Applied Studies

The Eating Disorders
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Chapter 8

Descriptive and Operational Study of Eating in Humans

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INTRODUCTION

The most fundamental research on feeding is directed toward mechanisms responsible for the initiation, maintenance, and termination of eating. This enterprise can be partitioned into investigations of the control of caloric intake, selection of foods and nutrients, and the distribution of eating episodes. This body of research helps to provide explanations for disordered eating, whether represented by overingestion or underingestion of calories, aberrant preferences and selection of food, or abnormal sizes or patterns of eating episodes. In turn, investigations of mechanisms and causes of eating disorders depend on the accurate and reliable monitoring of the target behavior, namely, eating.

A number of methods are available for the measurement of this activity. However, eating cannot be properly represented simply as a block of behavior detached from the sensations and feelings evoked by food or the responses that accompany ingestion. Eating is certainly an act of behavior, but it achieves meaning because it is embedded in a context of mental events and physiological happenings.

Eating can perhaps be viewed most profitably as a part of a broader bio-psychological system [1,2]. For this reason the descriptive and operational study of eating should include ways of assessing the accompanying attitudes, feelings, sensations, experiences, motivations, and cognitions together with certain physiological responses. This chapter provides an inventory of techniques and procedures used to research and analyze normal and disordered eating. The review is accompanied by critical comment on the nature of the research devices and on certain of the mechanisms that they have revealed. This assembly of procedures represents the basic instruments for the experimental study of eating in humans in the laboratory, clinic, or natural environment.

THE STRUCTURE OF EATING BEHAVIOR

Clinicians and researchers frequently need to know not only the total amount of food ingested (grams, calories, joules) by clients or subjects, but also the temporal distribution of eating. This forces an assessment of the structure of eating behavior. In turn, this can be carried out at the macro or micro level of analysis (or at certain intermediate stages).

On one hand, eating can be viewed as an activity distributed over very long periods of time, the study of which can reveal large- scale patterns or trends. On the other hand, a fine-grain analysis reveals how tiny individual acts are assembled in a nonarbitrary fashion into the complex behavioral sequence that constitutes the familiar act of eating. Indeed, eating is such a commonplace act that it is easy to overlook the fact that it represents a well-organised sequence of individual movements.

It is clear that investigation of mechanisms responsible for eating requires the analysis of micro-events as well as the study of large-scale, long-term trends in consumption. Consequently, the structure of eating involves monitoring consumption over months and sometimes years as well as the recording of events occurring within a single meal.

Naturally, different types of procedures are required for these distinctive tasks. The principle division is between direct and indirect techniques. Direct measurement of behavioral events is possible over short intervals of time, while long-term assessment usually depends on indirect recording of food intake. One other distinction is between monitoring in a free natural environment with attendant problems of control and precision and measuring in artificial laboratory or clinic situations where accuracy is clearly easier to achieve. The particular limitations of data collected under these different circumstances presents researchers with the dilemma of assigning importance to either the (relatively) inaccurate recording under natural circumstances or the (very) accurate recording in unnatural situations. This review deals with both sets of conditions.

The Dietary Study of Individuals

Many of the methods for surveying individual and group dietary practices are long established and have been extensively detailed and reviewed elsewhere [3-6]. The methods described in this chapter refer only to the food intake of the individual and should be distinguished from those designed to give more general information about populations, institutions, or families. The information they provide is particularly useful when complementing data from other techniques.

Individual dietary studies fall into two basic categories:

1. *Recording present intake.* This may be done in two ways. Subjects may maintain detailed diary records of all food eaten, describing the quantities in terms of household measurements or by estimation. Alternatively, all the ingredients used in the preparation of the food when cooked may be precisely weighed, together with an wastage at the end of the meal. Obviously, while the latter is the more precise method, it requires a great deal of effort on behalf of the participant and frequent supervision by the researcher. Both methods also suffer from the handicap of constantly drawing attention to the process of selection and consumption of the food. Procedures involving a high level of self-monitoring may therefore impose their own influence on the behavior under study and alter subjects' normal eating habits. This occurs with obese individuals [7] and may also influence the extreme patterns characteristic of anorexia nervosa and bulimia nervosa.
2. *Recording past intake.* The techniques used to aid the subject to remember and describe their previous intake differ largely in the duration of the recall period. The most common procedure elicits an inventory of the food eaten over the previous 24 hours, either by asking subjects to note the foods on a checklist or by detailing the meals together with estimated amounts of food. This recall maybe extended over a period of three days or up to a week. Alternatively, an estimate of the subjects' "usual dietary intake" or "diet history" maybe obtained by cross-checking the 24-hour recall in an interview where questions relating to purchasing, likes and dislikes, and food uses supplement the recall data. The subsequent direct recording of food intake for a short period or use of multiple 24-hour records may be used as additional cross-checks.

