MODEL AND MEASUREMENT METHODOLOGY FOR THE ANALYSIS OF CONSUMER CHOICE OF FOOD PRODUCTS[1]

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ABSTRACT

The consumer can be conceived as an imperfect problem solver. Consumer behavior with respect to food products is purposive, but the consumer is bounded by limitations of information, cognitive skills, memory and time.

From this starting point, this paper develops a model of the process by which a consumer chooses a particular item (e.g. type of meat, vegetable, soft drink) from a class of food products. Different attributes of the product may play a role: hedonic, instrumental and symbolic attributes. In the model the overall preference for a product is the result of (i) the relevant perceptual dimensions and the beliefs of the consumer with respect to the performance of the product on the relevant dimensions (ii) the way the consumer trades off these product dimensions against each other (preference functions).

The paper then discusses methods to measure the various variables of the model and to analyse the factors that determine preferences in a specific product class. Sensory profile construction, multidimensional scaling and factor analysis can be used to measure product perceptions. Also preference estimation methods and the data requirements for these techniques are discussed.

A demonstration of the approach is provided for the choice of vegetables in The Netherlands.

The paper ends with a brief discussion about the practical use of the insights obtained with this model and some speculation about research to make further progress in understanding the factors determining consumer choice of food products.

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INTRODUCTION

This paper considers the problem of a consumer purchasing a food product within a certain product class (e.g. meat, bread, vegetables, soft drinks, cheese) and making a choice from the different alternatives that are available.

These alternatives may be for example: different brands, different types (e.g. pork or beef or lamb for meat products, cauliflower or lettuce or French beans for vegetables), different packages or different nutritional contents (e.g. whole milk versus skim milk). It is important to know how these choices are made and which factors affect the outcome of the choice process, i.e. the alternative actually chosen. This insight is important to the suppliers-producers and retailers who attempt to offer products for which the consumers have a preference and also to nutrition scientists and people involved in nutrition education. If it is desirable to change people's habits of buying and eating food, the factors that influence this behaviour must be known.

VIEWS OF CONSUMER BEHAVIOUR

In the past, different approaches have been used to explain consumer behaviour.

In the economist's view, the consumer is a rational consumer; knowing all the different productrs, their prices, qualities and other attributes; the consumer compares all possible combinations of products that he can buy with his income and ultimately chooses the combination that maximizes his total utility. For the axioms of economic theory of consumer behaviour, see, for example, Green (1971).

A quite different school of thought—the motivation research school—believes that the consumer's motivations are of psycho-analytical origin; this view was very dominant in the 1950s and 1960s. In this approach, what might be called the Freudian consumer is considered as a passive being, irrational and driven by uncontrollable forces from his subconscious. Experiences early in life and sexual connotations play an important role in consumer behaviour according to this theory (Dichter, 1960). The consumer is very vulnerable to manipulations by his environment. The advertising industry in particular exploits the hidden forces in consumers to make them buy certain products (Packard, 1957).

The theoretical starting points of economics are charming in their clarity and simplicity, and economic theory has a good deal to say about how consumer expenditure is allocated among product categories

such as food, clothing, leisure, etc. However, at the more detailed level of choices between alternatives within a product class, the theoretical assumptions are not tenable. Usually the consumer is unaware of all the alternatives available and knows even less about all the specifics of each alternative. Also, the goals of a consumer are more than economic: in his consumption behaviour he may also strive to satisfy other needs, e.g. being accepted by other people, feelings of safety, status and prestige.

It is now generally agreed that the claims of followers of the motivation research school to explain consumer behaviour by very simple and straightforward factors such as associations with sex, obedience to parents, etc. have not been substantiated. Often their explanations have been no more than speculative. Nevertheless this approach has drawn attention to the role symbolic, non-economic aspects of products may play in consumer choice behaviour and to the need of studying consumer motivation, perceptions, beliefs, attitudes, etc. to explain comsumer behaviour.

In this paper a third view of consumer behaviour is adopted, which is emerging after a period of ever-increasing activity in consumer research: the consumer as an imperfect problem solver or decision-maker. This view can be found in a number of recent textbooks on consumer behaviour, such as: Engel et al. (1982), Schiffman & Kanuk (1978) and Zaltman & Wallendorf (1979).

Consumer behaviour is not irrational but purposeful and goal-oriented. But—as already mentioned—these goals are more than economic. Moreover, the consumer has limited information about alternative choices and often his perceptions are biased. His memory and information-processing capabilities are limited. Furthermore, a consumer can only spend a very small amount of time on each individual decision. Within these limitations of information, cognitive skills, memory capacity and time, the consumer has to solve his problems of choice.

