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Food likes and their relative importance in human eating behavior: review and preliminary suggestions for health promotion

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Abstract

The present article reviews research about the psychological determinants of human eating behavior. A hypothetical model of food choice and intake is introduced, presenting various factors influencing eating behavior. Internal factors include sensory food aspects. Among the external factors are information, the social context and the physical environment. Processes such as mere exposure, Pavlovian conditioning and social learning shape the relationships between these factors, food liking and eating behavior. The relative contribution of the various determinants is discussed. In spite of a scarcity of studies, liking for the sensory aspects of food seems to be at the center of the development, maintenance and change of dietary patterns. Consequently, efforts for promoting healthy eating behavior might benefit from an increased attention towards learning principles and food likes in the development of interventions. Existing intervention strategies are criticized and preliminary suggestions are formulated to enhance their effectiveness.

Introduction

A variety of social, cultural and economic factors contribute to the development, maintenance and change of dietary patterns. Intra-individual determinants such as physiological and psychological factors, acquired food preferences and knowledge, can be distinguished from interpersonal or social factors such as family and group influences (Glanz and Mullis, 1988). Liking, or the affective response to the sensory properties of a food (Rozin, 1990), is believed to play a major role, or even more, to be the best predictor of human food choice or intake in the absence of economic and availability constraints (Cowart, 1981; Rozin and Zellner, 1985; Rozin and Schulkin, 1998). Customer interviews have shown that people consider sensory perceptions of food as a dominant value or limiting factor, tending to be less negotiable than other values influencing their food choices in the supermarket or restaurant [e.g. (Furst *et al.*, 1996)]. In short, if a food is not perceived as positive in its appearance, smell, texture or taste, it is unlikely to be eaten (Hetherington and Rolls, 1996).

If liking truly is that important a determinant of food choice, health practitioners should focus their efforts on processes determining liking in order to improve food habits. However, claiming that one determinant is dominant over the others implies knowledge about how the various determinants inter-relate in their influence on food choice.

Comprehensive models have been developed to sketch out the way people construct the process of choosing foods. For example, Furst *et al.* (Furst *et al.*, 1996) group the factors involved in food choice into three major components (life course, influences and personal systems)—the particular relationship of these components to one another generating the process or pathway leading to the point of choice. Although such models document the full complexity of food choice, their comprehensive nature makes it difficult to make predic-

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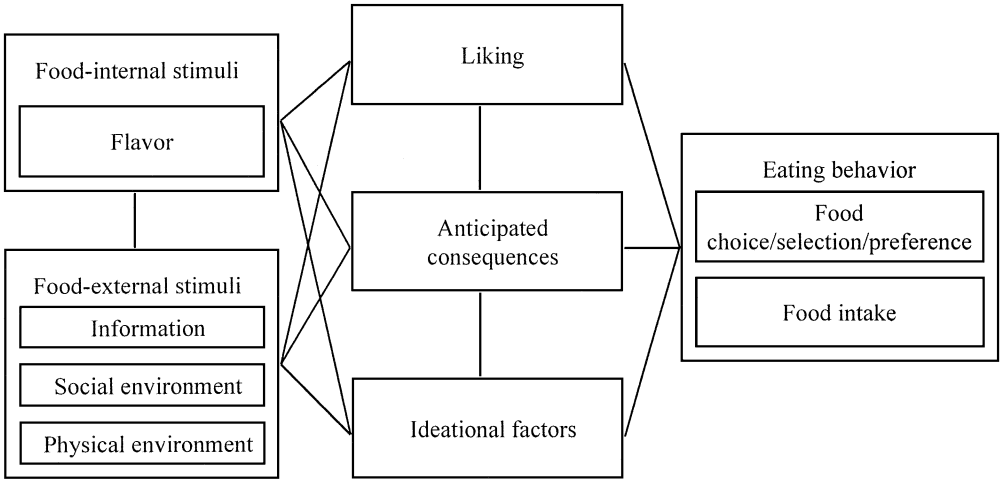

Fig. 1. A hypothetical model of eating behavior.

tions about actual food choice behavior. We propose a hypothetical model of eating behavior illustrating its complexity in a more concise manner. In order to model the role of liking and other determinants in eating behavior, we draw on Fallon and Rozin's taxonomy of food (Rozin, 1990), which categorizes three criteria for food acceptance or rejection: (1) sensory-affective responses (liking), (2) anticipated consequences and (3) ideational factors.

