So the diet problem is literally a matter of life or death.

³ Essential nutrients (i.e., nutrients without which humans cannot sustain life) are known to include not just the obvious calories, protein, vitamins, and minerals (see Table 1), but also, for example, omega-3 and omega-6 fatty acids, and the amino acids leucine, isoleucine, valine, lysine, tryptophan, threonine, methionine, phenylalanine, and histidine (Groff and Gropper 2000 p. 125, p170). There are, of course, non-essential nutrients (i.e., compounds that the human body can synthesize via the biochemical transformation of essential nutrients) without which health may be adversely affected; examples include carbohydrates, omega-9 fatty acids, and the non-essential amino acids.

Table 1: Diseases of Malnutrition

Some Consequences of Micronutrient Deficiency

Micronutrient (disease)	Symptoms/Consequences
<i>Ascorbic Acid (scurvy)</i>	Bleeding gums; hemorrhages under the skin; joint pain
<i>Biotin</i>	Muscle pain; extreme tiredness; numbness
<i>Choline</i>	Possible effects on learning and memory
<i>Chromium</i>	Insulin resistance; possible increased risk of heart disease
<i>Essential Fatty Acids</i>	Scaly skin; hair loss; impaired wound healing
<i>Fluoride</i>	Increased incidence of dental caries
<i>Folic Acid (megaloblastic anemia)</i>	Impaired production of red blood cells; spina bifida and other birth defects; possible increased risk of heart disease and cancer
<i>Iodine (goiter)</i>	Large swelling in the throat; birth defects including mental retardation, deafness, dwarfism, and paralysis of the limbs
<i>Iron (anemia)</i>	Weakness; shortness of breath; diminished physical work capacity
<i>Magnesium</i>	Tremors; muscle weakness; lack of reflexes; irregular heartbeat
<i>Manganese</i>	Scaly, red rash on the upper torso
<i>Niacin (pellagra)</i>	Severe dermatitis and fissured scabs; diarrhea; dementia; death
<i>Pantothenic Acid</i>	In humans: unknown In animals: loss of appetite, slow growth, skin lesions, ulceration of the intestines, weakness, death
<i>Riboflavin</i>	Swelling, fissuring, and ulceration of the lips and mouth; dermatitis on the scrotum or vulva; retarded growth; infertility; nerve degeneration
<i>Thiamine (beriberi)</i>	Anorexia; enlarged heart; cardiac failure; mental confusion; quivering of the hands or limbs; paralysis of the muscles of the eyes; coma; death
<i>Vitamin A (blindness)</i>	Night blindness; visual impairment; total blindness; possible increased cancer risk
<i>Vitamin B₆</i>	Depression; confusion; convulsions; seizures
<i>Vitamin D (rickets)</i>	Skeletal deformities
<i>Vitamin E</i>	Lesions in nerves and muscles; retinal degeneration; anemia; loss of coordination
<i>Vitamin K</i>	Bleeding episodes; infant death
<i>Zinc</i>	Facial rash; diarrhea; hair loss; impaired immune function; lack of sexual maturation; small stature

Sources: Brody (1999); Groff and Gropper (2000)

1.4 Making an “Optimal” Decision

The complexity and uncertainty associated with dietary choice are not so different, perhaps, from other choices the average consumer faces on a daily basis: consumers face a trade-off between immediate gustatory pleasure and future health consequences, and given available information, the consumer chooses the best diet from a menu of affordable diets. Indeed, people everywhere go about their daily lives giving little attention to their choice of diet, and appear nevertheless able to solve the diet problem reasonably well. An observer of this outcome might conclude that markets for food products are remarkably efficient at delivering products to consumers. To be sure, consumers have incomplete information⁴ when making dietary decisions, but there is also a market for nutrition information, and to the extent that the marginal benefit of learning more about nutrition exceeds the marginal cost of obtaining the information, we might expect that consumers are in fact choosing an optimal level of knowledge with respect to nutrition.⁵ The efficiency argument could also apply to private-sector producers of food: the amount and proportion of foods produced necessarily reflects both consumer demand and available food production technologies, and new technologies would presumably be developed and adopted only to the extent that they better

⁴ The cause of the information constraint need not be due to a contractual failure on the part of the supplier as in the excellent work of Akerlof (1970) and Stuart (1981); for most common food products, relatively complete nutritional information is publicly available in the nearest library. Indeed, “information” here is taken to include not just the nutritional content of a given food item, but also more general knowledge of nutrition science and one’s personal nutritional requirements.

⁵ This is not to say that the marketplace will provide an optimal amount of basic nutrition research, which is an important aspect of the consumer’s decision problem. Basic research is generally thought to be a public good, and thus will be insufficiently provided by the private sector. On the other hand, if consumers were willing to pay, at the margin, for additional information with respect to the health consequences of eating a particular diet, then perhaps they would demand that government fund the relevant research until the uncertainties were sufficiently resolved.

serve to satisfy consumer demand.⁶ So perhaps there's not a problem: consumers may be making uninformed decisions with respect to the composition of their diets, but they do so by choice, implying by their actions that the *status quo* allocation of foodstuffs is Pareto optimal.

1.5 Health Consequences of the Modern Diet

The first clue that there might be a flaw in the standard efficiency argument comes from a closer examination of the foods people *actually* choose in modern choice environments, and how changing food technologies affect market outcomes.

If consumers were concerned *only* with health outcomes, the consensus of modern nutrition science is that they should choose a diet comprised largely of whole grain foods, with ample fruits and vegetables, sufficient amounts of protein and calories, and limited amounts of sugar and saturated or processed fats. This “consensus” diet has been advocated, with minor variations, for the better part of a century, and is now supported by a substantial body of scientific research.⁷ But in spite of this triumph of modern science, the average American diet looks nothing like the consensus diet. For example, adults in the U.S. reported in a recent survey consuming an average of 6.7 servings of grain products per day, only 1.0 of which was whole grain⁸; the same survey showed that on any given day, approximately 50% of Americans consume *no* fruit or fruit juice, and only 10-15% will consume the dark-green

⁶ Again, there is the sticky question of whether the “right” amount of research and development in food production technology might be undertaken when spillovers (benefits to other producers who are able to “borrow” innovations for free) are likely. Nevertheless, innovation happens, and it seems reasonable to expect that the familiar mechanisms of supply and demand will ensure that only those innovations that improve the lot of the consumer will survive in the marketplace.

⁷ For an excellent and accessible survey of the current state of knowledge in nutritional science, see Willet (2001). Nestle (2002, Ch. 1) provides a summary of the history of nutrition science.

⁸ A sample of 9,323 adults over the age of 20 was drawn from the U.S. Department of Agriculture's 1994-96 Continuing Survey of Food Intakes by Individuals. Reported in Cleveland *et al* (2000).

or deep-yellow vegetables touted by nutrition scientists (Enns *et al*, 1997, Tables 2 and 4). Just as revealing are analyses of the components of caloric intake: Americans obtain 16% of calories from added sugar, and 60% of adults obtain more than 10% of calories from saturated fats (Tippett *et al*, 1999, p. 43). Results such as these—combined with epidemiological evidence linking diet to diseases such as type 2 diabetes, cancer, and obesity—has led at least one public health advocacy group to proclaim that “...nine out of ten adults are at increased risk of diet-related chronic diseases...” (American Public Health Association, 1993).

It is worth noting that many of the excesses of diet are related to the food processing technologies of the industrial age. For example, it has been the goal of wheat milling since prehistoric times to separate the bran and germ from the endosperm, in order to make white flour. Over the course of thousands of years, millers have become increasingly efficient at this task, successively developing millstones (ca. 8000 B.C.), papyrus sieves (ca. 5000 B.C.), quern stones (ca. 800 B.C.), windmills (ca. 1100 A.D), steam engines (1769), screw conveyors and bucket elevators (1808), roller mills (1878), middlings purifiers (ca. 1900), and air classifiers (ca. 1960). Compared to simple stone-ground wheat flour, today’s white flours have many desirable properties, including an extended shelf life (crucial to an efficient system of distribution) and a delicate flavor when baked into pastries, breads, or cakes. But the protein, vitamins, and essential fatty acids in wheat are mostly concentrated in the germ, and the bulk of the fiber is contained in the bran, leaving the carbohydrate-rich endosperm (and hence white flour) with a wealth of calories, but little else.^{9,10}

The overwhelming evidence that the average person fails to choose a healthy diet does

⁹ An excellent history and nutritional analysis of wheat and milling is provided in Ensminger *et al* (1983, pp. 767-769 and 2301-2321).

¹⁰ A similar story could be told about granulated sugar—first produced in 1795, with average annual consumption in the U.S. subsequently increasing from less than 9 pounds in 1850 to nearly 100 pounds today (Ward, 1941, p. 494; Ensminger *et al*, 1983, pp. 2061-2068)—or beef cattle, which have become progressively richer in saturated fat over the years as selective breeding and practices such as castration and grain (feedlot) fattening have been adopted in

not, in and of itself, imply that he is making a *mistake* when he disregards the dictates of modern nutrition science. Diet, after all, is a highly personal choice, and—as noted above—consumers must weigh future health consequences against the immediate pleasure of consumption. Who better to make such a decision than the consumer himself? But the severity and ubiquity of the health consequences of the modern diet and the apparent role of food production technology in aggravating the problem suggest that perhaps something has gone awry in the market for foodstuffs. At the very least, a closer look at the problem seems warranted.

1.6 How People Choose

...an emigrant tends to forget the language of his fatherland before giving up his native food habits.

--Max Rubner (quoted in Renner, 1944, p. 58)

As discussed above, the complex and uncertain nature of the diet problem does not preclude the sufficiency of free market mechanisms in helping consumers solve it. That consumers see a trade-off between *taste* and *health*, however, presents a more difficult problem, on at least two counts. The first difficulty stems from the fact that food preferences in humans are dynamic, a product of culture and habit. That food preferences are determined in part by the society in which one lives and—once determined—are resistant to change raises the question of *equilibrium selection*. Specifically, we might ask whether one “equilibrium” (i.e., *status quo*) diet is superior to another, *ceteris paribus*, and whether a given society might be better off if the local culture were to dictate some alternative diet.

The second, more troubling difficulty stems from the fact that food preferences are at least partly *genetic* in nature. As I have argued elsewhere (Smith, 2002), when preferences are passed on genetically the corresponding genes necessarily imply certain assumptions about the choice environments in which they were formed. If these assumptions prove to be in error, then the decision-maker will make mistakes in a systematic way.

These two problems, the influences of culture and genes on dietary choice, are the subject of this essay.

the quest for a more tender, better-tasting cut of meat (Coyle, 1982, pp. 65-67).

2. Solving the Diet Problem: Culture and Genes

2.1 *Omnivory and Imitation*

In the parlance of the biological scientist, humans are *omnivorous*, an ambitious term suggesting we will eat just about anything. A survey of world foodways leads one to think this characterization is not far from the truth: in addition to the familiar Western habits of eating roots, leaves, seeds, and animal flesh as well as fungus, spoiled milk, tree bark, and unmentionable body parts¹¹, one need not look far to find instances of peoples obtaining nutrition from the likes of insects, grubs, dirt, or even human corpses.¹² But the relative uniformity of diet within a given culture (which gives meaning to phrases like “Thai food” and “Mexican food”) raises the question of what determines dietary preferences.¹³

It is not difficult to explain cultural differences in cuisine in terms of historical differences in locally available ingredients (see, for example, Harris (1978), Harner (1977), and Johns (1991)). A more puzzling observation, given the demonstrated versatility of the human palate, is resistance to change among those of us old enough to have become accustomed to a given diet. This tendency manifests itself, for example, in immigrant communities, which—in spite of the nutritional equivalence of the local cuisine—have a strong tendency to bring their dietary habits with them. A striking example of the stubborn nature of food preferences is found in the earliest New World colonists: in the 17th century settlements at Jamestown and Plymouth, the newly arrived European colonists’ stubborn taste for familiar imported wheat over the novelty of corn took them to the brink of starvation before local foodstuffs were reluctantly adopted (Root and de Rochemont, 1976). Of particular interest, therefore, is the process by which cultural dietary preferences develop.