Simon uses the expression "bounded rationality": an individual can only have rational behaviour "that is compatible with the access to information and the computational capacities that are actually processed by organisms" (Simon, 1979, p. 7). For an information-processing approach to consumer behaviour, see also Bettman (1979).

In this paper, keeping the consumer as an imperfect problem-solver in mind, I shall consider the various factors that affect consumer behaviour in choosing food products: economic factors such as prices and income, psychological variables such as perceptions, beliefs, motives and attitudes, and sociological factors such as culture, social class and reference groups.

To integrate all these factors and their interactions, a comprehensive model of consumer choice behaviour is required. Such a model for the choice of food products is presented in the next section. This model, which draws upon more general models from the literature, e.g. Howard & Sheth (1969) and Engel et al. (1982), offers an analytical framework for the analysis of consumer food choice. The model has no pretentions to being complete or the only possible model. Its function is merely to offer guidance to thinking about and analysing consumer behaviour in choosing food. The model is give in two stages (Figs. 1 and 2 respectively): first, a comprehensive general model, and secondly, a more detailed model describing the formation of perceptions and preferences with respect to food products.

The subsequent section concerns methodology. Methods are discussed for the measurement and analysis of important components of the model: perceptions and preferences. To give an idea of the possible results that may be obtained, some applications are also briefly described and discussed.

The last section of the paper discusses the potential insights that can be obtained using the approach presented here and discusses the desirability of and the possibilities for extending the analysis.

THE MODEL

Fig. 1 gives a schematic picture of the model. When the consumer has to make a choice between the alternatives in a product class, he has certain perceptions and beliefs about these alternatives. When evaluating alternatives he weighs these perceptions with his preference weights, indicating the importance he attaches to the various aspects. This results in an overall utility or an attitude with respect to the various alternative choices. In principle, he will choose the alternative with the greatest utility and this choice leads to a certain outcome: the satisfaction obtained from the product chosen. In a general model of consumer decision-making (Engel et al. 1982, Chapter 2) it is customary to distinguish 5 stages in the decision process: problem recognition (1), Search (2), Alternative evaluation (3), Choice (4) and Outcome (5).

Here we assume that stage 1 has been passed: through triggering mechanisms such as physiological needs (hunger, thirst) or observation of products in shops, advertisements or elsewhere, the consumer has somehow become involved in a problem of choice.

Stage 2 refers to the information-seeking activity of the consumer before he makes his choice. Since most food products are low-cost items, we assume that the consumer does not become involved in an extensive

