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Food choice and intake: the human factor

David J. Mela

Consumer Science Unit, Unilever Research, 3130 AC Vlaardingen, The Netherlands

Human perceptions and selection of food are derived from the prevailing and momentary food, agro-economic and cultural environment, cognitive and biological characteristics of individuals, and the real and perceived intrinsic and extrinsic attributes of foods themselves. The range of items typically chosen and consumed within a given population is largely determined by interaction of the external environmental context with guiding sets of implicit and explicit social and psychobiological ‘rules’. Within the rather broad limits of biology, individual food choices and intake behaviours relate to and reflect aspects of food availability, existing habitual behaviours, learning mechanisms, and individual beliefs and expectations. Many of the relevant features of these variables are uniquely human, together determining what is ‘food’, when, how, by and with whom it is chosen and eaten, and in what quantities. They also provide the opportunities for individuals to establish and maintain a relatively stable set of culturally and biologically determined affective responses (‘likes’) and intake behaviours. Understanding of the potential contribution of these influences under different conditions can serve to explain many of the observed characteristics of human eating, and highlight potential avenues for intervention.

Food choice: Eating behaviour: Food preferences

Eating fulfills biological needs and provides sustenance to all animals, but for human subjects in particular, it is also a source of pleasure and comfort, and reflects and conveys information relating to personal and cultural characteristics, social status and relationships (Stein & Nemeroff, 1995). ‘Expert’ views of the major influences on human food choice and intake may be analogous to the tale of the elephant and the blind men, each of whom characterized the unknown creature (as a tree, snake, rope, etc.) based on their own limited point of contact and assumptions (Saxe, 1883). Thus, economists will tend to focus on market forces and interventions, food scientists on ‘quality’ and taste, social scientists on societal and cultural systems and values, physiologists on biological functions and requirements, and so on. Hence, any attempt to review this very broad topic in just a few pages must be approached with considerable trepidation, knowing that it is impossible meaningfully to address everything, and that one's personal limitations and biases will inevitably be apparent. In this case, it means focusing largely on psychobiological and perceptual aspects of food choice and intake, with acknowledgement but little consideration of economics, politics, and promotional or other business practices. Any of these aspects can, of course, be shown to exert significant marked effects or even dominate food choice and intake in a given context, but will exact their influences in different degrees and situations, over different time frames, and on different aspects of the liking, selection, and consumption of foods and food combinations (Furst *et al*. 1996). Thus, the emphasis here is placed on working from a few basic, global rules which operate on human food choice and intake, and which represent an interactive outcome of many possible combinations of sets of underlying forces (Table 1).

If it is not available, it will not be eaten

There is little argument that availability is very often the primary determinant of quality of food intake and, within limits, quantity as well. Yet this is commonly overlooked, partly because the term ‘availability’ is often rather

Corresponding author: Dr David Mela, fax +31 10 460 5876, email david.mela@unilever.com

Table 1. Examples of some basic global rules to consider in understanding human food choice and intake

If it is not available, it will not be eaten
If it is available, it is likely to be eaten
If there is no alternative, it will be eaten
Behaviour tends to be stable ('familiarity breeds content')
Past behaviour is a good predictor of future behaviour
If learning can take place, it probably will
If learning cannot take place, it won't
Context is as important as content
Perceived quality and intake reflect matching of expectations

narrowly interpreted. 'Availability' of course includes, but is not limited to, physical and economic access. In many parts of the world there are still tremendous fluctuations in the food supply, and seasonal effects are observed even in nations where few other physical or economic constraints exist. Furthermore, summaries about general food availability within a large geographical or population unit may fail to take account of internal variation, such as 'food deserts' in developed countries (residential areas lacking easy access to well-stocked food shops) and constraints attributable to particular work arrangements (e.g. Jack *et al*. 1998). For many individuals, in many situations, dietary intakes will reflect the composition of foods chosen by others (Shattuck *et al*. 1992). In these cases, the food chosen may not necessarily be that which would be preferred, or even liked. Although beyond the scope of the present review, it must also be acknowledged that food prices and promotions have a marked effect on consumer food-purchasing patterns (Ritson & Hutchins, 1995*a*). This is a major route through which commercial interests and national food policies may exert influence on consumer behaviour, and a tool with which governments can effect changes in agricultural production and perhaps also health-related changes in consumer food-buying patterns (Ritson & Hutchins, 1995*b*).