The hypothetical model is presented in Fig. 1. Its broader context, culture, may influence eating behavior directly, but more often it plays a moderating role on other variables to determine interindividual differences in food likes and eating behavior (Chrisler, 1997). The model consists of three levels of variables and their inter-relationships. Eating behavior is viewed as the ultimate dependent variable, operationalized either as food choice/selection/preference or as food intake. The food taxonomy is situated on the intermediate level. Fallon and Rozin's category of anticipated consequences is expanded to include expectations and attitudes towards nutrition and health. Both eating behavior and the food taxonomy are dependent of food-internal and food-external stimuli, situated on the first or independent level. Flavor and other sensory food aspects are instances of food-internal stimuli. Food-external or contextual stimuli include information, the social context and the physical environment (e.g. purchase location, availability and diversity of food products).

Other factors influencing liking and eating behavior are beyond the scope of our review and model. These include innate regulatory mechanisms indicating deficits in nutrients (e.g. sodium, water and energy) (Rozin, 1990), the physiological states of hunger and satiety (Hill *et al.*, 1984; Hill and Blundell, 1986; de Castro and Elmore, 1988; Pliner *et al.*, 1990; Rolls, 1993; Stricker and Verbalis, 1987; Gibson and Desmond, 1999; Lozano *et al.*, 1999), personality traits (e.g. neophobia and sensation seeking) (Stone and Pangborn, 1990; Venkatramaiah and Devaki, 1990; Raudenbush *et al.*, 1995; Pliner and Melo, 1997; Pliner *et al.*, 1998) and socio-economic factors (e.g. socio-economic status, the price of foods) (Cabanac, 1995; Jeffrey and French, 1996; Steptoe and Wardle, 1999). Phenomena that are also related to food liking and consumption but not discussed in the present article are alliesthesia (i.e. the variability in the pleasure sensation aroused by a given food stimulus, depending on the subject's internal state) (Cabanac *et al.*, 1973; Cabanac and Lafrance, 1990) and sensory-specific satiety (i.e. a decline in the liking for a food after repeated consumption,

not necessarily involving ingestion of nutrients, but possibly merely a 'flavor fatigue') (Rolls *et al.*, 1981; Drewnowski *et al.*, 1982; Rolls, 1986; Hetherington *et al.*, 1989; Hetherington and Rolls, 1996).

We will go through the model stepwise, describing its main variables and elaborating on the various relationships. Due to a lack of data, we will not be able to discuss all the links. In the following sections, we will first relate liking to food-internal stimuli. Next, we will discuss food-external stimuli and their relationship with several dependent variables (i.e. liking, expectations and food choice). Then, we will take a closer look at the learning mechanisms shaping the model's relationships. Finally, we will evaluate the research investigating the relative impact of the various determinants on eating behavior. The previously discussed topics will allow us to make some preliminary suggestions for alternative interventions in eating behavior after having evaluated the existing strategies.

Food-internal stimuli: flavor perception

Perception of flavor involves the integration of several sensations, both within and between sensory modalities. Although taste and smell play a central role, the appearance of a food (e.g. its color and shape), its texture, fat content and temperature, pain sensations (caused by, for example, chilli pepper), and even the sound of chewing, also contribute to the overall flavor perception (McBride and Anderson, 1990; Bartoshuk, 1991, 1993).

The question of interest is how these sensory food aspects interact to produce a particular flavor perception. Most studies seem to have focused on relationships between taste and another component. More precisely, they have investigated interactions among tastes (Moskowitz, 1972), interactions between smell and taste (Hornung and Enns, 1984; Frank and Byram, 1988; Mozell, 1988), interferences of color with taste (Hyman, 1983; Alley and Alley, 1998; Frank *et al.*, 1989; Strugnell, 1997), influences of texture on taste (Green, 1993; Alley and Alley, 1998), effects of temperature on taste (Paulus and Reisch, 1980; Bartoshuk *et al.*, 1982; Calvino, 1984; Green and Frankmann, 1987), interactions between fat and taste (Drewnoswski and Schwartz, 1990; Drewnowski, 1993), and between irritants (e.g. the capsaicin in chilli peppers) and taste (Prescott *et al.*, 1993; Prescott and Stevenson, 1995).