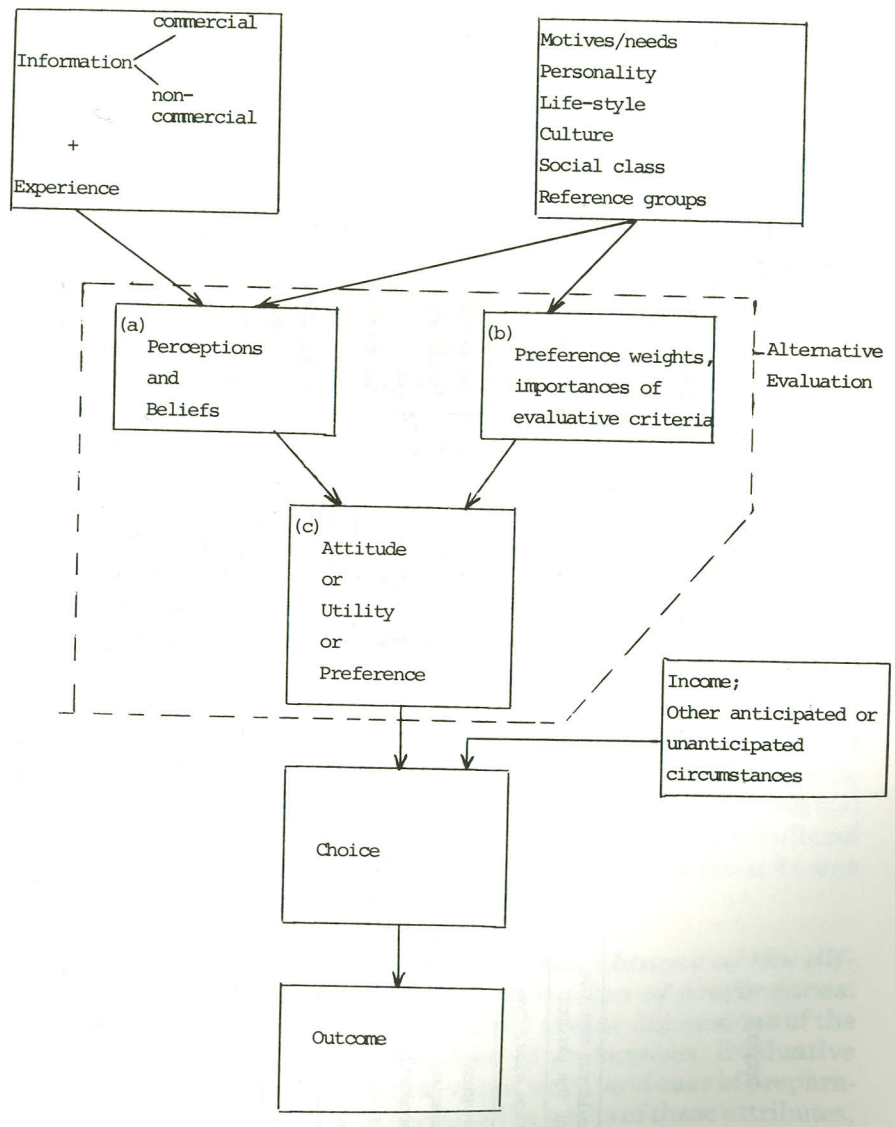


FIG. 1. A MODEL FOR THE CHOICE OF A FOOD PRODUCT

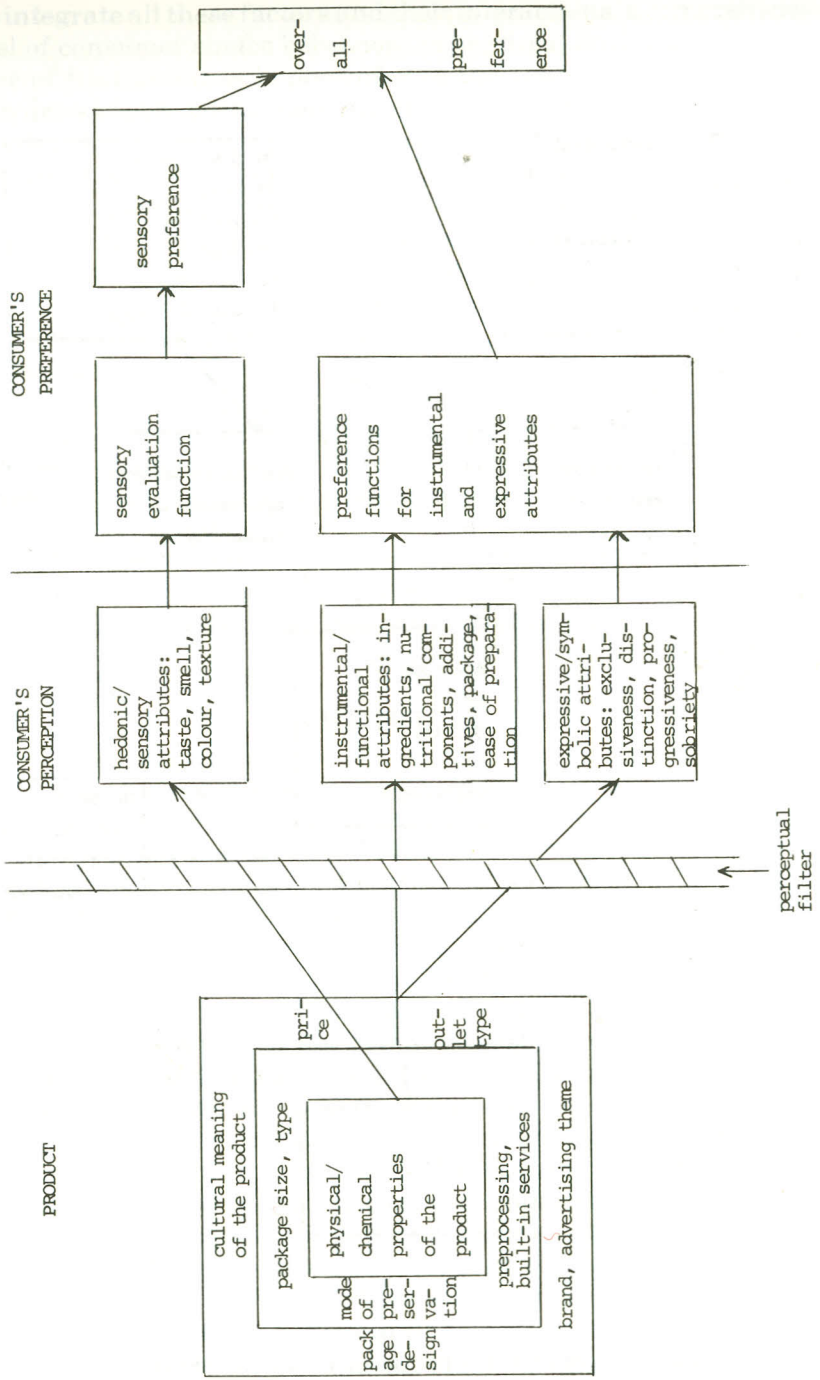


FIG. 2. FORMATION OF PERCEPTIONS AND PREFERENCES WITH RESPECT TO FOOD PRODUCTS

information-search process at the moment of the purchase. (This is not the case when a more expensive product, for example an automobile, is being purchased.)