However, even when the actual choice of foods is both expansive and readily affordable, and availability in its strictest sense is therefore not an issue, cultural rules of cuisine and appropriateness exert tremendous influences on what may appear on the plate and when. Thus, different ethnic or cultural groups often manifest rather different food choice behaviours, only some of which are obviously due to external constraints on food availability, and which occur even where the present cultural and geographical variations are relatively small (e.g. within northern Europe). Culture is perhaps the most obvious influence on food preferences and choice, and has strong historical antecedents, rooted in unique combinations of environment (geography, climate, and range of native plant and animal species), ritual and belief systems (religious and secular), community and family structure, human endeavour (innovation, mechanization, experimentation), mobility (exploration, immigration), and economic and political systems, which are integrated into a range of particular 'traditional' and accepted rules of cuisine and appropriateness, and 'ideals' (Furst *et al*. 1996). Within larger cultural units there are also identifiable subgroups which manifest their own particular norms and behaviours (e.g. demographic groups such as teenagers). The family or household unit, and contact with peers, typically provide extensive opportunities for modelling, entrainment and reinforcement of common food choice and eating behaviours, sensory likes and dislikes (see later), and probably also methods of food intake control (Birch, 1990*a*, 1998; Ray & Klesges, 1993; Johnson & Birch, 1994).

Within this general food choice environment, individuals make decisions about what to eat. Although the sensory and immediate hedonic dimensions of food acceptance often dominate discussions of food choice, it is crucial to recognize that sensory-affective ('taste' or 'liking') responses may often be a secondary contributor to variance in expressed preferences for specific foods and food combinations (Rozin & Fallon, 1981; Rozin, 1990; Schutz, 1994; Shepherd & Sparks, 1994) or to the volume consumed (Mela & Rogers, 1998). Importantly, expressed sensory likes and dislikes, and relationships of sensory attributes with intake control, are often a result of experience, and the associations of sensory stimuli with other food properties or eating contexts (see later; Lappalainen & Sjödén, 1992; Mela & Rogers, 1998). Thus, sensory likes may be a proximate, rather than a true root cause of choice, and, as noted, foods are certainly very often rejected or accepted for reasons largely unrelated to their orosensory characteristics or actual nutritional value (Furst *et al*. 1996). The reasons why Western Europeans do not eat soy sauce on bread, fried clams for breakfast, or cats at any time have little to do with sensory affect or physiology. These items might all score highly (i.e. be 'liked') in a blind tasting, and are reasonable sources of nutriment, but the chances of anyone being served or choosing to eat them is extremely low.

The preceding discussion, it is hoped, also serves to point out that the study of human food choice is, in fact, often the study of lack of food choice, where many alternatives are not just physically unattainable, but also lie beyond self-imposed social and psychological barriers. Whereas nature has only a few basic rules about what is or is not food, and none about when and in what contexts it may be eaten, human subjects have created many more. Such implicit rules of behaviour dictate, for example, that coffee and tea in many Western nations will appear several times daily invariably accompanied by sweet energy-dense baked goods or confectionery, rather than by carrots, olives, or popcorn. Similarly, it would be unusual in these same countries to attend a banquet where the central feature of the meal did not include the flesh of an animal. These rules are automatic, prompting observation and comment only if they are not followed, yet can exert tremendous influence on dietary intakes (e.g. Barker *et al*. 1996). Learning of these rules relating to appropriateness and context takes place early in life (see Birch *et al*. 1984; Birch, 1990*b*), and can undoubtedly be a powerful and lasting force in subsequent food beliefs and acceptance. They may determine not only the frequency of consumption and context in which an item might be consumed within a particular society, but also whether an item is even considered to be 'food' at all.

The availability of foods in its widest sense therefore sets the stage for all other influences on food choice and intake to enter into play, and also has potentially broad implications for national diets and public health pro-

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grammes, as well as commercial food promotion. In order for such efforts to succeed, an appropriate range of products must of course be available for purchase at affordable prices. This ‘availability’ in part reflects economic and agricultural policies and circumstances, but may also reflect the individual attitudes and social context which makes particular food products appropriate and desirable (e.g. Forsyth *et al*. 1994). Hence, under many conditions, food choice and food availability are mutually reinforcing.