Humans are not alone in the animal kingdom in their dietary adaptability, nor do they hold

¹¹ Examples of such foods include potatoes, lettuce, rice, steak, mushrooms, cheese, cinnamon, and hot dogs, respectively.

¹² See, for example, review by Stinson (1992) and cites therein.

¹³ Birch (1999) provides an excellent recent survey of the literature on this subject; see also the classic treatise of Rozin (1976).

a monopoly on social behavior. These facts, together with the economic and ethical disadvantages of conducting experiments directly on humans, have resulted in a literature replete with evidence of how animals select foods in social settings. Rat pups, for example, are able to identify flavor cues in their mother's milk, which allow them to preferentially select their mother's diet at weaning, and they show strong preference, *ceteris paribus*, for feeding sites at which an adult (or even the scent of an adult) is present (Galef and Henderson, 1972; Galef and Clark, 1971; Galef and Heiber, 1976; Laland and Plotkin, 1990; 1993). Though housecats will typically refuse to eat bananas, Wyrwicka (1978; 1981) was able to train mother cats to do so by electrical stimulation of the hypothalamus; when their kittens observed this novel behavior, they too began to lick and eat bananas, and continued to accept bananas four months later. Similar experiments with sheep trained to eat wheat yielded similar results: weaning lambs offered wheat for the first time ate much more wheat if it was offered in the presence of their mothers who had been trained to eat wheat; and again the effect was long lasting (Lynch *et al*, 1983; Green *et al*, 1984). Hatchling chicks can be induced to peck at foodlike objects that are first "pecked" at by a mechanical pointer (Turner, 1964; Suboski 1989). Older chickens, after observing either an adolescent chicken or its television image feeding at a visually distinctive site, actively sought out and fed from similar sites two days later (McQuoid and Galef, 1992; 1993).¹⁴

Though experimental evidence on imitative behavior in humans is much more limited, available data indicate a pattern similar to that described for other social species. Some evidence suggests that distinctive flavors such as garlic and vanilla (when present in the maternal diet) can be detected by infants both *in utero* and via mother's milk, and that such early experience can shape later dietary preferences (Mennella and Beauchamp, 1996). Slightly later in life, children from 1 to 4 years old are twice as likely to taste a novel food if a friendly adult "visitor" eats it first (Harper and Sanders, 1975). Children from 3 to 5 years old with demonstrated aversions to certain foods are reportedly more than four times as likely to eat the aversive food when a group of peers chooses to eat it first (Birch, 1980; see also Duncker, 1938).

¹⁴ For an excellent survey on the subject of social influences on dietary preferences in animals, see Galef (1996).

The process of learning about new foods necessarily involves the interplay of fear of new foods or *neophobia*, and curiosity about new foods. As might be expected, these attitudes (as indicated, for example, by both breadth of diet and incidence of accidental poisonings) vary in a predictable way throughout the life cycle, with curiosity holding sway during the first two years of life and neophobia reaching its zenith around age 5 (Cashdan, 1994; 1998). A similar pattern was observed in a study of free-living Japanese macaques: when candy was introduced to the group, only 10% of adults ate candy on initial presentation, whereas 50% of monkeys less than three years old did; a year after the initial introduction, 100% of 1-year-olds continued to eat candy, whereas only 51% of older females and 32% of older males did (Itani, 1958).

2.2 The Physiology and Genetics of Taste

Culture certainly plays a role in determining the foods we choose to eat, but there are also aspects of human dietary choice that are undoubtedly influenced by our genes. From the day they are born, infants demonstrably prefer sweet tastes and avoid bitter and sour tastes (Nisbett and Gurwitz, 1970; Desor *et al*, 1973; 1977; Desor *et al*, 1975; Steiner, 1977), and by four months of age a preference for salt reliably develops (Beauchamp *et al*, 1994). These “four basic tastes” have a well-known physiological basis, with receptor cells in the tongue responding to the presence of specific classes of chemicals (simple carbohydrates, many structurally unrelated compounds, acids, and sodium, respectively) by stimulating taste-specific neural pathways and brain regions (Carlson, 2002, pp. 211-216).¹⁵

In some cases, the genes that code for receptor cells and their associated neural machinery have been identified (see Sullivan [2002] for a recent survey), and there is also much evidence that taste perception varies within human populations, and that this variation is heritable. For example, it has long been known from family studies that sensitivity to the bitter taste of the indicator compounds 6-*n*-propylthiouracil (PROP) and phenylthiocarbamide

¹⁵ Recent evidence has suggested that humans may have two additional “basic tastes,” one for *umami* or “savory,” triggered by monosodium glutamate, and one for fats, triggered by the essential fatty acids. There is not yet a consensus that these deserve “basic taste” status, and research on their effects on ingestive behavior is much more limited than for sweet, salty, bitter, and sour. Current research is summarized in Carlson (2002).

(PTC) follows a simple (single-gene) Mendelian inheritance pattern (Blakeslee and Fox, 1932; Snyder, 1931). Sensitivity to PROP and PTC is measured by a threshold method that sorts people into the three genetically distinct categories of non-tasters, medium-tasters, and super-tasters (Drewnowski *et al*, 2001). The PROP/PTC studies, however, test sensitivity to only a single class of bitter-tasting compounds; many other compounds (chemically unrelated to PROP and PTC) are perceived as “bitter” by human subjects, and recent evidence suggests there may be as many as 60 distinct bitter receptors—all of which appear to transmit the same message to the gustatory regions of the brain (Adler *et al*, 2000). Nevertheless, the simple PROP screening test has been used to demonstrate that (genetically determined) variation in taste perception translates into predictable variation in dietary choice behavior (Drewnowski *et al*, 2001; Duffy and Bartoshuk, 1996).

The basic tastes of the gustatory system are but a small fraction of what we experience as “flavor”. In particular the human olfactory system (the second “chemical sense”) gives us the ability to recognize up to 10,000 different odors (Shepherd, 1994). None of these, however, appear to trigger innate, unlearned responses in humans, and the number of receptor types are thought to be much smaller than 10,000. Rather, any given odor molecule appears to activate several different types of olfactory receptors, and it is the *pattern* of activation that is learned and recalled later (Carlson, 2002, pp. 219-220). This in turn can translate into learned dietary preference: for example, people given unfamiliar teas (presumably distinguishable mostly by aroma), some sweetened and some unsweetened, show an increased preference for the tea that had been sweetened, even when it is subsequently presented unsweetened (Capaldi, 1996; Zellner *et al*, 1983).

2.3 Nausea Aversion and Other Postingestive Consequences

Another demonstrated determinant of food preferences is *postingestive consequences*. For example, it is generally the case that when humans or animals experience nausea or gastrointestinal distress after eating a particular food, they subsequently avoid that food. Food aversions will develop even when *subjects are fully aware that the food is clearly not the cause of the nausea*, as when subjects are treated with a nausea-inducing drug or radiation treatment, or when the subject just happens to be ill. Such aversions can last for years, and

will develop even if nausea occurs only several hours after ingestion.¹⁶

There is also evidence that the postingestive consequences of eating high-calorie foods can increase preference for a given food. For example, Kern *et al* (1993) fed 3- and 4-year-old children flavored yogurt drinks, and surreptitiously amended certain flavors with additional dietary fat. After six weeks of conditioning (of two drinks per week), subjects again tasted the various flavors, this time without added fat; they strongly favored those flavors that had been served with added fat. Experimental evidence such as this suggests that people choose foods not just for flavor or by habit, but also by caloric density, as measured by postingestive feelings of satiety.

2.4 Culture, Genes, and Decisions

It is tempting to emphasize the dichotomous nature of the evidence on dietary choice. After all, some of this behavior can only be described as innate—preference for sweets, for example—while there is also a demonstrable role for culture and learning.¹⁷ But the goal here is to develop a single, parsimonious theory that brings these seemingly disparate behavioral phenomena together.

One obvious difficulty in applying conventional neoclassical economic decision theory to dietary choice is that some cases—nausea aversion, for example—seem better described as emotional or biological than as the conscious, rational deliberation typically implicit in neoclassical theories. But this does not necessarily preclude the usefulness of neoclassical principles in describing dietary choice. Indeed, the classic defense of the neoclassical approach (which generally views behavior as a tool for the decision-maker to achieve his

¹⁶ See Schafe and Bernstein (1996) for a survey; the phenomenon is also discussed by Romer (2000).

¹⁷ It is important to note that genes and culture are two sides of the same coin. As I have argued elsewhere (Smith, 2002), it is logically impossible for *any* behavior to be classified as the sole product of either culture or genes. On the contrary, all behaviors are necessarily the joint product of an individual's genes and his life history. It is legitimate to ask whether variation in a given behavior is due to variation in genes or in environment, but there is a strong sense in which it is unnecessary to establish the genetic underpinnings of behavior.

goals, whatever they might be) is that no alternative approach provides a superior positive theory of *behavior*, regardless of what might be happening within the mind of the decision-maker (Friedman, 1953). In what follows I argue that neoclassical decision theory can provide insight by providing a formal framework in which biology and culture both have a place.

3. Subjective Decision Theory

...the troubles of the neoclassical theory begin as soon as we introduce uncertainty...

--Herbert A. Simon (1992, p. 15)

3.1 The Basics

The classic exposition of modern decision theory is Leonard Savage's *The Foundations of Statistics* (1954). Though many variations on (and alternatives to) Savage's approach have been proposed since its publication, it remains the standard against which alternative theories are measured and will serve as a useful starting point here.

The primitive elements of Savage's theory of subjective expected utility are:

- S , the set of *states* of the world, with elements s_1, s_2, \dots ;
- Z , the set of *prizes* or consequences, with elements z_1, z_2, \dots ;
- A , the set of *actions*, functions mapping from S to Z ; and
- \succ , the *preference relation*, a binary relation on A .

By assuming certain properties on each of these four elements, Savage (and many subsequent authors) showed that choice behavior within this framework will implicitly assign a unique probability $p(s_i)$ to each state s_i of the world, and a unique (up to a positive affine transformation) utility $u(z_i)$ to each prize z_i , and that choices will maximize the expected value of utility, $\mathbf{p}(S) \cdot \mathbf{u}(Z)$. In other words, it is not necessary for an expected utility-maximizing decision-maker to "know", *a priori*, the probability of each state and the utility of each prize: as long as he is able to choose among available actions, he is implying by his actions his own personal, subjective judgment of both probabilities and utilities.

That both probabilities and utilities may be taken as subjective is Savage's greatest innovation, as it reconciles the theory of expected utility with the fact that virtually no one, if you ask them, can tell you with any confidence the probabilities of the multitude of various states of the world they face, much less assign numerical values to all possible consequences of their actions. After all, people face uncertainty every day, and make choices nevertheless,

and the theory of subjective expected utility allows the behavioral scientist to focus on actions, with little deference to “black box” comprising the inner workings of the mind.