Usually the consumer will base his decision on the information about products that is currently stored in his memory. As Fig. 1 indicates, this information is acquired from experiences with the product in the past, advertisements seen, communication with other consumers, etc. For a comprehensive study of consumer information processing with respect to food products, see Rudell (1979).

For an important part, consumer choice of food products is of the routinized response behaviour type (Howard, 1977). Only occasionally, e.g. with the introduction of a new product or brand, or new packaging for an established brand, will the consumer become involved in some information-acquiring activity at the moment of purchase. So here we assume that the product perceptions have been formed already.

The treatment in this paper concentrates on the Alternative Evaluation stage (3) (the area within the dotted lines of Fig. 1).

Here we have three important elements.

(a) Perceptions of products/beliefs about products. This refers to the way products are "seen" by consumers, e.g. whether or not a product is considered as nutritious, high in fat-contents, tasty, safe, modern, exclusive, status-enhancing, etc. Since consumers often have imperfect information, perceptions of products may well differ from objective reality. (For example, Dutch consumers wrongly perceive butter as containing more fat than margarine.)

As already mentioned, perceptions are formed by information and experience. However, as the second arrow to box (a) in Fig. 1 indicates, the formation of perceptions may also be affected by psychological factors, such as needs and motives (Simon, 1967) and by socio-cultural elements. Certain food products may be perceived as inferior in one culture, but as a luxury in another culture.

(b) Preference weights indicating the importances of the different evaluative criteria in the determination of preferences. The evaluative criteria or attributes of choice are the dimensions of the product that play a role in the formation of preferences. Evaluative criteria may include: taste, nutritional value, price, and ease of preparation. However a certain product is perceived in terms of these attributes, a consumer may assess these attributes differently when forming his preferences. For example, a consumer may attach great importance to taste and nutritional value, but find price and ease of preparation less important. This is reflected by different weighting factors in his prefer-

ence or utility function. Usually, different persons have different preference weights. These weights, as Fig. 1 indicates, are related to motives, needs, personality factors, culture, social class, reference groups (family), etc.

(c) Attitude or utility. The way the product is perceived in terms of the various attributes on the one hand and the preference or utility weights on the other hand together determine the consumer's overall attitude to or utility for that product.

For example, the consumer's overall attitude to a product or choice alternatives can be determined with the Fishbein-Rosenberg model (Engel et al., 1982):

$$A_b = \sum_{i=1}^{n} w_i B_{ib}$$

where A_b = attitude toward alternative b
w_i = weight or importance of evaluative criterion i
B_{ib} = belief with respect to the ability of alternative b to satisfy evaluative criterion 1, i.e. score of alternative b in terms of attribute i
n = number of salient attributes

Subsequent Stages in the Decision Process

The next stage in the choice process after alternative evaluation is the Choice (4). Of course, normally one would expect a consumer to buy the alternatives he perfers the most (most favorable attitude). However, there may be a discrepancy between preference and choice. For example, he simply may not have enough income to purchase the most preferred alternative, he may not have the equipment necessary to prepare the product, the shop in which the purchase is made may not have the most preferred product in stock, etc. After an alternative has been chosen, it is consumed, which results in a certain Outcome (5). The product may or may not live up to expectations. The experience constitutes a feedback-loop in Fig. 1. According to the outcome of the process, the information and experience is updated, which may change the perceptions of the alternative choices and may affect the preferences and actual choice at the next purchasing occasion.

After this more or less general description of the choice process, I shall now elaborate on the nature of perceptions and preferences in the case of food products.

The attributes of a food product that play a role in the determination of preferences and choice can be categorized into three classes:

(i) Hedonic attributes. These attributes are related to feelings of joy, pleasure and delight in consuming the product. Hedonic attributes refer to aspects such as taste, smell, flavor, i.e. the sensory aspects of a product. Delicious food scores very favorably on hedonic attributes.

(ii) Instrumental or functional attributes. Apart from the joy of consumption, food products have to perform certain very important functions for the consumer. Food products are the inputs to the physiological processes, produce energy and help to build and maintain the various cells and organs of the body. Attributes such as ingredients, contents of specific nutritional components (e.g., carbohydrates, proteins, vitamins), types of components, presence/absence of additives can be classified as instrumental or functional. Use-related aspects of products, e.g. package size, ease of preparation, method of preservation, baking quality of flour, spreading quality of butter, can also be classified as instrumental attributes.