These multiple sensory components interact to have an effect on liking and sensory-affective responses towards food strongly depend on the relative proportions of nutrients (e.g. sucrose and fat) (Drewnowski and Greenwood, 1983; Abdallah *et al.*, 1998; Geiselman *et al.*, 1998; Rozin and Schulkin, 1998). The link between food perception and liking or hedonic responses towards foods is either innate or acquired during later life (see below).

Food-external stimuli

Information

Information about healthy food aspects (e.g. reduced-fat labels) sometimes appears to have a positive effect on liking (i.e. an increase), sometimes a negative effect (e.g. a higher liking for the full-fat labeled version) and sometimes no effect at all (Martins *et al.*, 1997; Westcombe and Wardle, 1997; Engell *et al.*, 1998). These inconsistent results may be related to the type of products tested, to the precise way the information was worded or to consumers' expectations about the products and attitudes towards nutrition. Information-based expectations can influence liking ratings in the direction of both high and low liking, implying an assimilation of rated pleasantness to expectations held before tasting. This has been illustrated with young men rating the expected and actual pleasantness of two samples of Bologna sausage (regular or reduced fat), either with or without prior information about fat content (Kähkönen and Tuorila, 1998). However, unrealistically high expectations may cause a contrast effect on actual ratings: if the actual quality of the tasted food is substantially lower than expected, food

liking may be rated significantly lower than would be derived from a 'blind' evaluation (e.g. without prior information). Other important moderating factors in the relationship between information and liking are people's attitudes towards nutrition or their concern for health consequences of ingesting specific foods. The liking ratings of people with a higher concern appear to be more influenced by nutrition information (Engell *et al.*, 1998).

Mixed findings have also been reported as regard the effects of nutrition information on actual food choice. Significant shifts in prospective consumption of healthy foods (e.g. reduced-fat cookies) have been observed, as well as insignificant or even counter-productive effects on the likelihood of trying novel foods (Martins *et al.*, 1997; Engell *et al.*, 1998). Some findings suggest that a 'low-fat' label acts as a license to consume more than one would customarily consume (Engell *et al.*, 1998). Although general nutrition information was found to increase willingness to taste novel 'healthy' foods in subjects for whom nutrition is important (McFarlane and Pliner, 1997), evidence remains inconclusive as to whether these attitudes are significantly related to eating behavior (Wardle *et al.*, 1997; Engell *et al.*, 1998).

The social environment

Interpersonal similarities in eating behavior (e.g. eating rate, style and amount) suggest important direct or indirect social influences (Agras *et al.*, 1988; Rozin, 1996). Indirect social influences are very broad, including beliefs, culinary traditions and occasions that set the stage for or modulate the interpretation of food encounters. Direct social influences require the mediation of another person present on the occasion, while indirect social influences do not. Social factors appear to exert their influence on eating behavior through social facilitation, resulting in increased food intake when eating in the presence of others (de Castro, 1991; de Castro and Brewer, 1992; Redd and de Castro, 1992), through the establishment of family food rules at a younger age (De Bourdeaudhuij, 1997a) or through various learning mechanisms (see further).

The physical environment

The last category of food-external determinants in our model consists of food availability and accessibility. There is a whole sequence of steps leading to the availability of foods in the final consumption situation (Baranowksi, 1997). First, foods should be available in the neighborhood (stores). Next, selection in the store brings foods to the home situation. When access to a certain food (e.g. a highly liked high-calorie food) becomes increasingly limited, people will shift their food choice to another food (e.g. a lesser liked low-calorie food) (Smith and Epstein, 1991).

Innate and acquired food likes

Innate food likes

Researchers investigating innate food or flavor likes and dislikes have mainly depended on facial reflexes of the neonate offered tastes or smells (the major elements of flavor), as reflections of hedonic responses towards these stimuli (Cowart, 1981; Birch, 1990).

Several studies have failed to discover innate pleasures or displeasures associated with olfaction (Engen, 1982). However, there are so many distinct olfactory sensations that no single experiment can sample them all and the possibility remains that some other odorants then those targeted by the experimenter might have produced effects in human infants. Moreover, studies in the pheromone literature suggest that some odorous are intrinsically attractive, although there is also evidence for learned attractiveness (Bartoshuk, 1993).