Another part of the appeal of the theory of subjective expected utility stems from the fact that it allows the behavioral scientist to infer both $\mathbf{p}(S)$ and $\mathbf{u}(Z)$ simply through observed behavior. For example, a subject might be offered a choice of a \$10 prize if Team A wins the Super Bowl or a \$10 prize if Team B wins. If the subject chooses the first contingency, he is implying by his choice that he believes the winner is more likely to be team A than team B—i.e., the two states of the world being “Team A wins” and “Team B wins,” an observer could infer that the subject’s subjective probability of the former is greater than his subjective probability of the latter. On the other hand, utility might be inferred by observing behavior in situations involving known objective probabilities. A subject might be offered, for example, the choice of an ice cream cone if the toss of a fair coin comes up heads or a bowl of cherries if it comes up tails. A subject choosing the ice cream would reveal by his actions that he assigned a higher utility to the prize “ice cream cone” than the prize “bowl of cherries”. The relative sizes of the utilities of the two prizes could then be more clearly revealed by adjusting the probabilities of receiving each prize (i.e., by decreasing the probability of ice cream and increasing the probability of cherries, perhaps by employing another randomizing device such as balls in an urn) until the point is reached at which the subject is indifferent between the chance of winning an ice cream cone and the chance of winning a bowl of cherries.¹⁸

The examples employed thus far may make the decision environment described by S , Z , A , and \succ seem overly simplistic. This framework, however, can be used to describe much richer decision environments; a few relevant examples are offered in the next section.

3.2 Information, Signals, and Contingency

The subjective probability measure $\mathbf{p}(S)$ is often referred to as the decision-maker’s

¹⁸ One might well ask how an observer knows exactly what the decision-maker cares about and which “states of the world” he considers relevant; i.e., what are the elements comprising Z and S ? In principle, these too might be inferred from behavior, by examining an individual’s sensitivity to variation in Z and S .

“beliefs” about the world. Because we might expect subjective probabilities to change when the decision-maker receives new information, it can be useful to explicitly define a collection of information sets \mathcal{I} , each element I_i of which is a set of signals providing information about the world such that $\mathbf{p}_i = \mathbf{p}(S|I_i)$.

Making \succ endogenous in this way adds a significant complication to the theory, and Savage himself (1954, pp. 82-90) was quick to emphasize that his theory of decisions must necessarily be applied only in the “small world” of an individual decision-maker acting at a given time with a given amount of knowledge or information. But people are undoubtedly sensitive to new information in many ways, and the point here is that subjective decision theory can still be applied—as long as it is applied to each information state separately.¹⁹

In principle, making \succ dependent on \mathcal{I} does not preclude the behavioral scientist from inferring \succ directly from behavior; he merely needs to identify those informational aspects of the world to which \succ is sensitive, and control for them accordingly. In practice, of course, the data required to construct such measures in detail are prohibitive. And even when the information problem is neglected, merely distinguishing \mathbf{p} from \mathbf{u} by behavioral observations alone can be problematic: most applications of expected utility theory instead employ *a priori* knowledge of probability distributions, and draw inferences about utility from observed behavior. There is no reason, however, that the reverse approach shouldn’t be employed: the observer might just as well begin with *a priori* knowledge of utilities and attempt to estimate subjective probabilities.

3.3 Evolution of \succ by Natural Selection

Nothing in biology makes sense except in light of evolution.

--Theodosius Dobzhansky (1973)

¹⁹ A related complication that often arises is the case of sequential decision-making, perhaps with new information arriving over time. Savage and others have argued that this problem can be reduced to a single decision problem in which the decision-maker chooses an optimal sequence of decisions, contingent upon the arrival of new information (Savage 1954, pp. 15-16).

As noted in Section 2 above, evidence from a variety of sources documents the link between human genes and dietary choice. That genes might influence behavior suggests a biological or evolutionary interpretation of subjective decision theory,²⁰ which opens the door, in turn, to a rich and diverse body of theory and evidence.

The elements of subjective decision theory fit nicely with the theory of evolution by natural selection. One could imagine natural selection choosing among members of a population of foraging animals on the basis of the relative success of the (genetically transmitted) behavioral algorithms employed. The measure of “success” in evolutionary biology is Darwinian fitness, loosely defined as the number of descendants surviving in the distant future. In an uncertain environment—evolution doesn’t make a lot of sense without elements of uncertainty—the proper maximand is the expectation of Darwinian fitness.²¹ The parallels with subjective decision theory follow immediately: the behavioral algorithm upon which natural selection acts might be represented as a binary (preference) relation on the set of possible actions; under fairly general conditions, the preference relation chosen by natural selection (i.e., surviving in the long run) will be that which maximizes expected fitness $\mathbf{p}(S) \cdot \mathbf{f}(Z)$, where \mathbf{p} is a vector of actual probabilities over states of the world and \mathbf{f} is a vector of Darwinian fitnesses, each of which corresponds to one possible consequence. An observer, of course, could infer both \mathbf{p} and \mathbf{f} from behavior alone, as above, in the process

²⁰ The notion that biology and evolution can inform theories of economic behavior has been developed by a number of authors. See, for example, Hirshleifer (1977, 1985), Rogers (1994), Bergstrom (1996), and Robson (1996). E.A. Smith (2000) suggests that current approaches to the evolutionary analysis of human behavior can usefully be thought of as falling into three broad categories, which he terms *dual inheritance theory*, *behavioral ecology*, and *evolutionary psychology*. Appendix I briefly describes each of these and relates them to parallel approaches in economics.

²¹ An important qualification to the expected (i.e., arithmetic mean) fitness hypothesis is the requirement that risks must be independent. If, on the other hand, uncertainty is the manifestation of environmental fluctuations (i.e., risks that affect the entire population) evolution will tend to select agents that maximize the *geometric* mean fitness (see, e.g., Houston and McNamara, 1999; Bergstrom, 1997; Robson, 1996; or Smith, 2002).

learning something about the environment (as characterized by the Darwinian prize space, state space, and probability distributions) in which the decision-maker evolved. But the reverse is also true: an observer with knowledge of the environment in which the decision-maker evolved could make predictions about the nature of the preference relation.

Explicitly acknowledging the evolutionary origins of \succ and the fixed nature of the genetic code that apparently underlies it casts subjective decision theory in a new light. Making sense of modern dietary choice in this light requires the informed behavioral scientist to have some understanding of the decision environment in which humans evolved. This is the subject of the next section.

4. Whence the Solution: Shadows of Human Evolution^[TGS17]

I believe the main reason habitual behavior permeates most aspects of life is that habits have an advantage in the biological evolution of human traits. For as long as habits are not too powerful they have social as well as personal advantages.

--Gary S. Becker (1996, p. 9)

4.1 Signals and Shifting Priors

For an animal foraging in the wild, the problem of choosing foods is not only information-constrained, it is downright dangerous: a novel object might well turn out to be tasty and nutritionally valuable, but on the other hand it could be toxic, contain deadly poisons, or be tainted with infectious microorganisms. The same was true, of course, for humans living in small-scale pre-agrarian societies—as humans have for most of our collective evolutionary past. So we might expect Mother Nature (i.e., the process of evolution by natural selection) to have endowed us with behavioral algorithms that help us to nourish ourselves without doing ourselves in. The way Mother Nature has done this, it will be argued here, is to take advantage of regularities in the environment that provide clues as to which novel items in the local environment are likely to have nutritional value.

If, for example, foods with characteristic X are more likely than not to be nutritionally valuable and toxin-free, then individuals favoring foods with characteristic X would, on average, be favored by natural selection. Consider the decision problem faced by the omnivore: when presented with food X, and the choice of actions at hand is “eat item X” or “don’t eat item X,” the states of the world correspond to possible degrees of nutritional value for item X, with the prizes being the consequences of eating item X (which will vary with

state) or of not eating item X (which will not). Then we would expect Mother Nature to choose the relation \succ such that the utilities implied by \succ to correspond to the true nutritional value of foods, just as we would expect the probabilities \mathbf{p} implied by \succ to correspond to the true probability distribution on nutritional quality. In effect, when signal X is received with respect to a given potential food, the corresponding \mathbf{p} shifts to reflect higher probability of nutritional value, increasing the chances that item X will be eaten.

In keeping with Savage's tradition of focusing analysis on a "small world" of decision-making, I will limit analysis here to the simple problem described in the previous paragraph. This decision problem is implicitly made in the context of the problem of "assembling a menu". That is, the decision-maker's larger task is to search for and adopt foods to be included in his diet in the future.²² For foraging omnivores this is an important adaptive problem: although dietary flexibility conveys obvious advantages, it also increases the possibility of poisoning early in life, when the young animal must learn which objects are good to eat and which are to be avoided. Given what is known about how animals actually solve this problem (discussed in Section 2 above), the signals upon which they rely can be divided into three groups: cultural signals, chemical signals, and postingestive signals. Roughly speaking, these signals might be thought of as arriving in sequence: first the young omnivore observes his peers eating item X (a cultural signal), then he tastes X (a chemical signal) and finally he waits to see how he feels after eating X (a postingestive signal). The evolutionary rationale for relying on these particular signals will be discussed briefly in the next section. The applicability to real human decision environments will then be considered.

4.2 Three Important Signals: Culture, Taste, and Aftereffects[RGS19]

4.2.1 Culture as Information

The simplest method of search for foods in a natural environment would perhaps be trial-and-error, sampling the local flora and fauna and accumulating knowledge of their various physiological aftereffects. But given the inherent risks of sampling new foods—including

²² This is a much simpler problem than that of choosing an optimal diet. The complete diet problem might be thought of as a two-stage problem: i) assembling a menu of acceptable foods and ii) choosing a diet from that menu. George Stigler's classic treatise, "The Cost of Subsistence" (1945) and the large literature it spawned emphasize the second stage.

death from poisoning or infectious disease—a better strategy would be to take advantage of cues in the local environment that signal which potential foods are more likely to be toxic and which are more likely to be nutritious. An obvious example of such a strategy is to make use of the accumulated knowledge of your conspecifics, observing what they eat and selectively consuming these same foods yourself.

As Section 2.1 established, humans and other social species clearly make ample use of imitation early in life, learning to eat foods they see others eat. But is this always a good idea? Might it not be possible, in the course of human evolution, that the established food habits of others might overlook valuable resources, so much so that the benefits of trying something new would outweigh the risks? Perhaps, but surveys of the traditional diets of modern hunter-gatherers and subsistence farmers suggest most cultures have been very successful at developing well-rounded diets from local foodstuffs (Eaton and Konner, 1985). One striking example is found in the ancient American practice of alkali processing of corn: Katz *et al* (1974) have argued convincingly that this process has been adopted in areas in which the local population would otherwise be subject to outbreaks of pellagra. Pellagra (described in Table 1, above) is caused by a dietary deficiency of niacin; corn is very low in niacin, but treatment (boiling the corn with calcium oxide) greatly increases the amount of biologically available niacin. The origins of the practice are unknown, and traditional practitioners are reportedly unaware of the nutritional benefits: they claim to process the corn into masa simply because it improves the taste. Other examples of the wisdom of traditional local cultures include Asian soy processing techniques, which remove potentially harmful compounds (Katz, 1987), and *geophagia* (soil consumption) in areas where the local organic diet provides a dearth of essential minerals (Hunter, 1973; Danford, 1982).

A related question is why people might rely on imitation rather than collecting information directly from peers and parents, by asking questions about the known properties of various foods. It may make sense for animals—which cannot speak or read—to rely on observation of others, but wouldn't humans be better off relying on oral or written histories of food? Perhaps they would, and no doubt some information has always been transmitted this way, but judging from the content of contemporary children's television advertising (see Appendix II), many young people are indeed susceptible to the influence of visual representations of food consumption. The evolutionary rationale for this seemingly irrational behavior is simple: in assigning relative weights to social experience (i.e., visual observation)

and asking around (or it's modern equivalent, reading about nutrition) in determining dietary behavior, Mother Nature has the benefit of eons of experience. It is not hard to imagine scenarios in which peers or parents might give false testimony with respect to the merits of a highly valued treat (all the more for themselves...), so perhaps such information should be discounted accordingly; a more reliable signal of nutritional value in human evolutionary history might have been the observation of a couple of peers fighting for a coveted fruit or piece of meat.