(iii) Expressive or symbolic attributes. The consumption of a food product may also have symbolic connotations, for example, a consumer may express status, exclusiveness, distinction, "savoir vivre", progessiveness, thrift, sobriety or modesty in consuming specific food items. These symbolic aspects may be important to the consumer himself (trying to buy products that are in agreement with his "self-concept") or may be meant to convey something about the consumer to persons in his social environment (conspicuous consumption).

These symbolic functions of a product may be rather removed from the physical product itself. For these symbolic functions the meaning of a product in a specific culture, subculture or social class is important; the way consumers talk about the product and the way the product is communicated in advertisements and package designs. Sometimes also the price of the product and the outlets where the product is available contribute to the expressive values of a product.

Fig. 2 shows how the different types of attributes are related to product characteristics. For this purpose the product is depicted in three layers.

The hedonic/sensory characteristics are a function of the innermost layer: the physical and chemical properties of the product.

The instrumental/functional attributes refer to an extended product concept: the physical/chemical properties and aspects such as type of processing, package size and type and other aspects that determine the in-use properties of the product.

The expressive/symbolic attributes refer to the most extended product concept, including brand name, advertising, package design,

price, etc.

Consumer choice is not only determined by the objective product attributes as such, but also by the way these attributes are perceived by consumers. Therefore in Fig. 2 a "perceptual filter" is shown, indicating that in the perception process stimuli may be lost or stored in the consumer memory in a biased way. False properties may be attributed to products.

The attribute perceptions are, so to speak, the inputs to the process of preference formation. Through the preference or utility function of the consumer (of which equation (1) is a very simple version) the attribute perceptions are converted into attitude or utility ratings. In Fig. 2, separate preference functions have been introduced for sensory attributes and for instrumental and expressive attributes.

METHODOLOGY FOR MEASUREMENT AND ANALYSIS, AND EXAMPLES OF APPLICATION

When, starting from the framework of Fig. 2, we wish to explain how a consumer makes a choice within a specific product class, the following questions are relevant.

(i) What are the dimensions or attributes: hedonic, instrumental and expressive, that are important in consumers' perceptual judgments about the product? In other words: which attributes do consumers use to distinguish between the alternative choices in a specific product class.

(ii) How do the various alternative choices load (score) on these perceptual dimensions? How do the consumers "see" these alternatives?"

(iii) How do the consumers weigh (trade off) the product dimensions against each other when arriving at their overall preferences? For example, one alternative may be very tasty but not so good for the health, another alternative may have a less pleasant taste but better health connotations. How does the consumer trade off these dimensions? This question refers to the preference or utility function.

This section deals with measurement and analysis methods that can be used to answer these questions.

Let us first consider perceptions: questions (i) and (ii) above.

In principle, a great many attributes can play a role in the formation

of perceptions. It is not difficult to list 20 attributes that are potentially important for the choice of a given food product. However, as mentioned earlier, human capacity for storing and processing information is limited and in practice much fewer attributes really play a role. It is important then to be able to determine the nature of these attributes and the loadings of the different alternative choices on these attributes. Generally speaking, we need methods directed at finding the underlying factors behind a possibly complex response pattern. This leads immediately to dimension-reducing techniques such as principal component analysis, factor analysis, discriminant analysis and multidimensional scaling. Let us see how these techniques can be applied in the context of this perception analysis.

Sensory Perception

Here the purpose is to determine the "sensory profile" of the choice alternatives: the underlying dimensions of the sensation with respect to appearance, smell and taste of the product. A possible procedure is to start with a relatively large number of attributes or sensory parameters and have members of a trained panel rate a number of different formulations of the food product on these attributes. Afterwards the correlations between these attribute ratings are computed and the underlying dimensions are found by means of principal component or factor analysis.

Here it is important for the test persons to react to the physical product as such and for the results to be unaffected by brand name, package design, price, etc. Therefore all these cues should be removed from the products to be tested.

Using this procedure, Horsfield and Taylor (1976) found that there are 3 more or less independent dimensions on which meat or meaty products are judged by consumers: toughness, succulence and flavour. Together these three factors explained 96% of the variance in an original set of 11 attributes. Frijters (1976) applying a similar approach, found that the basic sensory dimensions in cooked chicken breast meat are: cohesiveness, dryness and fattiness.

Three aspects of these sensory measurements are important. In the first place, the test persons should, if at all possible, really see, smell and taste the products.

Hughes (1976), also in a study about meat, asked consumers to rate specific meat cuts, such as lamb chops, stewing steak, pork chops on a number of scales, such as tastiness, tenderness, flavour, juiciness and leanness. Here the respondents did not actually taste products, but had to base their answers on the information about the different products

stored in their memories. The problem is then that the respondents may use different reference products in their answers. Some may think of first quality lamb chops, others of chops of a very low quality. Also in this way sensory judgments may easily be contaminated with aspects such as price, quality perceptions of outlets, etc.