Stronger support exists for innate taste preferences. Neonates' expressions suggest an innate preference for sweet and reflexive aversions or rejections to bitter and sour. Hedonic responses to salty tastes seem to be unstable during childhood, shifting from a neutral or negative hedonic value in the neonatal period and older infancy to a positive hedonic value by late childhood (Cowart, 1981). There appears to be a role for intake experience during early infancy in the acquisition of salt preference (Harris *et al.*, 1990).

In general, studies conducted with twins suggest that the expression of genetic differences in taste and food preference may be overwhelmed by early intake experiences, as they show that heritability in preferences is essentially zero, compared to experience (Greene *et al.*, 1975; Rozin and Millman, 1987).

Acquired food likes: learning mechanisms involved in eating behavior

Experience may lead to newly acquired food likes, alter innate likes or maintain innate likes that would otherwise disappear (Beauchamp and Moran, 1982; Beauchamp and Cowart, 1985). Various mechanisms are at play, with a central role for mere exposure, Pavlovian conditioning and social learning (Birch, 1993; Zellner *et al.*, 1983; Letarte *et al.*, 1997; Rozin and Schulkin, 1998).

Mere exposure

Independent of stimulus recognition, mere repeated exposure to a stimulus object enhances the affective response towards it, and can even overcome an initially negative response (Zajonc, 1968; Zajonc *et al.*, 1974; Moreland and Zajonc, 1977). In the context of food likes and intake, this mechanism has been attributed an influence starting in early human life. Although scarce, evidence suggests that exposure of the unborn child to flavors in the amniotic fluid and human milk may contribute to later preferences for such flavors (Beauchamp and Bartoshuk, 1997).

Research has been conducted with both children and adults to determine the relation between food preference and exposure frequency, the number of feedings needed to increase intake of a (novel) target food, and whether exposure effects generalize to other foods (Birch and Marlin, 1982; Pliner, 1982). Results indicate that food preference is an increasing function of exposure frequency: the more frequently a food has been tasted, the better it is liked. An exposure to a target food once a day for 10 days can dramatically increase intake of the target food and intake may nearly double after only one exposure (Birch *et al.*, 1998). Generalizations of exposure effects have been found over manufacturers and over similar foods (Birch *et al.*, 1998), and declines in preference for other foods appear to accompany the increased intake of the target food (Sullivan and Birch, 1990).

The question remains what exactly causes an increase in food liking during repeated exposure. Two possibilities have been proposed. Mere exposure is either a necessary and sufficient condition for an increase in liking or a condition giving other processes (e.g. Pavlovian conditioning) an opportunity to act (Zellner *et al.*, 1983).

Pavlovian conditioning

Classical or Pavlovian conditioning refers to a procedure in which a subject is exposed to a relationship between a conditional stimulus (CS) and an unconditional stimulus (US), after which a change in behavior towards the CS can be attributed to the pairing of both stimuli. This learning mechanism may be the principal process in the acquisition of food (dis)likes, and evidence suggests that it can occur both through direct experience of the association and through verbal messages (Pelchat and Pliner, 1995; Rozin and Schulkin, 1998).

A double distinction can be made in this paradigm. The first dichotomy is situated on a process level, as Pavlovian conditioning can result in expectancy learning and affective-evaluative learning. In descriptive terms, expectancy learning implies the acquisition of knowledge such as 'CS is a predictor of US' or 'CS causes US'. Affective-evaluative learning (evaluative conditioning) refers to a process by which an evaluative response (in terms of good/bad, pleasant/unpleasant), elicited by a significant stimulus, is transposed on a previously neutral stimulus that is presented contingently with the significant stimulus. Baeyens and his colleagues further elaborate on the functional differences between both kinds of learning (Baeyens, 1998; Baeyens *et al.*, 1988a,b, 1989, 1990). Expectancy learning and affective-evaluative learning should not be considered as mutually exclusive. They can either occur separately or concurrently through experiences with food: evaluative conditioning shapes the relationship between food internal stim-

uli and liking, while anticipated consequences of ingestion and expectations about foods' properties are linked to food through expectancy learning.