The prevailing food environment therefore provides multiple opportunities for the acquisition and reinforcement, from very early in life, of a relatively stable set of likes and dislikes and accepted habitual intake behaviours (Rozin, 1990).

Behaviour tends to be stable (‘familiarity breeds content’)

At an individual level (people and products), there is a range of personal and situational factors which prompt a degree of variety in food product choices, including intentional desires to reach particular goals (e.g. an ethical position or health outcome), but also more fundamental (‘variety-seeking’) behavioural processes (van Trijp, 1995). Fluctuations in the food product environment (individual items and styles) may also be apparent to consumers. However, these fluctuations tend to occur within an existing food product category, and typically affect only the fringes of long-established core dietary patterns. These patterns (‘habits’) hold considerable momentum, and it clearly takes a degree of force and time to effect a meaningful change in their course. The general stability of dietary intake behaviour therefore reflects the general stability of the core food environment and eating context, and the multifactorial determinants of food choice, whereby any one factor may have limited overall effect. This stability is further bolstered by the required level of motivation, the uncertainty, and perceived implications of change, in terms of food preparation, sensory affect, acceptability to other family members, etc. (for example, see Piacentini *et al*. 1995). These barriers are reflected in the expense of launching and promoting new products, as well as the limited uptake of national dietary recommendations.

This stability of behaviour has implications for understanding public health approaches to changing the dietary behaviours of populations and individuals. The sluggish response of populations to dietary guidance may perhaps be likened to altering the movements of a large ship, with course corrections usually occurring well downstream of a recommended change in heading (and with more immediate shifts resulting from obstructions and eddies in the form of food scares, agricultural disasters, promotional campaigns etc.). However, preparatory steps can be crucial even when they have no measurable impact on behaviour by themselves. For example, while knowledge (or familiarity) alone is recognized as insufficient to change behaviour, it is clearly a contributor to the formation of beliefs, and these beliefs are a precursor to voluntary action. Thus, while nutrition education and health promotion campaigns might seem to be failures as measured by behavioural outcomes alone, this criterion may mask important progression along critical intermediary steps (Patterson *et al*. 1996).

Dietary change may be effected by changing people (their habits, beliefs etc.) or by changing food (composition, price, marketing). The accumulated experience from nutrition education and health promotion research strongly suggests that it is faster and more feasible to change food (Keenen *et al*. 1996; Sigman-Grant, 1997). Thus, the stability of dietary behaviour also has implications for commercial interests and involvement in food choice and dietary change. It suggests that, at least in the short term, the introduction of changes in the macro- or micronutrient composition of existing foods should prompt a more immediate and direct change in dietary intake measures than approaches requiring substantive changes in eating behaviour or food selection and cuisine, even if the latter is the long-term goal. Furthermore, the stability of food patterns highlights the potential barriers to the introduction of novel food products or concepts which are too far outside or beyond existing behaviour.

This stability may also have important implications not only for food choice, but also for individual food intake behaviour. For example, Poppitt & Prentice (1996) reviewed studies in which human subjects were given *ad libitum* access to normal foods manipulated in energy density (high or low) for varying periods of time. In these trials, subjects had the opportunity to compensate for the altered energy density of the diets by altering the volume of food consumed. However, what is remarkable from the data (Figs. 3 and 6 of Poppitt & Prentice, 1996) is that most studies revealed a relatively constant level of food volume (weight) intake, rather than food energy intake, in the face of modest to quite substantial changes in composition. The general effect was seen to last through periods of up to several weeks of diet manipulation, leading to measurable changes in body weight. This response almost certainly reflects strong cognitively-based maintenance of a normal habitual and culturally appropriate quantity of food portion size and frequency intake, which overrides post-ingestive cues that should act to preserve a rather more stable energy intake (but see subsequent discussion, p. 517). This finding has important implications for short- and long-term energy balance, and supports the putative importance of energy density and food structure in appetite control (Mela & Rogers, 1998).

Although many of the features of food choice and intake are marked by stability, this position is reached and influenced over time by the effects of experience and learning.