A second aspect of this type of measurement is the desirability of having a trained panel of test persons. It is important that the panelist attach the same meaning to the different points of a specific attribute scale. For this purpose, training sessions are held where the test persons give ratings to a number of test products and discuss the ratings given among each other, paying special attention to large discrepancies. In this way it is possible to develop a panel that is able to give scores to new products (not used during the training) with some degree of unanimity.

Finally, care should be taken that only perceptual and not evaluative questions are asked. The respondents should say how much or how little of a certain attribute a specific product contains, not how he appreciates that level (e.g. how near this is to his ideal point). If perceptual and evaluative aspects are mixed, the results are difficult to interpret. For example Hughes, in the study mentioned earlier, uses attributes such as "good flavour", "tasty" (evaluative) as well as "juicy" and "tender" (perceptual/descriptive).

After the determination of the basic perceptual dimensions, the preference functions of these dimensions (the sensory evaluation functions) can be estimated. But here we reach the stage of preference analysis. Now the respondents should be a representative sample of real consumers. It should be known where the preferences of the real consumers lie. The preferences of a possibly heavily biased group of trained test persons are not so interesting.

Horsfield & Taylor (1976) followed this approach. After they had determined the basic sensory dimensions using a trained panel of testers, they recruited 390 housewives and asked them acceptability (or preference) scores for products whose sensory profiles were known. This enabled them to estimate sensory evaluation functions and obtain indications of promising new products.

Perception with Respect to Instrumental and Expressive Attributes

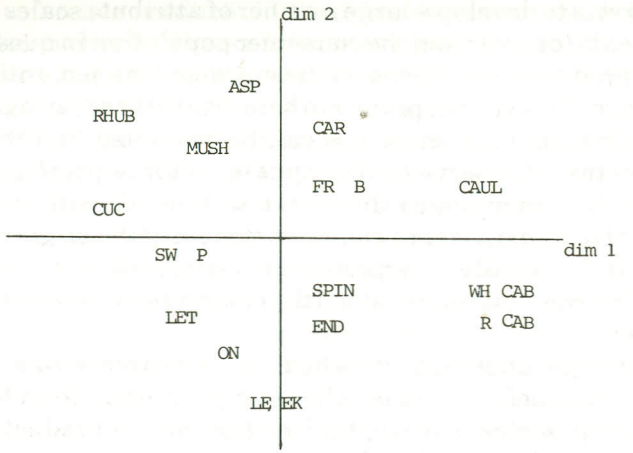
Here again the purpose is to reduce the large number of potentially important attributes to a limited number of underlying perceptual dimensions. Now we want to have the respondents' reaction to the complete product, including package type and design, way of processing, brand, price, etc. Broadly speaking there are two approaches to find these underlying perceptual dimensions.

The first is to develop a large number of attribute scales and have the respondents (drawn from the consumer population in question) rate the various product alternatives on these scales. The semantic differential scale (Osgood) is very appropriate here. From these ratings, the correlation coefficients between scales can be computed and the correlation matrix in turn can serve as the input to factor or principal component analysis. It is then hoped that these techniques will produce a small number of dimensions that summarize most of the original ratings and which can be readily interpreted. Discriminant analysis can also be used to find the basic dimensions that distinguish between the different products.

This type of approach, in which the researcher has to define the various scales beforehand is called compositional: from the ratings on the different scales a perceptual picture of the product is composed (Wierenga, 1980 (b), pp. 279-280).

The second approach which is called decompositional, takes the opposite starting point. Here we start with the total perception of the product and try to decompose it into its basic components. This is the procedure followed in multi-dimensional scaling. An advantage of this approach is that no perceptual attributes have to be specified beforehand (with the risk of overlooking important attributes). On the other hand it is not always easy to interpret the dimensions resulting from multidimensional scaling. Often this interpretation can be made easier by using ratings on specific attributes. So a mixture of a decompositional and a compositional approach offers the best prospects. This approach will be illustrated here with some results about consumers' perceptions of vegetables in the Netherlands, based on a sample of 150 housewives.