The second distinction regards the type of US that can be identified in Pavlovian conditioning of food likes and dislikes. Post-ingestive consequences and taste or flavor are two common categories of US (Rozin and Schulkin, 1998). Disgust eliciting stimuli appears as a third category of stimuli that may produce conditioned food aversions in particular.

Post-ingestive consequences. Pavlovian conditioning involving negative post-ingestive consequences is a very potent mechanism in the formation of flavor or food aversions. Humans especially develop a dislike for the taste of a food when nausea follows its ingestion (Pelchat and Rozin, 1982). Other negative events (e.g. diarrhea, respiratory distress or rashes) motivate avoidance, without causing the foods to become distasteful. In other words, food experiences associated with nausea may result in both evaluative learning (a decrease in food liking) and expectancy learning (negative anticipated consequences about future experiences with the target food), whereas negative events lacking the nausea component will only induce expectancy learning. Nausea-based taste aversions can find their origin in various situations, such as food poisoning, overconsumption, allergic reactions and some medical treatments (e.g. chemotherapy) (Batsell and Brown, 1998). Although 59–83% of naturally developed food aversions are linked to the taste of food, gastrointestinal nausea is associated with its smell for 12–51% of food aversions (Logue *et al*., 1981; de Silva and Rachman, 1987).

Contrary to learned food dislikes, it has been more difficult to demonstrate clear acquired likes in humans as a result of specific potent positive consequences (Zellner *et al.*, 1983). However, consequences of ingesting foods with high starch or fat content or high caloric value appear capable of producing positive hedonic changes (Booth *et al.*, 1982; Birch *et al.*, 1990; Johnson *et al.*, 1991). The direction of these conditioning effects, though, depends on the state of satiation: a conditioned increase in pleasantness was observed when flavors were eaten and tested in a state of normal hunger, whereas the opposite occurred in replete states.

Flavors. Flavor–flavor conditioning possesses the characteristics of evaluative learning. It results in a transfer of any affective tone of one of the paired flavors to the other flavor (Capaldi, 1996). This is so whether the affective tone of one of the flavors is inherent (e.g. in the case of sucrose) or has been learned (e.g. when one of the flavors has previously been paired with positive or negative post-ingestive consequences). Sclafani [in (Capaldi, 1996)] offers considerable empirical support for this mechanism in rats. However, similar learning effects can be expected with humans. For example, a shift towards a negative affective tone was demonstrated for a flavor that had previously been paired with the aversive flavor Tween 20 (Baeyens *et al*., 1996b).

Flavor–flavor conditioning appears as a powerful way to increase liking not only towards isolated tastes, but also towards specific foods. This is illustrated when the food is mixed with a liked flavor or food. For example, earlier experiences of coffee with cream and sugar can be viewed as opportunities for coffee (the CS) to be repeatedly paired with sugar (the positive US), leading to an increase in the liking for coffee (Rozin, 1996). Similarly, the liking for unsweetened vegetables and unfamiliar teas increases after they have been presented sweetened in a number of taste occasions (Zellner *et al.*, 1983; Capaldi, 1996).

The finding that people's willingness to try novel foods increases after providing them with the verbal information that the foods taste good, suggests that flavor–flavor or food–flavor conditioning can also occur in written messages (Pelchat and Pliner, 1995).

Disgust eliciting stimuli. Disgust eliciting stimuli are a third category of unconditioned stimuli that can be distinguished especially in Pavlovian conditioning of food or flavor dislikes. Contrary to the 'traditional' taste aversion caused by nausea (see above), this type occurs without the direct mediation of an illness-producing US. Instead, it appears

to be mediated by knowledge and mental images. Two situations in which taste aversions are mediated by cognitive processes are: negative information and forced consumption (Rozin and Fallon, 1987; Batsell and Brown, 1998). They may produce a disgusting mental image, respectively a disgust response. 'Cognitive aversions' have been found to comprise a substantial portion (19%) of learned taste aversions, and to be stronger and longer lasting than traditional aversions (Batsell and Brown, 1998).