4.2.2 *Chemical Signals*

The fact that humans—via the senses of taste and smell—have the ability to test directly for specific classes of chemical compounds is evidence that the evolution of sophisticated chemical sensing systems is possible. But how sophisticated *should* such systems be? That is, given the metabolic costs of sensing, storing, and processing additional information with respect to the chemical makeup of a given food, at what point do the costs of additional information exceed the benefits? The usual answer in economics and behavioral ecology—the point at which marginal (fitness) cost equals marginal (fitness) benefit—is complicated by the fact that the chemicals of interest are not distributed at random in natural environments. While some important nutrients—pantothenic acid, for example—are found in virtually all foods of plant or animal origin, making a specific sense perception perfectly useless, others are to some extent grouped neatly into packages of deadly toxins and valuable nutrients, for reasons to be discussed below. A good strategy in such an environment would be to identify compounds that serve as reliable signals of toxicity and/or nutrition, and test for these, relying on the fact that other important nutrients typically coexist with the signals.

For many years plant toxins such as alkaloids, quinones, and terpenoids were thought to be secondary metabolites, waste products of no particular use to the plant that made them. But further study made it clear that these energetically costly compounds were made for a reason: as a defense against herbivorous foraging animals. By a process known as *coevolution*,²³ the production of plant toxins is now thought to have arisen because the toxins

²³ Coevolution refers to the evolution of two or more interdependent species, each adapting to changes in the other. The term is also sometimes used to describe the interdependence of social environment (culture) and individual (genetic) strategies within the same species (e.g.,

protect the plant from being eaten. The logic of coevolution can also lead, however, to precisely the opposite strategy. There are instances in which consumption by animals can serve to pollinate a plant's flowers or disperse its seeds; in these cases, the plant typically generates pollen or a fruit free from toxins and rich in simple carbohydrates and other valuable nutrients.²⁴ In both the case of protective toxins and the case of seed or pollen dispersal, plants often couple the biochemical signal with a visual signal (distinctly shaped and/or brightly colored flowers, fruits, or leaves), reinforcing the lesson for the offending animal and facilitating future identification (see, e.g., Raven *et al*, 1999, pp. 546-551).

The chemical signals upon which Nature seems to have settled in the coevolutionary game between humans and their foods are suggested by the (genetically programmed) sensitivities of our tongues: sugars and salt are perceived as sweet and salty, respectively, and are sought after; whereas acids and chemically complex toxins are perceived as sour and bitter, respectively, and are avoided. In natural settings, sugars are rare and found only in ripe fruits and raw honey, both of which reliably contain a host of other valuable vitamins and minerals; likewise, salt is rare in most natural settings but metabolically necessary, so an attraction to salty foods would have been likely to serve humans well over most of their evolutionary history, as well. The sour and bitter compounds found in immature fruits and other plant (and some animal) materials, are often themselves toxic, imposing an immediate metabolic cost on those unfortunate enough to sample them.

4.2.3 *Postingestive Consequences*

The evolutionary logic of avoiding foods that make you vomit is perhaps obvious, but the inflexibility of this response is perhaps less so. Why should people develop such aversions when they have objective knowledge that the nausea was not caused by the food? The answer

Durham, 1991).

²⁴ A similar story emerges in the prehistory of agriculture, as described in Diamond (1997, pp. 120-121): It is thought that pre-agrarian human foragers inadvertently selected for beneficial traits in harvesting wild grains. Such foraging would naturally have favored those grasses whose seeds were larger and more readily harvestable. Over time, the resulting human-facilitated seed dispersal resulted in the evolution of a handful of wild predecessor species into domesticated wheat, barley, and other grains upon which the emergence of agriculture ultimately depended.

is that for most of human evolutionary history, such objective knowledge was presumably not very reliable, and the risks of eating poisonous toxins too great. In choosing the information states on which to condition \succ , Nature gave greater weight to postingestive nausea and less to objective knowledge because in the long run this must have resulted, on average, in better health outcomes.²⁵

It has also been suggested that nausea aversion plays a role in the omnivore's difficult task of choosing a well-rounded diet. In a series of classic experiments (described by Rozin [1976], pp. 38-48), laboratory rats fed thiamine-deficient diets to the point of malnutrition were subsequently given opportunities to try other foods. Rats, like humans, lack the ability to detect thiamine (vitamin B₁) directly via the chemical senses, but after becoming ill on a thiamine-deficient diet, they develop an aversion toward the diet, preferring to eat their own feces (which, in fact, contain trace amounts of thiamine) or any alternative diet offered, even if the alternative diet also lacks thiamine. This simple algorithm ("seek out new foods when ill") might go a long way toward helping foraging animals solve the diet problem in natural settings.

4.3 Evolutionary Equilibrium: Dynamic Consistency and "as-if" Rationality

When one considers the environment in which humans evolved, with the inherent dangers of unfamiliar foods, the convenient distribution of sugars and toxins, and the valuable accumulation of local dietary knowledge, it begins to become apparent why people choose foods the way they do. It is not hard to imagine an ancient environment in which there was no contradiction between one's dietary tastes and future health consequences. Behavior in this environment would have looked a lot like the behavior generated by neoclassical

²⁵ Robson (2002, p. 93) makes a similar argument in a discussion of why individuals seeking to maximize the number of offspring they produce ought to rely in some cases on evolutionary knowledge ("Nature") rather than personal knowledge: "An individual who relies on personal experience might...for example, observe one relative who has an unhealthy diet, but still lives a long life with relatively many offspring, and another relative who consumes a healthy diet, but dies early with no children. Because individuals see only a small sample, requiring them to learn what consumption choices lead to more offspring will be less effective than having them adhere to the ranking of these choices set by Nature."

economic models, in which choice (specifically, dietary choice under conditions of uncertainty) is a means to an end (good health).

In particular, in the evolutionary equilibrium described here there is no problem of self-control in choosing foods. An individual might actively seek out and gorge on sweet foods, but doing so would not be inconsistent with expected future health outcomes; he would not, on average, regret his actions, and he would have no reason to employ commitment devices that restrict his freedom of choice.

4.4 Conscious Deliberation and Bounded Rationality

This essay began with the stated purpose of investigating exactly *how* consumers solve the search theoretic problem of choosing a diet. The careful reader may have noted that in the evolutionary equilibrium described above, the actions of the decision-maker are not explicitly constrained by his information-processing capabilities. Though the equilibrium strategy might be described in terms of simple heuristics (“choose sweet over bitter,” “eat what others eat,” etc.), these rules were generated by an optimizing process more akin to neoclassical search than to boundedly rational search. This is not to say that an *individual* decision-maker deliberately performs all the necessary calculations, much less goes out and collects the information upon which the resulting strategy is based. He merely finds pleasure in sweet-tasting foods, or feels curiosity after watching his companions eagerly consume a novel food. He experiences these emotions, and acts upon them, because in the countless generations who came before those who were similarly predisposed enjoyed an advantage when it came to solving the diet problem. In other words, the computational heavy lifting of optimization is left to the process of evolution by natural selection.²⁶

Evolutionary analogies are often invoked in defense of the (unboundedly) rational consumer, as exemplified by the following passage:

This approach is...consistent with the view that tastes or preferences are competitively selected. Tastes are not arbitrary “givens”: they evolve in a crucible of continual competitive testing. In a nation of island dwellers, it is unlikely that we will find many persons who dislike fish. Nor are we likely to

²⁶ Robert Frank (1988) offers a similar explanation of human emotions in the context of social behavior.

find many vegetarians in lands well suited to grazing animals. Tastes so expensive as these are simply not likely to survive. The environment places limits on the variability of tastes among the residents of that environment. In one sense, the aim of civilization (including the growth of income) is to widen the tolerance of the environment.

--George J. Stigler (1987, p. 33)

But a deeper understanding of exactly how preferences for food are influenced by genetic predilections and childhood experience raises uncomfortable questions about this particular conclusion. It is indeed true that tastes are not arbitrary, and that they are the product of an evolutionary process. And it is also true that fish are likely to be eaten on islands, and meat in regions with productive grasslands. It does not follow, however, that tastes are *completely* malleable within spans of time that interest economists. Consumers' innate reactions to sweet, bitter, sour, etc., being encoded in their genes, cannot be altered within the span of a single lifetime. Nor does it follow, as Stigler implies, that the observed malleability of preferences ensures that advances in technology will always make us better off. This is the subject of the next section.

5. Biological Legacy Meets Modern Technology: The McDonald's Equilibrium

5.1 Food in the Modern Marketplace

Today we live in a world of rapidly changing technology, nothing like the pre-industrial (and even pre-agricultural) world that characterizes most of human evolutionary history. But an understanding of human dietary choice in light of an evolutionary view of our species yields a rich descriptive theory of how we might expect consumers and firms to interact in modern markets. It has been argued here that we can think of consumer behavior as being guided by a preference relation that is literally written into our genes. To the extent that this is true—and acknowledging Savage's demonstration that such a preference relation must implicitly incorporate *beliefs* about the world—it is necessarily true that consumers can usefully be thought of as making “mistakes” in modern market economies.

Specifically, evolution seems to have conditioned human dietary choice on the three information states discussed in Section 4.2: we prefer foods that are i) eaten by others, ii) taste sweet or salty, or iii) are associated with postingestive satiety—presumably because in the course of human evolution each of these cues was associated with a higher probability of the food in question being nutritionally valuable.

A profit-maximizing firm seeking to bring food products to the market would be foolish to ignore the effects of these dietary proclivities on consumer demand. And indeed, even a cursory look at the marketing practices and products of the largest U.S. food producers confirms that these firms are no fools.

5.2 Marketing and Design Aspects of Fast Foods and Snack Foods

5.2.1 Television Advertising

Consumer advocates have long argued that much advertising, especially television advertising, manipulates consumers into buying products that are detrimental to health or well being. In particular, television advertisements aimed at children (of which a current sample is described in Appendix II) are rich in imagery and action but rarely convey substantive information about the characteristics of the product being advertised.

The apparent lack of direct information in these ads would seem to make them good candidates for the compelling and influential theory of uninformative advertising offered by Milgrom and Roberts in 1986. In this view, advertisements may serve as valuable signals of product quality even if they convey *no* descriptive information about the product. It might well be argued that the television advertisements described in Appendix II fit into this category. But closer scrutiny of the visual information presented in these ads—together with knowledge of the decision algorithm employed by young children in choosing foods—makes it clear that information is indeed being conveyed. And knowledge of the evolutionary problem this particular decision algorithm is intended to solve suggests that the information conveyed on television ads is in a sense *misinformation*, to the extent that it induces the young consumer to act on the basis of biased subjective probabilities.²⁷

²⁷ This is not to imply that advertisers are necessarily aware of the biological underpinnings of the psychological mechanisms governing consumer behavior; all that matters for their purposes, of course, is that their advertisements are effective. It is interesting to note, however, that “advertising men” have long been aware of the strength of human “instincts”. The following passage from the classic advertising textbook of Tipper *et al* (1915, p. 75), though written nearly a century ago, could well have been drawn from a modern text on evolutionary psychology: “In the past experience of the (human) race certain objects or situations have stood out as fundamentally important in the struggle for survival, supremacy,

In the most common treatment, the food product being advertised is shown inducing a dramatically improved mood or state of health in the actors eating it. In another, the product is presented visually as a prize being scuffled over by two or more individuals. Other themes include presenting the product as a reward for athletic merit, or associating it with social success (see Appendix II, and the similar analysis of Rajecki *et al*, 1994). It doesn't seem too much of a stretch to suggest that many of these scenarios would have provided valuable information about the relative merits of local foodstuffs for most of our collective evolutionary past.