If learning can take place, it probably will

Human subjects appear to have a relatively narrow range of unlearned sensory likes (e.g. those which are biologically predestined, and which would exist without any form of previous exposure or cognition; Beauchamp *et al*. 1991; Mela & Catt, 1996). Genetic factors are known to influence markedly the ability to sense certain specific taste and odour compounds, and arguably may therefore also influence the sensory acceptance of certain specific foods (Beauchamp & Wysocki, 1990; Drewnowski, 1990). Although some studies of twins point to significant genetic influences on intakes of nutrients and perhaps some specific foods (de Castro, 1993),

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the genetic influences are commonly seen to explain only a very small part in family resemblance in overall food preferences (Greene *et al*. 1975; Krondl *et al*. 1983; Rozin & Millman, 1987; Borah-Giddens & Falciglia, 1993). However, such research rarely isolates sensory-affective responses, and it would be difficult to do so. Furthermore, most studies have focused on relationships of preferences of parents with those of young children, and the latter may be susceptible to many age-related and cohort effects which overshadow the expression of 'true' likes. Nevertheless, overall there is not a consistent case for a strong role of genetics in explaining observed variability in adult sensory affective responses, and even less so for liking of actual foods.

This view of 'innate' responses implies a major role for learning in the adoption and maintenance of food likes and preferences. It is certainly apparent that even likes or dislikes which are present at birth may be readily modified by later experience and learning (obvious examples being the acceptance and liking of hot spices, or of bitter foods such as coffee or beer). Many other lines of evidence also support the position that human subjects tend to like what they eat, rather than the reverse. This situation begs the question of when and how such likes and preferences are acquired.

The observation that habitually consumed items come to be liked or preferred over initially equivalent (or even initially preferred) alternatives is widely recognized, and many consumers will be familiar with personal examples (e.g. lower-fat milk, tea without sugar, a specific brand of sauce or spread). This phenomenon is also known to commercial food producers; however, it still is not clear what fundamental mechanisms generate this outcome, or how important it is in food preference development. The effects of 'mere exposure' have been the subject of considerable research and debate (Zajonc, 1968; Bornstein, 1989; Ye & van Raaij, 1997), including demonstrations with foods and flavours in experimental studies (Birch & Marlin, 1982; Pliner, 1982; Birch *et al*. 1987, 1998). Thus, this exposure may under certain conditions be an important contributor to acceptance and liking of many new foods in particular. It is argued that aspects of recollection or familiarity may in themselves be rewarding, although they may subsequently be linked to lower acceptance, with over-exposure leading to 'boredom' (Ye & van Raaij, 1997). However, exposure to food items in normal eating is rarely 'mere', but instead is frequently associated with cognitive food-choice decisions, or linked in some way to social situations, post-ingestive physiological consequences, or other cues which may prompt the formation of likes or dislikes. These links can be shown to be extremely powerful under many circumstances, and may underlie or complement 'mere exposure' effects.

The capacity to acquire consistent, specific sensory and food preferences is apparent from very early in life. Newborn infants have been shown to recognize and respond preferentially to specific environmental and food-related odours within hours of birth, and animal research demonstrates potentially important learned responses following *in utero* exposure through maternal diets (Schaal & Orgeur, 1992; Mela, 1997). Flavours from human maternal diets are known to be present in amniotic fluid, where they are probably sensed by the human fetus (Menella *et al*. 1995; Mela, 1997). Several lines of evidence suggest that the apparent initial responsiveness of human infants toward stimuli such as amniotic fluid and other maternal odours is likely to be an expression of learning occurring during the prenatal period (Varendi *et al*. 1996; Marlier *et al*. 1998; Schaal & Marlier, 1998). The initial responses of newborns shift within days to a greater orientation toward more postnatally relevant stimuli such as breast-milk or (among bottle-fed infants) milk formula (Soussignan *et al*. 1997; Varendi *et al*. 1997; Marlier *et al*. 1998). At this time, infants are also able to acquire stable preferential responses to non-maternal environmental odours (Davis & Porter, 1991). Food-derived odours are readily transferred to human breast-milk, and have been shown to have significant behavioural effects on the sucking infant (Menella, 1995, 1997; Mela, 1997). In addition, Sullivan & Birch (1994) have reported differences between breast- and formula-fed infants in their acceptance of weaning foods, and suggest that this process may be facilitated by previous exposure to sensory cues in mother's milk. The potential long-term implications of these early sensory experiences for influencing later food likes, and therefore possibly also adult food choice and diet, are not known, and generally not even considered in most discussions of the role of the pre- and perinatal food environment on later health.