Social learning

Although the above mechanisms describe dietary experiences of the individual, human eating behavior can only be fully understood in a social context. Particularly for the young child, eating implies an occasion for social interaction and learning about food. The degree of participation or intention of the social agent in the learning task may vary. Peers, siblings, parents and other adults serve as models who cajole, wheedle and coerce the child to eating (Rozin, 1990). Their influence occurs through mechanisms such as mere exposure and Pavlovian conditioning. For example, Baeyens *et al.* demonstrate that flavor–flavor conditioning can happen indirectly, through observation (Baeyens *et al.*, 1996a). In observational evaluative conditioning, participants are not confronted directly with a CS–US relationship, but observing a social model exposed to such an association. The model is tasting a food with a target flavor and communicating his/her reactions (especially facial expression). When the observers rate the target stimulus (CS) afterwards, an evaluative conditioning effect can be observed. In addition, similarity between model and observer enhances this effect.

Parents are very likely the most important models for their children. They are the main vehicle of culture-wide preference transmission because they offer the foods, create the context in which the foods are consumed and are the main source of social exchange at mealtime. However, zero to low (approximately 0.3) correlations between food preferences of parents and children (Rozin *et al.*, 1984) reveal a 'family paradox' (Rozin, 1990): although the family is a powerful force for instilling culture-wide preferences, it is a very weak one for instilling family-specific preferences. There are no explanations for this paradox but the presence of other major social influences, exerted by siblings, peers, adults other than parents and the media (Birch, 1980; Pliner and Pelchat, 1986).

The social-affective context in which foods are presented is extremely important in the formation of young children's food preferences. When children are presented neutral foods (i.e. neither highly preferred nor non-preferred) as rewards or paired with adult attention, the foods appear to produce significant increases in preference, whereas no consistent changes are noted when foods are offered in a non-social context or at snack time (Birch *et al.*, 1980). Apparently, the positive affective processes elicited by the reward and attention context become associated with the foods. However, the use of food rewards can also produce opposite effects. Especially when parents coerce children to consume disliked (but nutritious) foods by restrictively using highly liked foods as rewards for doing so, children come to dislike the foods and tend to develop a great liking for the rewards (Birch *et al.*, 1980, 1982, 1984). This destructive coercion (Rozin, 1990) shows that, what is learned by the children from their interactions with others is not always what is intended by the instructors.

The relative impact of liking and other determinants on eating behavior

The impact of food liking has been well established on several dimensions of eating behavior, such as initial rate of eating, meal duration and amount eaten (Spitzer and Rodin, 1981), and frequency of consumption (Woodward *et al.*, 1996). Despite this evidence in favor of a relationship between liking and actual food intake, discrepancies have repeatedly been found between both variables. For example, subjects who, merely on the basis of their sensory evaluation (assessed through taste-and-spit tests), preferred medium to high sucrose or aspartame concentrations in a dairy product

nevertheless chose lower concentrations for actual intake (determined in *ad libitum* consumption tests) (Lucas and Bellisle, 1987; Monneuse *et al.*, 1991). These discrepancies are caused, both directly and indirectly, by the impact of other factors on eating behavior.

Comparatively little attention has been paid to the relative contribution of these determinants versus liking. Tuorila and Pangborn (Tuorila and Pangborn, 1988), for example, obtained questionnaire data about women's intended and reported consumption of four foods (milk, cheese, ice cream, chocolate and 'high-fat' foods—a generic category), showing that liking was a stronger predictor of consumption than health beliefs and evaluations (e.g. 'good for you' and 'bad for you'), although weight concern was a significant countering factor. From a survey with more than 2000 students, Woodward *et al.* found that self-reported usual (past) frequency of consumption of a diversity of foods could be better predicted by liking and parental usage of the foods than perceptions of foods' health quality and friends' usage (Woodward *et al.*, 1996). Wardle used the technique of within-subjects correlations between health or taste appraisal and consumption frequency of foods to index health and taste motivations in food choices among family members (Wardle, 1993). As the taste index was significantly and consistently higher that the health index, food choices appeared to be determined more by considerations of liking than by considerations of health. In their development of the Food Choice Questionnaire, Steptoe *et al.* ordered 'sensory appeal', 'health', 'convenience' and 'price' as the most important factors taken into account by their subjects when choosing what to eat, with statements concerning 'mood', 'natural content', 'weight control', 'familiarity' and 'ethical concern' typically being endorsed less strongly (Steptoe *et al.*, 1995).