Not surprisingly, there is also evidence that advertisements are effective in influencing dietary choice. Children often request specific food products after seeing them advertised on television, and their parents often buy them.²⁸ The diets of children exposed to more television advertising mirror the types of food products—generally high in fat, sugar, and/or salt—emphasized in television ads.²⁹ And in laboratory settings, children show a strong

and comfort. Definite modes of reaction have been found to be most appropriate in dealing with these particular objects or situations. Individuals who have reacted promptly and definitely in these appropriate ways have been successful, have flourished, and have left offspring who possessed the same inborn tendencies to reaction. Individuals who failed to react in these appropriate ways perished and left no progeny. So there has been a long process of selection, in which only those individuals have survived...who displayed mechanical tendencies to react in the ways which (human evolutionary) history has proved most expedient.” The authors also indicated an awareness that human instincts might no longer serve their original purpose (p. 67): “Even if there is no longer any biological necessity for the activity of the instinct mechanism, the psychological need is still present, and this is a real factor in the life of the individual. In this way arise many specific modes of reaction to particular objects in the world.”

²⁸ Borzekowski and Poussaint (1998) report that in a survey of mothers of Latino preschoolers, 55% had been solicited (within the previous two weeks) by their children to buy advertised foods, and 67% had fielded requests to go to an advertised store or restaurant. Taras *et al* (1989) report similar results, and also that more than half of requested food items were subsequently purchased by the child's parents.

²⁹ Taras *et al* (1989) find a striking pattern in survey data on foods advertised on television,

preference for advertised products after viewing a video with embedded ads.³⁰

5.2.2 *Designer Foods: Sugar, Salt, and Caloric Density*

Similarly, a look at the nutritional content of popular foods suggests that food producers have learned to isolate the chemical signals and calorie density that once helped human foragers choose nutritionally valuable foods. The McDonald's menu, for example, features a variety of sweetened, salty, and calorie-dense foods: sandwiches have an average calorie density 37% greater than a game meat such as venison and 327% greater than a ripe apple, and a single sandwich provides 40% of USDA's maximum recommended daily intake of sodium; soft drinks and shakes (excluding diet drinks) average 9% and 18% sugar, respectively (Appendix III).³¹

5.3 *Misinformed Search*

Each of these aspects of the modern food industry—television advertising, addition of sugar/salt, and increased calorie density—can be viewed as instances in which technological advances have altered the probability distributions underlying the information states each once represented for pre-industrial humans. The information that children once gleaned from watching their peers fight over a prized fruit is today replaced by television images of cartoon

requested by children, and purchased for children (as result of requests): of requested/purchased/advertised food products, 66%/58%/68% are high-sugar, respectively; 36%/34%/35% are high-fat; 19%/22%/17% are high-salt, and only 7%/10%/11% are low in sugar, fat, and salt. More generally, the authors find a significant correlation between weekly viewing hours and both reported requests for and subsequent purchases of advertised food products. This is consistent, for example, with the findings of Ortega *et al* (1996) that among a sample of Spanish adolescents, those who watched television for two or more hours per day ate less fruit, legumes, fiber, and Vitamin C than those who watched less.

³⁰ Such an experiment is described by Borzekowski and Robinson (2001): Forty-six 2- to 6-year-olds were shown an animated video either with or without embedded advertisements, then asked to choose between two similar products. Compared to the choices of the control group, the likelihood of choosing the advertised product was greater for 7 of 8 food products, and in most cases dramatically so.

³¹ See Appendix III for data and sources. For a broader comparison of modern dietary habits

characters fighting over a brightly colored candy; the information once provided by the sweetness in ripe fruits is today replaced by sugar refining technology, which allows the sugar to be presented without the fiber, vitamins, and minerals that accompany it in nature; and caloric density, once a signal of the likely presence of essential fatty acids and other valuable nutrients, is today replaced by processed fats and refined flour. In the language of subjective decision theory, in the modern environment \succ (and hence \mathbf{p}) is conditioned on signals that no longer convey information. That is, we are no longer able to solve the diet problem in an optimal way.

6. Some Implications for Welfare Economics

Quite a lot of high-brow economics...accepts the appropriateness of the standard general equilibrium model, with everyone pursuing their self-interest, given tastes and technology... But the high ground is not secure at all. The most basic element of such modeling, namely the motivation of human beings, is not well addressed.

--Amartya Sen (quoted in Klamer, 1989, p. 147)

One way of approaching the consumer's dietary choice problem is to ignore the biology and to treat it as a conventional economic choice problem. The peculiarities of how people choose food (in particular, the sensitivity of choice behavior to television imagery and temporally related nausea) are hard to reconcile with a strict neoclassical interpretation, so the analysis would probably employ the descriptive emphasis of behavioral economics. But it would be tempting, even within a behavioral-economic framework, to model each of the three choice situations discussed herein (interpreted here as cases of social, chemical, and postingestive signals) separately; and to treat the problem as one of deterministic intertemporal choice rather than one of information and uncertainty. Imitation, for example, might inspire a theory of social preferences in which one's own consumption is complementary to the consumption of others (or the television image of others). Strong preferences for sugar or high-calorie foods might be modeled as simple ranking of product qualities (i.e., the sugar and calories themselves becoming the objects of desire) or, if consumers claim lack of self-control, are found to regret their actions and/or to seek means of restricting their own dietary choice, then a behavioral model of dynamically inconsistent preferences might be applied. Nausea aversion—with its strong influence on dietary behavior

with the pre-industrial diet, see Eaton and Konner (1985).

even when the consumer is aware of the irrationality of the response—poses a particularly difficult problem even for behavioral economics; it would be tempting to dismiss such behavior as “emotional” and perhaps outside the purview of a rational theory of behavior.

But this “top-down” approach to economic theory would ignore all the evidence from biology: the many strong similarities between human and animal food selection behavior, the demonstrably genetic basis for (and hence constraint on) the chemical senses, and the parsimonious evolutionary theory into which all these features fit so neatly. It would also fail to generate *ex ante* detailed predictions about how food is produced and marketed.

The “bottom-up” approach applied here, on the other hand, begins by placing the behavior in question in its proper biological context, and draws on a firm foundation of scientific knowledge in answering the question (of *how* consumers solve the dietary choice problem) posed at the beginning of this essay.

The conclusions reached here have profound implications for the theory and practice of welfare economics. To suggest that people choose foods on the basis of biased subjective probabilities is to call into question the doctrine of consumer sovereignty. Although popular opinion has long been sympathetic to the notions that children are subject to manipulation by television commercials and that people have a weakness for sweetened high-calorie foods, conventional economic theory has largely ruled these ideas out with first principles.

Weakening the equivalence between individual *choice* and individual *welfare* that serves as the foundation for welfare economics need not imply drastic changes in public policy. Indeed, many existing policies could find a sounder theoretical foundation on the basis of the findings presented here: advertising for products such as tobacco and alcohol (which, it could be argued, share many features with candy and soft drinks) is already severely limited by federal regulation; producers of (“enriched”) wheat flour are now required to add a long list of B-vitamins to their product after the milling process has removed them; many states levy product-specific taxes on soft drink and snack foods (Jacobsen and Brownell, 2000); and Coca-Cola recently withdrew from its nationwide network of exclusive school vending contracts under pressure from consumer advocacy groups concerned about the dramatic rise in childhood obesity (Coca-Cola Company, 2001). Such policies, though difficult to justify in a neoclassical framework, make sense in light of our growing knowledge of the biological underpinnings of human dietary choice.

But if *some* restrictions on advertising or on food product characteristics are justifiable, at

what point do such policies become *too* restrictive? There is no simple answer to this question. It is not clear, for example, that the world would necessarily be a better place in the absence of refined sugar. It may be true that the pleasure we get from the act of eating sweets is no longer proportional—as it once was, according to the evolutionary theoretic explanation—to the expected future health consequences of that act.³² But this doesn't necessarily mean that the very real pleasure of eating sweets should be ignored by the welfare economist interested in maximizing human well-being. The evolutionary view does, however, imply that people—left to their own devices, in a market environment of cheap sweets and lacking education in matters of human nutrition—will fail to solve the intertemporal pleasure/health tradeoff in an optimal manner.

Last but not least, there is the important question of equilibrium selection. In light of the overwhelming evidence that culture influences diet and diet influences health, it seems a reasonable exercise to consider the feasibility of various combinations of cultural practice and public health. Health and well-being are intimately linked, after all, and culture can be influenced by such things as education and the media. Might we all be better off, for example, if—given our unfortunate tendency to choose foods that make us sick—we were better schooled in matters of human nutrition? Might we all be better off if, as children, we had been exposed to television images of actors grappling over a ripe apple, or a green salad, in place of Big Macs and Cokes?

Food for thought.

7. Appendix I: Three Styles in the (Economic) Analysis of Human Behavior

It will be informative at this point to clarify how my approach to a behavioral theory of dietary choice is related to other evolutionary and economic theories of behavior. In his essay “Three Styles in the Evolutionary Analysis of Human Behavior,” Eric Alden Smith (2000)

³² More precisely, in evolutionary equilibrium we would expect such pleasure to be proportional to $\mathbf{p}(S) \cdot \mathbf{f}(Z)$, the expected future *Darwinian fitness* of the act of eating sweets. Here the prize space Z (i.e., the vector of inputs to the fitness function \mathbf{f}) would presumably be comprised of the health consequences of eating the food item in question; the states of nature S correspond to the possible nutritional qualities of the food.

describes the methodology and current practices of the fields known as *human behavioral ecology*, *dual inheritance theory*, and *evolutionary psychology*.³³ Though all three fields explicitly aim to study human behavior in light of the principles of evolutionary biology, they differ in several important aspects (see Table 2). For example:

- Human behavioral ecology (which remains agnostic on the subject of the inner workings of the mind, asking instead how behavioral strategies might solve specific classes of problems) views behavior as constrained mostly by the physical or social environment;
- Dual inheritance theory (which emphasizes the interaction of cultural evolution with biological evolution—hence the term *dual* inheritance—in solving specific classes of problems) views behavior as constrained by information, and therefore both reliant upon and subject to the momentum of cultural change; and
- Evolutionary psychology (which posits that much of human behavior is the manifestation of a modular cognitive architecture that evolved for the purpose of solving specific classes of problems) views behavior as subject to cognitive (and therefore genetic) constraints.

Table 2: Comparison of the Three Styles of Evolutionary Analysis

	Human Behavioral Ecology	Dual Inheritance Theory	Evolutionary Psychology
<i>Explanandum</i>	Behavioral Strategies	Cultural Evolution	Psychological Mechanisms
<i>Key Constraints</i>	Ecological, Material	Structural, Information	Cognitive, Genetic
<i>Temporal Scale of Adaptive Change</i>	Short-Term (phenotypic)	Medium-Term (cultural)	Long-Term (genetic)
<i>Expected Current Adaptiveness</i>	Highest	Intermediate	Lowest

³³ Exemplary works and literature reviews cited by Smith (2000) include Barkow *et al* (1992), Buss (1995), and Daly and Wilson (1997) in evolutionary psychology; Krebs and Davies (1997), Cronk (1991), Smith (1992), Smith and Winterhalder (1992), and Winterhalder and Smith (2000) in human behavioral ecology; and Boyd and Richerson (1985), Durham (1990, 1991, 1992), Pulliam and Dunford (1980), and Richerson and Boyd (1992) in dual inheritance theory.

<i>Hypothesis Generation</i>	Optimality and ESS Models	Population-Level Models	Informal Inference
<i>Hypothesis-Testing Methods</i>	Quantitative Ethnographic Observation	Mathematical Modeling & Simulation	Survey, Laboratory Experiment
<i>Favored Topics</i>	Subsistence, Reproductive Strategies	Large-Scale Cooperation, Maladaptation	Mating, Parenting, Sex Differences

Adapted from E.A. Smith (2000, p. 34)

As Smith emphasizes in his essay, there is much more common ground in these approaches than a cursory reading of the literature would suggest, and indeed the importance of each is emphasized by the analysis of the diet problem offered herein:

- The evolutionary equilibrium described in Section 4.3 is very much in the style of behavioral ecology, with its specification of optimal food selection strategies, given available information;
- The importance of culture in conveying information about food fits well with the approach of dual inheritance theory; and
- The emphasis on informational cues as behavioral triggers (akin, perhaps to the triggering of “mental modules”) that persist in modern environments—in spite of the obsolescence of the underlying Darwinian logic—is consistent with the approach of evolutionary psychology.