According to the requirements of multidimensional scaling, first similarity data were collected. A similarity number for a specific pair of vegetables indicates how similar these two vegetables are in the eyes of the respondents. In multidimensional scaling these similarity data are then used to construct a perceptual configuration: a spatial structure of points (each point denoting a specific vegetable), which reflects the similarity information as well as possible. This means that in this configuration, similar vegetables will be close to each other, and vegetables that are not seen as very similar will lie further apart from each other. More specifics about multidimensional scaling can be found in Green and Carmone (1970), Kruskal and Wish (1978), Wierenga (1980a and 1980b). In the vegetable study, 15 different vegetables were used. It turned out that a good solution could be obtained in three dimensions. Fig. 3 gives the resulting perceptual configuration, projected into the 1-2



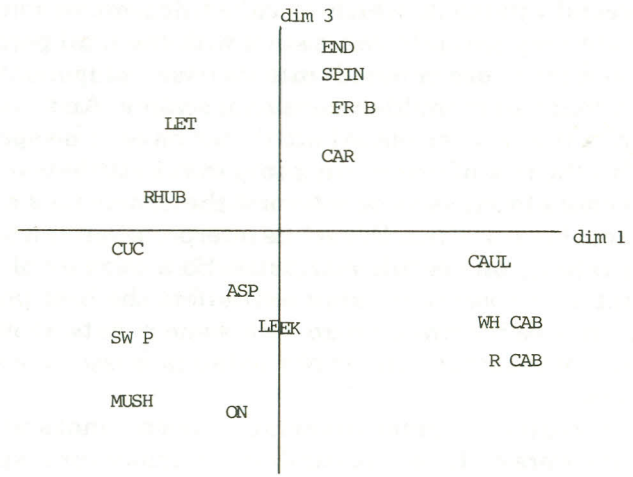


FIG. 3. PERCEPTUAL CONFIGURATION OF VEGETABLES; PROJECTIONS IN 1-2 AND 1-3 PLANE RESPECTIVELY

KEY:

ASP	=	asparagus	MUSH	=	mushroom
CAR	=	carrots	ON	=	onions
CAUL	=	cauliflower	R CAB	=	red cabbage
CUC	=	cucumber	RHUB	=	rhubarb*
END	=	endive	SPIN	=	spinach
FR B	=	French beans	SW P	=	sweet pepper
LEEK	=	leek	WH C	=	white cabbage
LET	=	lettuce			

*In the Netherlands, rhubarb is used as a vegetable

and 1-3 planes respectively. For the interpretation of the dimensions let us consider the correlations of the coordinate scores with ratings on attribute scales. Dimension 1 is highly positively correlated with "real vegetable" (r = 0.73), "for people with heavy work" (r = 0.80), "carbohydrates" (r = 0.93), and negatively correlated with "for a side-dish" (r = -0.85). So evidently the scores on dimension 1 indicate how much (in the eyes of consumers) a vegetable is a producer of energy. Dimension 2 has strong correlations with "expensive" (r = 0.62), "festive meal" (r = 0.67) and "for people with high incomes" (r = 0.62). Therefore we call dimension 2 the distinction dimension. Dimension 3 has high correlations with "iron" (r = 0.74), "vitamin A" (r = 0.76) and "vitamin C" (r = 0.76). This dimension can be called micro-component dimension.

Thus it turns out that the perception of vegetables is composed of three major dimensions: the extent to which a vegetable is a producer of energy, the extent to which a vegetable delivers micro-components and the extent to which a vegetable has connotations of distinction. The first two dimensions can be classified as instrumental; distinction clearly is an expressive dimension. Further research showed that, the energy dimension was related to the extent to which a vegetable is considered as a main vegetable (not intended to serve only as a salad or garnish). The distinction dimension is related to the day of the week the vegetable is consumed. Vegetables with a high rating on the distinction dimension are predominantly eaten at the weekend, especially on Sunday.

It has already been mentioned that product perceptions may well be at variance with objective reality. This is demonstrated clearly in this vegetable research. When we look at the correlation coefficients between perceived and actual contents for a number of nutritional components we find the following results:

iron	0.82
vitamin A	0.83
vitamin C	-0.03
carbohydrates	0.22
proteins	0.70

So for the components vitamin C and carbohydrates there is vitually no relationship between perceived and actual values. Probably this is a consequence of the limited capacity of information storage by consumers. There is a tendency in human information-processing to "chunk" information, i.e. to simplify the processing and storing of information by storing information about similar stimuli in the same chunk, Miller (1956). This seems to have happened here with micro-components iron and vitamins A and C. For example the correlation between perceived

contents of vitamin A and vitamin C is 0.88, whereas the correlation between the actual contents of these components is -0.27. In the same way the correlation between vitamin C and iron contents is 0.82 (perceived) and -0.43 (actual). This explains the poor results for vitamin C mentioned above. Apparently the information about the different micro-components is stored together and consumers simply think that a vegetable with a high rating on one micro-component is also relatively good on the others.

Preference Measurement and Analysis

The parameters of consumer preference functions can be estimated from preference judgments for different choice alternatives, whose ratings on the perceptual dimensions are known.