The biological advantage of a capacity to modify preferences based on the benefit derived from consuming a food is obvious, and it is likely that this plays an important role in determining sensory responsiveness, and guiding food choice and intake (Forbes & Rogers, 1994). In the previous examples, it is not clear whether the learning mechanisms require an explicit association between a sensory stimulus and the consequences of its consumption (as opposed to the context). In other cases, this link is critical. The most powerful example of such learning in adults is the development of prompt and persistent dislikes or aversions to specific sensory qualities or foods which occur when they are associated with negative outcomes, particularly nausea and gastrointestinal upset (Pelchat & Rozin, 1982). A large proportion of individuals report at least one strong food aversion, and these aversions may be directed at a wide variety of common foods (Garr & Stunkard, 1974; Mattes, 1991). When adults recall the origins of an aversion, it is often described as having a long history, perhaps several decades. Indeed, aversions are very often identified as having been acquired during childhood, a period when many foods are tried for the first time, and when the frequency of sickness with gastrointestinal symptoms may be particularly high. Such childhood aversions may last a lifetime, with dislike of the food usually remaining in the absence of any conscious recollection of any causal incident and despite recognition that the item is perfectly safe to eat. Of course, aversions can also form in adulthood, producing very intense and seemingly irrational negative reactions to the sensory characteristics of foods which were previously eaten and enjoyed (Stockhorst *et al*. 1998). Thus, food aversion learning is a potent phenomenon which may account for many apparently idiosyncratic and strong dislikes for the 'taste' of particular foods.

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In a similar manner, although perhaps less readily, human sensory preferences can be fostered by pairing specific qualities with positively ‘rewarding’ physiological or psychological outcomes. Although there are many clear demonstrations of nutrient-based preference conditioning in animals (Rozin & Shulkin, 1990; Sclafani, 1990, 1997), there are far fewer examples in human subjects. The best examples come from work showing that young children develop a relative preference for specific flavours which have been paired with foods higher in energy content, either as carbohydrate (Birch *et al.* 1990), or as fat (Johnson *et al.* 1991; Kern *et al.* 1993). The apparent human liking for the sensory attributes associated with fats in foods, for example, is probably secondary to their association with the metabolic or other after-effects of ingestion of fat-containing foods (Mela, 1995; Mela & Rogers, 1998). Acquisition of liking for fat-containing stimuli is not clearly independent of their role as an energy source (Pérez *et al.* 1995), although this is possible. Notably, although some individual very-high-fat foods are popular, food combinations (‘meals’) and self-selected diets comprising extremely high fat contents (e.g. >60–70 % energy) are not commonly consumed. Thus, casual observation suggests that there is perhaps a mechanism (responding to RQ, perhaps) which serves to promote a balance of dietary macronutrient intakes, although this is completely speculative at present. Influences of food composition on psychological (e.g. mood and performance) measures are a further current topic of study (Rogers, 1995), and the potential links of such effects to preference acquisition remain to be elucidated.

Likes and dislikes may also be acquired as a consequence of their association with other peri- or post-ingestive stimuli, not specifically linked to the composition of the food itself. For example, association of foods or flavours with other, previously (dis)liked sensory stimuli, may foster shifts in liking in the direction of the latter (Zellner *et al.* 1983; Baeyens *et al.* 1990). There are also many other experimental situations which have been shown to generate directional shifts in affect. For example, likes and dislikes can be acquired through observation of another individual expressing (dis)like for (what is ostensibly) the same stimulus (Baeyens *et al.* 1996), by temporal juxtaposition of an object with a different (dis)liked stimulus (Baeyens *et al.* 1992; Hammerl & Grabitz, 1996), or even by association with another stimulus for which liking subsequently (and independently) changes (Hammerl & Grabitz, 1996). These situations may all occur in the apparent absence of any explicit recognition of the associations between the test stimuli.

Short-term control of intake by human subjects and other animals has also been shown to be markedly affected by acquired associations between energy content of single foods and their specific sensory attributes (Booth, 1977; Booth *et al.* 1982; Birch & Deysher, 1985; Louis-Sylvestre *et al.* 1989; Shaffer & Tepper, 1994). That is, under many conditions the volume of food intake is adjusted using information conveyed by learned sensory cues to the composition of that item, rather than immediate physiological effects. Quantity of intake of such items is thus higher or lower, depending on whether these learned cues signal respectively lower or higher energy content (i.e. have previously been linked to lower or higher satiety-related after-effects). This possibility makes considerable intuitive sense, especially if many of the salient physiological signals reflecting energy intake would normally occur post-prandially (i.e. too late to appropriately adjust intake within a meal). The process also allows for inferences to be made about the likely energy content of items which are novel but share certain recognized sensory attributes.