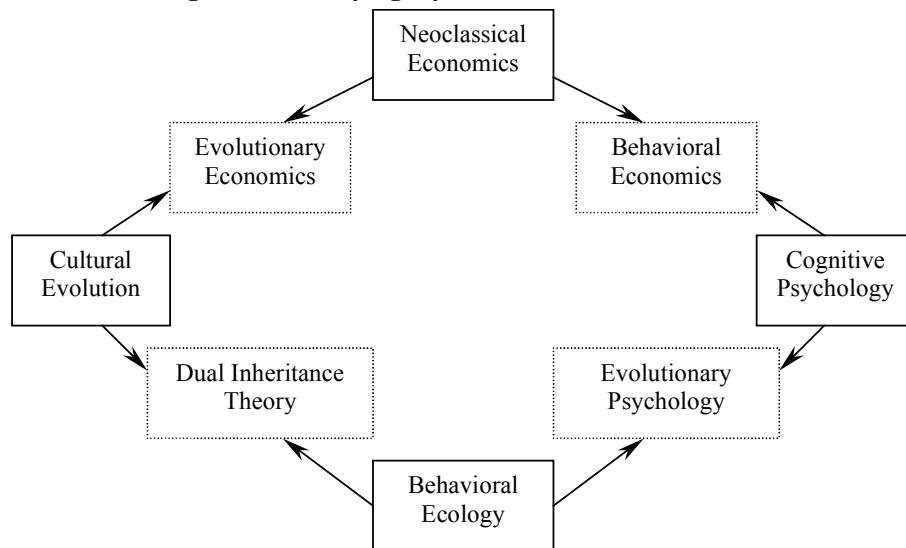
As the title of this subsection suggests, there are also three approaches to *economic* analysis that parallel E. A. Smith’s three styles of evolutionary analysis:

- Neoclassical economics generally assumes behavior is the manifestation of optimal strategies, given the material constraints of price and income, and the favored hypothesis-testing method is via empirical observation of individuals in real-world situations. This is also an apt description of behavioral ecology; indeed, the mathematical models employed in the two fields are often indistinguishable. The primary epistemological difference between neoclassical economics and human behavioral ecology is that neoclassical economics, at the most fundamental level, makes no presuppositions as to the nature of the object(s) of human desire, preferring instead to infer them from behavior (and perhaps, in practice, from introspection); human behavioral ecology, on the other hand, holds that all behaviors can be related back to the ultimate metric of Darwinian fitness.

- The field of study known as evolutionary economics³⁴ studies group-level phenomena (usually at the level of the firm or other organization), explicitly considers the dynamics of economic change, and takes seriously the potential that the oddities of human behavior or other structure or informational barriers might get in the way of achieving neoclassical equilibria. These aspects of evolutionary economics all describe dual inheritance theory as well.
- Behavioral economics departs from the presumption that behavior is (only) the manifestation of optimal strategies, explicitly acknowledging instead that the peculiarities of human psychology sometimes get in the way. The favored hypothesis-testing method is via empirical observation of individuals in controlled laboratory settings. This description also applies to evolutionary psychology.

These parallels are not accidental, but rather the result of parallel relationships among these behavioral sciences. Both evolutionary psychology and behavioral economics, for example, are based upon the precepts of cognitive psychology; both behavioral economics and evolutionary economics are built on the ultimate foundation of neoclassical economics; and so on, as shown in Figure 1.

Figure 1: A Phylogeny of Behavioral Science



The next section will conclude with a comparison and consideration of the implications of

³⁴ See, for example, the recent survey of Nelson and Winter (2002).

analyzing the consumer's diet problem from the top down (i.e., building a theory on the basis of neoclassical principles) and from the bottom up (i.e., relying instead on the precepts of behavioral ecology).

8. Appendix II: Content of Food Ads on Television

8.1 Ad Descriptions

The following are narrative descriptions of television advertisements aired during children's programming (Saturday morning animated features) in June 2002. The sample consists of 7.5 hours of programming on ABC, CBS, and Disney Channel. During this time, 31 food ads were aired, 19 of which were unique. Unique ads are listed by product in alphabetical order. A tabular summary of ad content is presented in Section 8.2, below.

1. **Air Heads** (fruit-flavored taffy candy)

Announcer: "Air Heads celebrates Disney's Lilo & Stitch. With an out-of-control sweepstakes that could send you and your family on a trip to Hawaii."

[Air Heads logo stretches onto screen like a rubber band, with "out of control" below and Disney/Lilo & Stitch logos above. Stitch (a small blue bipedal cartoon creature with big ears, big eyes, koala-like nose, and sharp white teeth) peeks out from behind a bamboo screen.]

[New scene (cartoon): Lilo (a small, brown-skinned girl) and Stitch surf an enormous wave.]

[static]

[A group of spaceships fly across screen on black background. The words 'Stitch has escaped and we need your help!' flash across screen.]

Announcer: "Stitch has escaped, and we need your help! For your chance to win, head to your local participating Air Heads retailer.

[New scene: A realistic image of planet Earth is obscured by a close-up of a colorful 6-pack of Air Heads, featuring picture of Lilo & Stitch.]

[New scene: A store display of Air Heads/Sweepstakes.]

Announcer: And pick up a 'Search for Stitch Sweepstakes' entry form. One lucky family could be on their way to Hawaii to search for Stitch!

[New scene: A real airplane flying to Hawaii.]

[New scene: Lilo and Stitch dancing the hula in the fruit section of a market.]

[New scene: Two Air Heads packages (one blue, one orange) superimposed over palm trees, sunny ocean beach.]

[New scene: Another beach scene, over which is superimposed the Air Heads logo, and the words 'Out of control' and 'Search for Stitch Sweepstakes'. Lilo & Stitch logo appears and Stitch pops onto screen.]

2. **Chips Ahoy Cremewiches** (chocolate chip cookie sandwiches filled with white icing)

[Animated clay Cremewich cookie rides a bus next to mother and baby, other passengers. Baby reaches eagerly for the cookie, is restrained by his mother. The

cookie parts begin to sing:]

Creme: “I’m squee—eezed. In the middle.”

Cookie: “Snack time. In the middle.”

All (passengers and cookie parts, singing enthusiastically): “Squee—eezed. In the middle. Snack time. In the middle. Squee—eezed...”

Announcer: “Two Chips Ahoy Cookies. Tasty Creme in between.”

[Bus driver puts a cookie in his mouth, chews contentedly.]

Announcer: “Mmmmm. Amazing.”

[The bus drives away. A large ad for the product is displayed on the rear.]

Announcer: “New Chips Ahoy Cremewiches.”

3. **Chocolate Creme Oreo Cookies** (chocolate-flavored cookies)

[(piano music plays) A small child sits at a table in an old-fashioned kitchen, balancing a stack of Oreo Cookies (each comprised of white icing sandwiched between chocolate-flavored cookies) in the middle of a plate. A woman’s hand places a glass of milk next to the plate. He picks one up, opens it, licks the icing and takes a bite.]

[(fade to new scene) In the same kitchen, a teenager now sits at the table with a plateful of Oreos. He picks one up, opens it, licks the icing and takes a bite.]

[(fade to new scene) In the same kitchen (now somewhat modernized), a middle-aged man now sits at table with plateful of Oreos. He picks one up, opens it, licks the icing and takes a bite.]

[(fade to new scene) In the same kitchen, a very old man now sits at table with plateful of Oreos. He picks one up, opens it, pauses, looks at it with disdain.]

[Close-up of cookie shows icing is brown instead of white.]

Old Man (shouting): “Ma!”

[New scene: Package of Chocolate Creme Oreos.]

Announcer: “Chocolate Creme Oreo.”

[Old man takes a bite, smiles.]

Old Man: “Never mind!”

4. **Chuck E. Cheese’s 1** (arcade and pizzeria)

[A song plays while images of pre-adolescent children playing arcade games flash across the screen:]

Singers: “Got it playin’ in my neighborhood—cool stuff! Trustin’ kids just to make ‘em feel good—cool stuff! So exciting, keeps you on the run. Chuck E. Cheese’s, yeah, he’s the one for fun.”

[During song, Chuck E. Cheese (a cartoon mouse in a purple, yellow, and green suit) appears holding a pepperoni pizza. Two kids standing nearby snatch the pizza from the mouse and wolf it down; the mouse expresses surprise and dismay.]

5. **Chuck E. Cheese’s 2**

[Chuck E. Cheese sits on grass in the rain with three children. The mouse raises a hand and the rain stops; the children react with joy and excitement. A song accompanies images flashing across the screen:]

Singers: “Rain, rain, go away, Cool Shops fun is here to stay. Can’t you see that it’s a blast, pourin’ good times, pourin’ laughs. If you come in, there’s one rule: Just have fun and be cool. Chuck E. Cheese’s!”

[During song, kids are shown playing arcade games and eating pizza inside Chuck E. Cheese’s. In the final scene, the mouse and three kids stand inside the arcade; a small cloud blows in, and the mouse reaches up and pushes it away.]

6. **Chuck E. Cheese’s 3**

[In a gymnasium, Chuck E. Cheese challenges a group of pre-adolescent children to kick soccer balls past him into a net:]

Chuck E. Cheese: “Get it past me...and you can go to my place!”

[Mouse then makes half-hearted effort to stop balls flying at him; he does not block a single one.]

[New scene: Chuck E. Cheese playing arcade games with kids, and posing for a group picture around a large pepperoni pizza.]

Chuck E. Cheese: “Chuck E. Cheese’s. The real cool place to be a kid. So have a...”

[He gets hit in the head with a soccer ball.]

Chuck E. Cheese: “...ball!”

7. **Danimals** (sweetened yogurt drink packaged in animal-shaped bottles)

[(cartoon) In an amusement park, a red balloon rises across the screen. “Danimals” is written across the front in yellow script.]

Kids: “The Funhouse! It’d be more fun with Danimals!”

[Several animals ride by in Danimals containers traveling on the rails of a roller coaster.]

Animals: “Heads up!”

Announcer: “Danimals! Something yummy for everyone!”

[A monkey with a pink substance covering his face licks himself clean with one circular swipe of his tongue. Nearby, an alligator in sunglasses leans against two Danimals containers.]

Monkey: “Fruit-ee-licious!”

Alligator: “Cool times two!”

[As a girl looks on, boy hits a lever with a mallet, sending two Danimals containers flying, ringing a bell and causing clouds of red cherries and strawberries to appear.]

[Girl and boy shown drinking product.]

Girl: “Mmmmm! Dee-Lish!”

Alligator: “Got that right!”

Kids: In Danimals Kingdom, kids rule!

[A real roller coaster streaks across screen.]

Announcer: “You can look for specially marked packages of Danimals, or ask parents permission to call the number below. You can win a Six Flags family vacation. Many will enter. Six Flags and Danimals!”

8. **Kellogg’s Strawberry Pop Tarts** (processed pastry snack with sweetened red strawberry-flavored filling and white icing with red sprinkles)

[A hand manipulates a bright red record on a turntable (note: throughout ad, red colors are very bright; other colors are predominantly muted earth tones). A rap song begins over low beat of background music. While song plays, scenes flash from an outdoor multi-ethnic gathering of adolescents dressed in the casual clothing of inner-city youth. A clean-cut young man bites into a red Pop Tart while talking to two male friends, each of which has a red Pop Tart in his hand. They laugh together. In background, people dance, one wearing a red hat. Red light bulbs are strung on a wire overhead. A young lady with a red pin on her jacket dances, holding a Pop Tart high as a bright red piñata hangs in the background.]