The evidence appears to be scarce and characterized by a number of methodological problems. More precisely, there is a lack of consistency in procedures across studies, alternative conceptualizations of liking have been used, and measures of liking vary in wording and response format. However, evidence suggests that liking plays a dominant role in food choice and consumption.

Towards an alternative for existing intervention strategies

Although many people are interested in developing healthier eating patterns, nutritional interventions do not always succeed in bringing about behavioral change. The difficulty of changing eating habits has been related to the multiple roots of people's ideas about food (e.g. the society's 'food ideology', the family environment, personal experience and the media), conflicts between intrinsic and extrinsic values (i.e. liking on the short term and health consequences on the long term) characterizing dietary advice, the gradual development (instead of immediate appearance) of diet-related health problems, the requirement of long-term changes in habitual food intake for risk reduction and disease prevention through nutritional means, and the less than obvious physical feedback of some dietary changes (e.g. increased fiber intake) (Glanz and Mullis, 1988; Wardle, 1993; Wardle and Solomons, 1994).

Basically, two broad intervention strategies exist to alter eating behavior. One strategy focuses on individual problem awareness and personal motivation and skills, the other on providing context stimuli intended to direct food choice. The effectiveness of these programmes can be questioned. Because food (dis)likes appear of major importance to eating behavior and learning mechanisms are responsible for their development and change, effectiveness of interventions may be increased by special emphasis on these two elements. We do not necessarily opt for one particular intervention strategy, but rather suggest to use specific opportunities within each strategy.

Raising individual problem awareness

Although classical education programs emphasizing information transmission increase basic nutritional knowledge and awareness, they do not appear to have a significant impact on dietary practices. Sometimes behavior is actually opposite

to the knowledge of nutritional guidelines (Collison *et al.*, 1996; Warwick *et al.*, 1997). Many people either do not know how or do not yet want to apply nutritional guidance to their food choices (Glanz and Mullis, 1988). In addition, a person may accept nutrition information at an intellectual level without necessarily finding it relevant to themself, or may discard the information because health-hazardous eating behavior perhaps adds real taste to life (Raaheim, 1990). The effectiveness of specific nutritional information appears to be moderated by people's health concerns and attitudes towards healthy food (Engell *et al.*, 1998).

The theoretical models upon which these strategies are built (e.g. Health Belief Model and Theory of Reasoned Action) take into account social-cognitive variables, such as risk information, peer influence and feelings of personal competence. However, they have been criticized for their heavy reliance on processes of rational decision making concerning own health (risk) behavior (De Bourdeaudhuij and Van Oost, 1997). Moreover, a review of the literature on psychosocial models predicting dietary fat and fruit and vegetable consumption revealed generally low predictiveness (Baranowski *et al.*, 1999). In our view, information and education may be too much oriented to health issues, rather than to taste, flavor and liking.

Manipulating context stimuli: environment and family

Environmental interventions are strategies that do not require individuals to self-select into defined educational programs (i.e. class, group or counseling situations) (Glanz and Mullis, 1988). Common environmental interventions, implemented to promote healthy eating behavior, are changes of food supply and variety, point of choice nutrition information, collaboration with food vendors, worksite nutrition policies and incentives, and changes in the structure of health and medical care.

The first two types have received most attention. Their basic principle is to increase the saliency of healthy products at the point of purchase, typically being the supermarket and the cafeteria. Significant increases of sales have been observed in worksite cafeterias and vending machines, though the effectiveness of such interventions has not always been confirmed (Glanz and Mullis, 1988; Pandelaere *et al.*, 1997). One problem is that the altered eating behavior does not generalize from the intervention setting to the home situation (Scholten *et al.*, 1994). Second, the way the information is framed and provided acts as a modulating factor: clear, simple and specific food information yields the strongest effects in both supermarkets and restaurants (Russo *et al.*, 1986; Pandelaere *et al.*, 1997).

In relation to the first problem, it has been argued that interventions should no longer target the person who is believed to be responsible for food decisions, purchases and preparation (most often the mother or the mistress of the house). As clear indications have been found that food choice, as well as consumption, is most often a case for the (nuclear) family, programs should foster the participation of families as a whole (including children and especially fathers) to obtain long-lasting changes (De Bourdeaudhuij, 1997b; De Bourdeaudhuij and Van Oost, 1997).