An interesting phenomenon, which might be viewed as the reverse of learned satiety, is the phenomenon of learned specific appetites, which links acquired aspects of both intake and choice. In this case, feelings such as hunger in general or the desire for a specific food may be come to be strongly triggered by environmental stimuli acting as cues (Heather & Bradley, 1990; Jansen, 1994; Mela & Rogers, 1998). For example, specific places or smells may prompt hunger or desire for a particular food, where there was no desire previously.

Learned associations can, of course, only develop or be expressed if the sequence or characteristics of the relationships among stimuli are suitable. The literature on learned satiety might lead one to predict that human subjects under controlled blind conditions should (like other animals) rapidly respond to changes in dietary energy density by adjusting intakes to an appropriately higher or lower volume. Yet, as noted, while this situation is seen in short-term studies with specific foods, much poorer energy compensation is typically observed in many of the relevant longer-term feeding trials with mixed diets (Poppitt & Prentice, 1996; Mela & Rogers, 1998). One possibility is that the conditions of such studies make learning or its appropriate expression quite difficult. Evidence from animal work shows that appropriate adjustment of intake volume to variations in energy density occurs when there is a consistent pairing of energy density with specific sensory attributes (Warwick & Schiffman, 1991). This pairing becomes disrupted if sensory cues and energy density are independently varying. Thus, for human volunteers with established habitual meal patterns and intake volumes, and a pre-existing learning history, it may be extremely difficult to adjust correctly to the experimental combination of a novel energy density plus a variety of foods. This situation may, to some extent, also be relevant to the real world, where the combination of nutritionally modified (e.g. reduced-energy) versions of ‘traditional’ foods, along with a diversity of flavour combinations, could perhaps impede the natural acquisition or appropriate expression of learned controls of intake. Under such conditions, humans may find themselves increasingly reliant on cognitive rather than biological controls of intake.

Context is as important as content

For human subjects, unlike animals, perceptions and choices of what and how much to eat are rarely completely separable from cognitive influences and meaning, and a set of expectations based on previous experience or present information. In the real world, of course, implicit or explicit information about a food’s ‘quality’ or specific attributes is often highly valued and overtly manipulated by manufacturers (e.g.

brand name, package design and claims) and also by consumers themselves (e.g. presentation of foods to guests). However, even in 'blind' experimental conditions with adult human volunteers, subjects enter situations with some previous (and typically unmeasured) beliefs, ideas, and expectations of the test situation and stimuli. The relationship between what is actually desired or experienced, and what was implicitly or explicitly expected or promised sets up the possibility of judgements and behaviours being influenced by this discrepancy (Oude Ophuis & van Trijp, 1995; Roest & Pieters, 1997).

Expectations about the sensory attributes of foods or their likely acceptability can significantly influence subsequent judgements in actual tasting or eating. Cardello (1994) and Deliza & MacFie (1996) give excellent reviews of the research in this area in relation to sensory perception of foods, and describe the main predictive models of consumer response to 'disconfirmation' of hedonic expectations. Cardello (1994) also points out that while many studies do not set out to study expectation effects, 'expectations' are often applied as a *post hoc* explanation for the results. In many studies of food intake expectations might also offer a plausible alternative interpretation of observations, especially where the research has explored the effects of changing situational or contextual variables such as visual information or setting. Discrepancies between what is expected and what is experienced can potentially generate positive or negative shifts in hedonic judgements, and the cited models make predictions about these outcomes, based on the degree and direction of deviation (i.e. how much different at better or worse it is from what was expected). With some exceptions, most recent studies of sensory acceptance favour an 'assimilation' model, whereby consumer judgements tend to shift toward the direction of prior expectations, minimizing the apparent discrepancy between what was expected and what was experienced.