Rap Song: “Yo, back up now and give a bruth-a room. The fuse is lit and I’m about to go boom!”

[(sound of needle scratching on turntable) Close-up of piñata as it is broken open with a stick, spilling a cascade of bright red contents toward the camera. Close-up of hand on turntable. Clean-cut boy cheers, his Pop Tart now half eaten. His friend cheers as well, jumping up and down. Two new partygoers arrive on shiny red beach cruisers. Close-up of clean-cut boy’s hands: one holds Pop Tart, other clasps hand of friend. Other friend holds his Pop Tart as he looks toward clean-cut boy.]

Rap Song: “Boom, shake, shake, shake the room. Come on. Boom, shake, shake, shake the room. Come on.”

[(sound of needle scratching on turntable) Close-up of hand on turntable. Wide-angle view of entire party as people dance, red lights turn on overhead.]

Rap Song: “Yeah. Yeah. Yeah. There’s only one reason why I came here. Ya really don’t want me—really don’t want me tell ya whas—up.”

[The three boys all turn to look at something off screen to the right. Close-up of innocent-looking young girl in a bright red dress, standing alone. She sees boys looking at her, looks down shyly. She smiles. Friend whispers to clean-cut boy, who looks tentatively at the girl, admiringly. Girl smiles brightly now toward clean-cut boy.]

Rap Song: “Go! Here I go. Here I go. Here I—here I go—go—go.”

[Clean-cut boy, in foreground, looks back at friends, who gesture encouragingly. He turns gaze back to girl. Close-up of hand on turntable. Clean-cut boy walks slowly toward girl, broken piñata dangling in background.]

Rap Song: “Boom, shake, shake, shake the room. Come on.”

[Clean-cut boy and girl in red dress stand facing each other as screen narrows to form bright red borders on the right and left. The couple is then enclosed in a box of Strawberry Pop Tarts. The words “All that’s good out there, in here” appear

below the box in red graffiti-script.]

Announcer: “All that’s good out there, in here.”

9. **Kool-Aid** (sweetened, fruit-flavored drink mix)

[In a large children’s game room, three pre-adolescent children holding glasses of Kool-Aid approach a wall of bookshelves with looks of eager anticipation.]

Announcer: “Lookin’ for the latest twist?”

[A boy reaches up and pulls out a book in the shape of the product logo.]

Announcer: “The new color-changin’, flavor-surprisin’...”

[Wall of books rotates to expose giant red animated pitcher concealed in secret compartment.]

Pitcher: “...Magic Twist!”

[Pitcher waves a magic wand, which generates a shower of sparks and causes product (a paper packet of drink mix) to appear in his other hand.]

[Close-up of orange powder being poured from packet.]

Kids: “Cool colors!”

Girl: “The orange powder turns...”

Pitcher (interrupting): “...It’s a secret!”

[Pitcher covers glass pitcher with a cloak to conceal contents.]

Boy (with expression of surprise, pleasure): “But it tastes like...”

Pitcher (holding up hands): “...Don’t tell ‘em!”

Announcer: “New Kool-Aid Magic Twist, what’s your secret?”

[Pitcher holds up package again and winks.]

[New scene: A boy approaches grocery store display of Kool-Aid Bursts six-packs.]

Announcer: “There’s something great behind every specially marked six-pack of Kool-Aid Bursts!”

[Boy pulls a six-pack off shelf, revealing a bright golden light and releasing a cascade of golden coins. A siren blares, as if a jackpot has been won. Boy smiles with glee as he holds red six-pack and coins spill to the floor.]

Announcer: “You can get ten free tokens for games at Chuck E. Cheese’s with this valuable coupon on the back.”

[Close-up of coupon next to six-pack, which features Chuck E. Cheese’s and Kool-Aid logos.]

Announcer: “Kool-Aid Bursts and Chuck E. Cheese’s. Cool.”

[New scene: Children playing games in Chuck E. Cheese’s arcade.]

10. **Kraft Singles** (processed cheese product)

[Two simply drawn cartoon characters (without mouths) stand next to Kraft Singles package. Words above them say “Red and Ned in ‘Cheese Trapeze’”. A deep-voiced announcer speaks off-screen.]

Announcer: “Red and Ned in ‘Cheese Trapeze’.”

[Red (the character wearing a red shirt) pulls cheese slightly toward himself. Ned (in blue) glares, then pulls it back. The both put hands on hips and glare at each other.]

[New scene: At home, Red carries plate of toast spread with steaming cheese across room, sets it on table next to Kraft Singles package. He bends over as if to smell it. He blinks. In a close-up of Red's black circular eyes, blue Kraft Singles packages appear, one in each eye. Red hearts emanate from Red's eyes.]

Red (while making sniffing sound): "Mmmmm!"

[Steam from the cheese drifts into the next room, where it forms the shape of a hand and taps Ned on the back.]

Ned: "Mmmmm!"

[Ned's eyes turn from black circles into red hearts, and with a thump a package of Kraft Singles protrudes from his chest like a beating heart. Following trail of steam, he flies into the first room (in the style of a low-budget cartoon superhero) and snatches plate from the table. Red grabs it back, they struggle, and toast goes flying, sticking to ceiling. Red looks up, his face turns red, his eyes turn into spinning red spirals, and steam comes out of his ears. Meanwhile Ned constructs a catapult with a board and a block of wood. Ned drops an anvil on opposite end of board, sending himself soaring the ceiling. He grabs toast and hangs from it as red hearts appear around his head.]

Ned: "Mmmmm!"

[Ned looks pleased, until cheese begins to stretch, and he is about to fall. A bead of sweat rolls down his face. Red kicks trash can under Ned; Ned falls in and Red catches toast. Red takes a bite, chews and smiles. Ned peers angrily from can.]

[New scene: Red stands next to package of Kraft Singles, holding cheese toast. A red heart appears on his face. Words appear above saying "It's My Cheese."]

Announcer: "Mouth-watering Kraft Singles."

Obnoxious Voice: "It's my cheese!"

11. **McDonald's 1** (fast food restaurant)

[Ronald McDonald comes running into the foyer of a natural history museum with a group of small children. Children's voices (offscreen) sing an upbeat song:]

Singers: "Makin' the world a better place. Sparking one more smiling face. Put a smile on. Put a smile on. Put a smile on. Put a smile on."

[Meanwhile, kids dance and skip from exhibit to exhibit, where the fossil skeleton of a dinosaur, a mummy, and a collection of ceremonial masks all sing along. During the last refrain, a young woman's voice makes an announcement.]

Announcer: "McDonald's is proud to be a part of Playhouse Disney. Where learning is powered by imagination."

[Final scene: Ronald McDonald, kids, and the mummy pose stiffly behind ropes as if they were an exhibit. They break out into exuberant dance when a stuffy old museum patron walks by, causing him to break out in dance as well.]

12. **McDonald's 2**

[A boy and a girl stare glumly into an empty fishbowl as the blues play in the

background. Ronald McDonald pops up on the other side, notices empty bowl with a frown, and says:]

Ronald McDonald: “You need a pet!”

[Boy and girl smile brightly.]

[At pet store entrance, the three of them skip in the front door. Children’s voices sing in the background:]

Singers: “Making the world a better place. Starts with one more smiling face.”

[Ronald McDonald skips through store holding girl’s hand; he points at something.]

[Ronald McDonald kneels over a warthog.]

[Ronald McDonald watches a cockatoo arch its head plumes, then imitates the action with his bright red hair.]

[A green chameleon sits on Ronald McDonald’s red and white striped sleeve. Slowly it changes color to match the stripes as boy and girl look on in amazement.]

Child’s Voice (singing): “When you and your friends are just hangin’ around. You can turn your world upside down.”

[A baby chimp’s face appears upside down from the top of the screen. Ronald McDonald and girl (both singing) also appear hanging upside down, their hair standing on end.]

Singers: “Put a smile on. Put a smile on.”

[Ronald McDonald and boy, singing and smiling, hold rabbits.]

[The three sit, each with a small dog on his/her lap.]

Singers: “Everybody come on. Put a smile on.”

[The boy sings as he holds up a goldfish swimming in plastic bag. Ronald McDonald smiles broadly. Outside the store, Ronald McDonald leads a conga line, followed by girl, then boy, then a small dog walking on hind legs, then baby chimp, then cockatoo, then another dog on hind legs. Logo appears at lower left.]

13. **McDonald’s Happy Meal** (fast food meal comprised of cheeseburger, french fries, soft drink, and plastic toy)

[Kids are lined up at a table in a summer camp cafeteria, looking glum and bored as oppressive piano music plays. Suddenly, Ronald McDonald (a clown dressed in a yellow jumpsuit, with white face and red nose, lips, hair, sleeves, stockings, and oversized shoes) appears, and singers (offscreen) begin an upbeat song:]

Singers: “Put a smile on, put a smile on, everybody come on, put a smile on, everybody come on...”

[During song, Ronald McDonald works cafeteria line, handing out Happy Meals on trays, smiling and laughing with (now overjoyed) children. During the last refrain, Ronald McDonald nudges a frumpy, overweight woman wearing a hair net and apron. She initially resists, then breaks out in contagious laughter.]

Singers: “...put a smile on!”

[New scene: A boy and a girl dancing with Lilo & Stitch (humanoid cartoon characters starring in a forthcoming movie) action figures.]

Children: “Hey Lilo! Hey Stitch! How long can we ri—ide this monster wave?”

[Cartoon image of Lilo & Stitch surfing an enormous wave.]

Stitch: “Cowabunga!”

[Back to boy and girl, who—it is now apparent—were sitting on a bouncing washing machine.]

Children: “At least until the towels are done!”

Announcer: “Where can you get one of these Lilo & Stitch Bobbleheads? In every McDonald’s Happy Meal!”

[New scene: A bright red and yellow Happy Meal box rapidly self-assembles and lands next to Stitch. The word “Smile” appears at bottom of screen.]

14. **McDonald’s Mighty Kids Meal** (fast food meal comprised of double cheeseburger, french fries, soft drink, and plastic toy)

[A coed, multi-ethnic group of pre-adolescent children play basketball in a driveway. One boy (Fred) catches the ball, then freezes in a state of suspended animation, mouth and eyes still wide open.]

Boy Announcer: “We were playing ball when it happened.”

Kids: “Fred! Fred?”

[Kids wave their hands in front of Fred’s face. He doesn’t move.]

Boy Announcer: “Fred just froze.”

[A boy pounds on Fred’s forehead. He doesn’t move.]

Boy: “Anybody home?”

Boy Announcer: “So we took him to the feeding station. We tried to be cool.”

[A boy and a girl lift Fred and carry him, prostrate, into the house as an old lady looks on from nearby.]

Boy Announcer: “And smooth.”

[They bump Fred’s head on the door jamb as they enter the house. Old woman looks appalled. They drag him by his feet down carpeted stairs, his head bumping on each one. Fred remains stiff, though now looking a bit scared.]

Boy Announcer: “But we know only one thing would satisfy Fred’s need to feed. McDonald’s Mighty Kids Meals. Which everyone knows is Fred’s favorite food.”

[Close-up of double cheeseburger, soft drink, and french fries. They place Fred on sofa in sitting position. Three Mighty Kid’s Meals sit on the coffee table in front of him. Fred begins to eat.]

Boy Announcer: “Suddenly, Fred was fine!”

[Fred smiles gratefully at his friends, who sit sipping their own soft drinks. A paper bag with product logo drops to cover screen.]

Boy Announcer: “Mighty Hungry? Mighty Kid’s Meals.”

Boy’s Voice: “Got another one!”

[Another catatonic child is dragged down the stairs, head bumping on every step.]