Sometimes a sensory preference function is estimated separately, as was the case in the research done by Horsfield and Taylor, referred to already. They regressed consumer acceptability scores on the ratings on the three sensory dimensions: toughness, succulence and flavour. They did not only try a linear specification like equation (1), but also a quadratic one, which implies an ideal-point preference model. (For a taxonomy of preference models, see Wierenga, 1980 (b), p. 271-276.)

Although their estimated preference function had a reasonable predictive power, there are two important limitations in the approach taken by Horsfield and Taylor. In the first place they estimated a preference function at the aggregate level. However, preferences tend to vary between consumers and an aggregate preference function has a very restricted meaning. A much more realistic approach is to estimate individual preference parameters and then to consider the distribution of these parameters over the parameter space. (For example the locations of ideal points or the directions of individual preference vectors.)

There are good algorithms available to estimate these preference parameters for individual respondents, e.g. PREFMAP (Caroll, 1972) and LINMAP (Srinivasan and Shocker, 1973).

A second limitation in Horsfield and Taylor's approach is the restriction to sensory attributes. But, as Fig. 2 indicates, sensory preference is only one (albeit very important) component of overall preference. Other product attributes: instrumental and expressive, related to packaging, price, brand, etc. may have a dominant influence on consumer choice behaviour. Maybe a consumer will not buy the most tasty product, but a product from a trusted brand or with attractive packaging.

Ultimately the preference function should incorporate all these different dimensions that affect consumer choice.

For the vegetable data, preference functions were estimated at the

individual level. These were based on pairwise preference judgments which the respondents had given for all pairs of vegetables in the study. The dimensions included in the preference functions were the three perceptual dimensions discussed above: distinction, energy and micro-components and a fourth variable: taste. The respondents had indicated for each vegetable whether or not they like the taste of that vegetable. This variable, taste, can be conceived of as a direct measure of sensory preference according to Fig. 2. (We did not determine the sensory perceptions of vegetables, neither was a sensory evaluation function estimated.)

The estimated preference functions are rather different for different respondents. As an illustration, for 3 different respondents the estimated preference functions are given below. Here:

p = preference value
d = score of the vegetable on distinction
e = score of the vegetable on energy
m = score of the vegetable on micro-components
t = score of the vegetable on taste

Consumer 1: $p = 0.55d - 0.60(e - 1.18)^2 + 0.51m + 0.33t$
Consumer 2: $p = -0.27(d - 1.64)^2 - 0.24(e - 1.13)^2 + 0.94m + 0.90t$
Consumer 3: $p = -0.17(d - 1.59)^2 - 0.60(e - 0.81)^2 + 0.68m + 0.55t$

We see that consumer 1 gives a weight of 0.55 to distinction, 0.51 to micro-components and 0.33 to taste. For energy his preference function is of the ideal-point type. Here preference increases with increasing energy until $e = 1.18$, but at energy levels beyond this point the preference decreases with further increasing energy scores. Consumer 2 puts a high weight on taste (0.90) and in addition to energy also has an ideal-point model for distinction. (A vegetable can also be too festive or expensive). This is also true for consumer 3, whose preference function, although of the same mathematical form, has quite different parameter values compared with consumer 2.

All in all, we were quite successful in estimating these preference function for vegetables. Over all 150 respondents the correlation coefficient (root-mean-square) between original preference order and preference order reproduced by the model was 0.82. Once the preference functions are estimated, these can be used to predict the effects of changes in product perceptions (i.e. other scores on distinction, energy, micro-components) on preferences and to predict the preferences for new products: new combinations of the attributes.

CONCLUDING REMARKS

Looking back at Fig. 2, what have we attained so far and which further steps should be taken?

With the approach described here we can analyse how consumers perceive products and how these product perceptions influence preferences. This can provide important insights that can be used for decisions about what and how to communicate about food products when the purpose is to change buying and eating habits. Also this can give cues about which combinations of attributes should be chosen for new products when the objective is to offer products that will meet a high degree of acceptance from consumers.

However, this analysis of perceptions and preferences clearly falls short of completely explaining how consumers choose food products.

Interesting relationships not discussed here are: (i) the link between the left part of Fig. 2 (the products at the different levels) and product perceptions. What is the relationship between physical product properties and sensory attribute scores? How does the presence of additives affect perceptions? How can advertising and nutrition education communication change the image of a product? (ii) the relationship between socio-psychological variables and product perceptions and preferences (Fig. 1); (iii) the relationship between preference (attitude) and actual choice.

For some of these relationships, interesting models and empirical results can be found in the literature. These elements should be integrated with the measurement and analysis procedures discussed so far. Further elements to be considered in more extended models for the explanation of food choice behavior are the phenomenon of buying combinations of products (so far we have concentrated on the purpose of one item from a product class) and to the effect of group influences (other family members) on consumer behavior.

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