In the past few years, there have been a very large number of experiments examining the relationships of nutritional information in particular on measures of product acceptance (e.g. Solheim, 1992; Aaron *et al*. 1994; Tuorila *et al*. 1994, 1998; Daillant-Spinnler & Issanchou, 1995; Kähkönen *et al*. 1996, 1997; Solheim & Lawless, 1996; Westcombe & Wardle, 1997; Engell *et al*. 1998; Kähkönen & Tuorila, 1998). This situation has largely come about through the recognition that nutritionally relevant labelling (e.g. 'low fat') sets up negative or positive expectations (depending on the consumers' attitudes to reduced-fat foods or 'healthy' eating in general) and thus affects the perception of hedonic and sensory quality (Aaron *et al*. 1994). One important point is that the direction and strength of effects of information are not the same for all individuals. For example, Aaron *et al*. (1994) found that 'reduced-fat' information generated differential effects on liking scores between subjects classified by their attitudes toward fat and 'healthy' eating. Analogous results have been seen in several other studies (Kähkönen *et al*. 1996; Westcombe & Wardle, 1997; Engell *et al*. 1998). Thus, there is a general tendency for nutritional information labels to move product judgements in line with pre-existing attitudes, which (presumably) influence expectations. Deliza & MacFie (1996), Deliza *et al*. (1996), and Solheim & Lawless (1996) also describe a variety of personality traits and experiential factors which may influence susceptibility to manipulation of expectations. Together, these studies all point out the importance of characterizing the population of interest. In extreme cases, labels may have equally intense but directly contradictory effects on different population subgroups (e.g. Aaron *et al*. 1994). Failure to consider this may account for the appearance of only very small mean overall population effects of nutrition information in some studies.

More recent work has begun to consider how sensory and nutritional information might best be optimized to enhance acceptance of nutritionally-modified (e.g. reduced- or low-fat or sugar) foods. Anecdotally, it is apparent that the sensory delivery of many such products falls well below the level suggested by promotions and package claims. We (Stubenitsky *et al*. 1997) have found that sensory descriptive information can potentially generate a significant negative effect on product evaluations, even where nutritional information may not. In such cases, sensory information may have established a very specific set of expectations, which are unlikely to match closely the actual experience of many consumers during eating. Thus, the challenge here is to ensure that there is reasonably acceptable agreement between the product itself and the description.

Information about nutritional composition of foods also sets up expectations, and interacts with cognitive aspects of food intake control to volume of consumption. This is an important issue, particularly in relation to nutritionally-modified (e.g. low-energy) foods. There is still considerable uncertainty about the potential benefits of such products, much of which centres on possible cognitive behavioural responses; specifically, whether many individuals will simply eat more volume of a food, because it is (believed to be) lower in energy. In some studies, the belief that a meal was high or low in fat or energy, for example, has been shown to prompt behavioural eating responses which are better attuned to the cognitive manipulation (labels) than any real nutritional aspects of the foods themselves (Caputo & Mattes, 1993; Shide & Rolls, 1995). These beliefs about the potential composition or effects of a food need not necessarily be explicitly expressed to individuals, but may be assumed (e.g. Wooley *et al*. 1972). Thus, it is also possible that the differential responses of certain subgroups to what are ostensibly 'blind' manipulations of foods (e.g. Rolls *et al*. 1994), might actually reflect unmeasured differences in the subjects' perceptions and expectations of the situation or test stimuli. These potentially important variables are relatively easily measured, and warrant consideration in many studies of food choice and intake.

Conclusions

At the broadest level, the agro-economic and cultural background and environment shape human food choice and intake by influencing the range and quantities of foods available to human populations. These factors have also been incorporated into general cultural rules for cuisine and appropriate eating behaviour, which strongly dictate much of what foods and food combinations will be eaten, when, how, and by whom. They also generate individual and group variation in opportunities and likelihood for biological predispositions and learning mechanisms to manifest themselves in certain ways.

Nutritional studies classically tend to treat human subjects like other animals, focusing on the food, the gut, and blood-borne and metabolic factors. There is often a desire to exclude from consideration those events occurring around and between these factors, including perceptions and cues which might give rise to links with experience and beliefs. Yet, arguably, little of human food choice and intake on a daily basis is directly determined by the chemical composition of foods and biological characteristics of the individual. Instead, much observed behaviour reflects outcomes of learned cues, perceptions and responses which have been acquired through previous direct or indirect experience. Many of the interactions of food composition with its biological and social contexts are uniquely human, and together lead to the expression of a relatively stable and potentially predictable set of food choice and intake behaviours.

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