Adult Announcer: “Now you can get a Lilo & Stitch Bobblehead toy. Only at McDonald’s.”

[Close-up of Lilo and Stitch toys sitting on surfboard between Lilo & Stitch, product logos. Their heads bobble.]

15. **Post Cocoa Pebbles** (sweetened chocolate breakfast cereal)

[(cartoon) A judge and jury preside over a courtroom while Barney Rubble and Fred Flintstone (well-known cartoon characters) stand before judge. The words “Cocoa Court” are emblazoned on the wall.]

Judge (pounding gavel): “Mr. Rubble, how do you plead?”

[Barney shrugs, then bolts for the evidence table, which holds box of Post Cocoa Pebbles, bowlful of cereal, buttered toast, orange slices, and “postopia.com” banner. Fred steps forward and restrains him.]

Barney: “Hungry! I can’t stop swipin’ Fred’s Post Cocoa Pebbles cereal! Part of this good breakfast!”

[Close-up of evidence table, with jury in background looking eagerly at cereal. Several conspicuously lick their lips, then all scribble notes on their notepads.]

Judge: “The evidence?”

[Fred holds up bowl of cereal covered with fingerprints.]

Fred: “...with Barney’s fingerprints!”

Judge (accusingly): “Mr. Rubble?”

[Close-up of judge’s gavel smashing chunk of solid chocolate sitting on chocolate pedestal amid pool of melted chocolate.]

Barney: “I love all those chocolatey pieces—almost as much as I love Fred!”

[While Barney speaks, his image is shown eating a spoonful of the product with a pool of melted chocolate in the background. In the courtroom, tears run down his face.]

Fred: “Barney!”

[Fred and Barney embrace, Fred still holding bowl of product. The judge vaults over the podium, snatches the bowl and runs off.]

Judge: “Case dismissed!”

Fred and Barney: “Huh?”

[They embrace again, this time with tears of despair spewing to the floor.]

16. **Ring Pop** (fruit-flavored hard candy attached to a finger-sized plastic ring)

[Three young children sit in a movie theater munching snacks as they watch a movie. A very fat man holding buckets of popcorn and soda appears at the end of the aisle.]

Fat Man: “Excuse me. Pardon me.”

[Man squeezes past kids. As he does, first boy spills box of colored candies.]

Boy #1: “Ahhh!”

[Girl, when bumped, fumbles and then drops her lollipop.]

Girl: “Oh...oh no!”

Fat Man: “Comin’ through.”

[Second boy, when bumped, takes Ring Pop from his mouth and wildly flails his arms about as man passes.]

Boy #2: “Unngh! Unngh!”

[After fat man passes, second boy grins, proudly displays the candy still attached to his finger, and resumes eating.]

Announcer: “Ring Pop stays on your finger. So you’ll never lose the flavor. Great tasting, long lasting Ring Pop. The flavor’s always on hand.”

[Closing scene: Product logo is shown with two small hands, each of which is wearing three Ring Pops.]

17. **Tang** (sweetened, fruit-flavored drink mix)

[A bright orange vortex swirls toward viewer, opening on a scene in which an orangutan wearing a yellow tank top and orange flowery boxer shorts pushes a shopping cart (equipped with steering wheel, headlights, “Tang” logo and oversized rubber wheels) over the crest of a hill. Cart then careens downhill on a gray road among a bright orange landscape as the pusher (now hanging on for dear life) and three other orangutans hoot, holler, and gesticulate wildly.]

Announcer: “Your day need a serious kick? Send it flying, five times faster! Five frantic flavors with slash of vitamin C!”

[One rider reaches out a long arm and touches landscape, which turns out to be covered with bright orange liquid. A splash of the liquid is generated, covering screen, along with the words “100% Vitamin C”.]

Announcer: “One hundred percent pure mayhem.”

[Cart approaches a fruit stand at a fork in the road. The proprietor (an orangutan wearing a blue checkered apron, bifocals, and a Panama hat) screams as the cart hits the stand at full speed and a cascade of cartoon fruit and Tang packages are launched into orange vortex. The vortex opens on a wide-eyed teenage boy holding a Tang drink.]

Boy (shouting excitedly): “Whoa!”

Announcer: “Tang. It’s a kick in a glass!”

[Announcer’s words also appear onscreen, on two kitchen cupboard doors. The doors burst open, revealing five orangutans holding Tang drinks and smiling. The big one holds up his drink with a toothy grin.]

Orangutan: “Tang, baby!”

18. **Wendy’s Kids Meal** (fast food meal comprised of cheeseburger, french fries, Frosty [chocolate ice cream drink], and plastic toy)

[Zoom in on farmyard with large sign saying “Camp Runamuck” over entry gate. Fade to camp cafeteria, where an old man in a hair net ladles a nondescript green chowder into bowls under a sign saying “Today’s Special~Tuesday Surprise!” A young girl approaches.]

Man: “Here’s your Tuesday Surpri—ise!”

Girl (grimacing): “What is it?”

[Man shrugs.]

[New scene: In a futuristic control room in which cafeteria scene is shown on a large video screen, two children are dressed in futuristic uniforms.]

Boy's Voice: "Dispatch Wendy's Kid's Meal agent!"

[A uniformed boy on flying personal hovercraft swoops into camp, blowing off man's hair net with a cloud of luminous gas, freezing him in a state of suspended animation and leaving his hairpiece askew. Hovercraft circles above tables where children are eating, delivering a Wendy's Kid's Meal to each child.]

Boy (excitedly): "A cheesburger!"

Another Boy: "And Frosties!"

[Hovercraft leaves as operator nods to girl. Man is unfrozen, hair still askew.]

Girl (to man, smugly): "Nice hair."

[New scene: In futuristic control room, screen flashes "Wendy's Kid's Meals. Great Food. Cool Toy." Two uniformed boys exchange high fives.]

Announcer: "Wendy's Kid's Meals. Great food. Cool toy. Like this:"

[New scene: Three children in a blue room.]

Boy: "Look!"

Girl (pointing excitedly): "Over there!"

[Close-up of wind-up robot toy bobbling along.]

Announcer: "Now, Bots are invading Wendy's Kid's Meals."

Metallic Voice: "Start launch sequence."

[A toy robot top is set spinning.]

Announcer: "You can send this helicopter into orbit."

[A child's hand pulls a string on helicopter toy, sending circular rotor flying.]

Announcer: "This Bot will self-destruct upon impact."

[A robot toy slams into wall, breaks apart.]

Announcer: "And if you collect all five, you can build one Mega-Bot."

[Five toys are snapped together.]

Announcer: "There's one Bots toy in every Wendy's Kid's Meal."

[All five Bots shown in blue room with Wendy's logo.]

19. **X-treme JELL-O Gel Stick** (clear plastic tube containing blue-green sweetened gelatin)

[Product sits on white surface with hand-drawn clouds in a white sky overhead. A white stick figure appears, looks at product, and scratches his head in puzzlement. He then runs over to it, pokes it with one finger (it jiggles) then whistles for his stick figure friends, who run over and begin bouncing on product like a trampoline. One bounces off the right end, landing on the shoulders of a stick figure who is standing on the shoulders of another. The three stagger back and forth, nearly falling over.]

Announcer (matter-of-factly): "Introducing X-treme JELL-O gel sticks. It's jiggley JELL-O fun in a tube."

[Three other stick figures at left end of product struggle to tear off the end of the

plastic tube. They succeed, at which point the figure at the top of the threesome at the far end dives gracefully through the air and (in slow motion) lands sprawling on the logo at the center of the product. JELL-O squirts out the open end into the waiting mouths of four stick figures. Their round heads turn the color of the JELL-O as they break out in smiles.]

Announcer: “But be warned. The X-treme flavor just might make your head spin.”

[The four smiling blue-green heads spin wildly and bump into one another. The head on the end gets bumped off its body and crashes into the head of an approaching stick figure. The newcomer (who hasn’t eaten product, as indicated by his still-white head) is briefly knocked unconscious (as reconstituted blue-green figures look on, laughing) and blue-green stars circle his head. He then sits up and grins sheepishly.]

Announcer: “How cool is that?”

[New scene: Multi-pack of product containing green apple and watermelon flavors and decorations. A stick figure bounces on it and it changes to cherry and green apple. Another bounce makes it blue raspberry and strawberry.]

Announcer: “New X-treme JELL-O Gel Sticks. They’re extreme. Yeah.”

8.2 Summary of Ad Content

A few key themes present themselves repeatedly in the ads described in Section 8.1. Six of these—denoted “medical miracle,” “social success,” “adjunct prize,” “exhilaration,” “squabble,” and “reward”—are tallied and described in Table 3. There is also something of a pattern to the colors used in product logos; these are also tabulated below.

Table 3: Summary of Television Advertisements

Selected Story Themes

Situation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
<i>medical miracle</i>		•	•		•		•		•	•	•	•	•	•	•		•	•	•	
<i>social success</i>		•		•	•	•		•							•	•			•	•
<i>adjunct prize</i>		•			•	•	•	•	•				•	•						•
<i>exhilaration</i>		•			•	•		•	•		•								•	
<i>squabble</i>			•	•						•						•				
<i>reward</i>							•	•												•

Situations are defined as follows: “medical miracle” is indicated where consumption of the product and/or the appearance of the product or product mascot eliminates physical illness or brings about a positive emotional change; “social success” is indicated where the product is associated with peer approval; “adjunct prize” is indicated where an unrelated product (usually a toy or sweepstakes entry) is explicitly mentioned and bundled with the product; “exhilaration” is indicated where music or action induce a feeling of exhilaration in viewer; “squabble” is indicated where two or more individuals are involved in a physical struggle over the product being advertised; “reward” is indicated where the product is held up as a reward for athletic merit.

Table 4: Colors Featured in Logos and Packaging of Advertised Food Products

Logo Colors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
<i>red</i>		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•	
<i>yellow</i>			•		•	•	•	•			•	•	•	•	•					•	•
<i>white</i>		•	•	•				•	•	•					•	•	•	•	•	•	
<i>blue</i>		•	•	•			•	•	•											•	
<i>orange</i>										•										•	
<i>brown</i>				•												•					

9. Appendix III: Nutritional Content of Fast Food

Table 5: Calorie Density and Sodium Content of McDonald's Sandwiches and Other Foods

Product	Serving Size (g)	Calories	Calorie Density (cal/g)	Sodium (mg)
<i>Hamburger</i>	107	280	2.62	590
<i>Cheeseburger</i>	121	330	2.73	830
<i>Quarter Pounder</i>	172	430	2.50	840
<i>Quarter Pounder w/Cheese</i>	200	530	2.65	1310
<i>Big Mac</i>	216	590	2.73	1090
<i>Big N' Tasty</i>	251	540	2.15	970
<i>Big N' Tasty w/Cheese</i>	265	590	2.23	1210
<i>Crispy Chicken</i>	219	500	2.28	1100
<i>Filet-O-Fish</i>	156	470	3.01	890
<i>Chicken McGrill</i>	213	400	1.88	890
<i>Chicken McGrill (plain w/o mayo)</i>	199	300	1.51	810
<i>Apple</i>	150	84	0.56	1.5
<i>Venison (cooked)</i>	28	48.7	1.74	NA

Sources: McDonald's Corporation (2002) and Ensminger *et al* (1983, pp. 884-936). NA=data not available.

Table 6: Sugar Content of Selected McDonald's Beverages

Product	Serving Size (ml)	Sugar (g)	% Sugar (g/100 ml)
<i>Coca-Cola Classic</i>	630	58	9.2
<i>Sprite</i>	630	56	8.9
<i>Hi-C Orange Drink</i>	630	64	10.2
<i>Vanilla Shake</i>	444	76	17.1
<i>Chocolate Shake</i>	444	82	18.5
<i>Strawberry Shake</i>	444	79	17.8

Source: McDonald's Corporation (2002).

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