Preliminary suggestions for interventions and future research

Environmental interventions such as changes of food supply and variety may enable repeated positive experience with (novel) healthy products and an increase in the liking for and choice of these foods through the mechanism of mere exposure. Experience with the food should include experience with its taste and not merely with its visual aspects. For example, in teaching children about healthy foods one should not limit oneself to the use of pretty pictures, but give them the opportunity to taste the foods as well (Birch *et al.*, 1987). This purpose can easily be fulfilled by offering adapted lunches at the school canteen. However, 'taste games' could also be designed and implemented in the curriculum, allowing children to have exciting taste experiences right in the classroom. At the supermarket, free samples of healthy (and tasty) food products can be distributed. Similar interventions can be implemented in the

restaurant, worksite cafeteria or family dining room. Although these last two strategies have the potential of reaching families instead of individuals, one should keep in mind that changes of food supply and variety have not always proven effective (see above). Further research is necessary to determine if such tactics work.

Occasions for evaluative and expectancy learning can be offered in the same contexts. This can happen through direct experience as well as verbal messages. For example, people's liking for healthy foods can be increased by adding positive valenced flavors (e.g. a sweetener) and gradually decreasing it as in a flavor–flavor conditioning paradigm. This procedure has appeared effective in enhancing the liking of college students for vegetables (Capaldi, 1996). Similarly, informational means should emphasize an association between healthy products and good taste. The potential effect of such an intervention is illustrated in a study showing that prompts pointing at both the tasty and the healthy character of a restaurant dish stimulated its sale to a greater extent than prompts pointing only at the healthy character (Colby *et al.*, 1987). Evaluative conditioning can also be used more explicitly in a social or observational manner.

Pavlovian conditioning may also induce beneficial anticipated consequences of ingestion, suggesting the occurrence of expectancy learning. People can be provided with information emphasizing consequences of healthy eating habits, such as reduced cholesterol levels and health risks. However, these health effects are at best long term and often weak. Although dieticians or general practitioners act as facilitators for expectancy learning in stressing the association between healthy eating and health effects, finding recognizable instant rewards for (or benefits of) eating healthy foods remains a challenge for food industry and research.

Industry and research have already played an active role in the development of low-fat products, meeting the recommendations of health agencies to decrease fat intake in order to reduce the risk for obesity, cardiovascular disease, diabetes and some types of cancer. The problem is that reducing fat content alters a food's texture and flavor. 'Healthy' low-fat foods often suffer from expected and real sensory problems (Tuorila *et al.*, 1994), and are often judged to be 'tasteless' or even 'distasteful' (De Bourdeaudhuij, 1997a; Pandelaere *et al.*, 1997). Moreover, people's preferences for high-fat foods are remarkably resistant to change (Drewnowski, 1990). Although the food industry has recently developed zero-calorie fat substitutes with the same functional and sensory properties as fat (Sanchez *et al.*, 1995; Peters *et al.*, 1997; Rolls *et al.*, 1997), likely to enhance compliance with low-fat diets (Borzelleca, 1996), the long-term effect of fat substitutes on fat intake and weight control are still unknown (Miller and Groziak, 1996).

Conclusion

Before formulating any conclusions, some limitations of the perspective adopted in the present review should be noted. Most of the reviewed studies concern white, western and young to middle-aged people. This may limit the generalizability of conclusions across populations. For example, the major role of food (dis)likes in food selection may only hold within our western 'culture of plenty' with little economic and availability constraints, while physiological and socio-economic factors may determine food choice more in countries facing food scarcity. Also, our hypothetical model of human eating behavior needs further research to determine its utility and validity.

Although research on the relative contribution of the various determinants to human eating behavior appears to be scarce, it suggests that food likes and dislikes are at the center of the development, maintenance, and change of dietary patterns. Processes of mere exposure, Pavlovian conditioning and social learning give shape to relationships between liking and other determinants. Consequently, learning principles and food likes should receive a central place in the design of interventions in eating behavior. Using specific opportunities within existing efforts for promoting healthy eating behavior (focused either on the individual or on

his environment) might render these strategies more successful where they have previously lacked effectiveness. We have formulated a few preliminary suggestions. However, further creative thinking and research along these lines is necessary.

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