Generally, recall techniques are quick and inexpensive and do not require specialist supervision. Their cost-effectiveness, however, may vary according to the required accuracy of the study. Many more 24-hours records are needed to establish accurately protein or fat intake than to describe energy intake [8]. Dietary recall is also liable to the "flat slop syndrome"—a tendency to overreport low levels and underreport high levels of consumption, a consideration particularly important in cases of disordered eating.

Finally, mention should be made of the uses of tables of food composition. These texts are frequently used to convert dietary data into caloric or nutritional composition, and there is some controversy about the accuracy of this procedure [3,4]. Paul and Southgate [9] say of their own revision of McCance and Widdowson's The Composition of Foods, the values are of "representative samples" of the foods and as such may reflect the "average composition of the food." Isolated samples may therefore be of a quite different composition. Data from large groups of people should have intrinsic accuracy, but in studies of individuals, accuracy may be improved by extending the period of study and thereby increasing the size of the food sample consumed.

Obervational Studies

Many studies on human eating use as the dependent variable some portion of the act of consumption or a particular sample that reflects the quantity of food eaten. However, one apparently uncomplicated procedure for describing eating behavior is to observe and subsequently classify the entire sequence of behavior. This strategy is commonly used by ethologists [10] for the study of animal behavior, but has been extended for use in humans—particularly children [11]—and provides both a qualitative and quantitative account of the expressed behavior. In principle, because behavior is recorded in its totality, the strategy used should be a powerful tool for describing feeding in man.

Behavior may be monitored in naturalistic settings (cafes, restaurants, refectories, or homes) or in the laboratory under controlled conditions. Analysis can be done on "live" behavior or carried out from video recordings. In general, the observational method frequently makes use of some form of sampling. Event sampling requires that every occurrence of a specified event during the course of the observational period is recorded. Time sampling means that whatever event is occurring at specified (brief) intervals during the observational period is monitored. For eating behavior, which normally spans a relatively short period of time (usually a meal), a number of significant events (taking a bite, pausing, swallowing, etc.) are continuously recorded by an observer. It is necessary to check the accuracy of the ratings of this observer by comparing them (coefficient of concordance) with an independent observer rating the same sequence. This is a necesssary requirement, since even events such as taking a bite of food, which can be defined fairly unambiguously, may be recorded differently by two independent observers. This is particularly important when the onset and termination of an event is recorded as well as the overall frequency of events. Consequently, although the observational method is apparently uncomplicated, its interpretation is hindered by a number of methodological pitfalls and its use must be governed by clear methodological principles.

In studies of eating behavior the main variables extracted from the behavior sequence are listed below:

1. Meal duration
2. Total number of mouthfuls (or bites)
3. Average mouthful size
4. Duration of each mouthful
5. Number of chews per mouthful
6. Mouthfuls per meal
7. Chews per meal
8. Mouthfuls per minute
9. Amount per minute
10. Number of noneating episodes during the meal
11. Intermouthful interval

Certain of these variables refer to the frequency of specific events (eg, taking a mouthful of food), whereas others refer to the rate of expression of behavior. Alterations in these variables have been used in attempts to detect differences between particular groups of individuals, eg, obese and normal weight [12], between foods varying in preference value [13], between drugs with different neurochemical profiles [14], and to assess the development of satiation during the course of a meal [15,16].

Studies using observational methods have been the subject of two critical reviews [17,18]. Over the years the main theoretical focus of attention has been the attempt to use the observational procedure to define an obese eating style. No general agreement has been reached on this issue—probably due as much to difficulties in defining obese and normal as to problems associated with descriptions of style. Used carefully, observational procedures can be sensitive research devices. Owing to the considerable variability in qualitative eating profiles between individuals, the procedures function best in within- group rather than between-group research designs.

Techniques Using Specialized Apparatus

During the last 20 years a number of specialized devices have been developed or adapted to improve the sensitivity, accuracy, or reliability of measuring food consumption. Most provide continuous monitoring of intake. Some are designed for liquid rather than solid food, and others allow a degree of food choice. Some demand a somewhat unnatural eating response, while others attempt to allow unhindered eating to take place. No device is perfect; they all have strengths and weaknesses.

1. *Liquid food reservoirs and pumps.* Automated devices for continuous monitoring of the food intake of animals have been used in experiments for more than 40 years. The first of this type of monitoring apparatus for humans appears to have occurred about 20 years ago [19]. The device was used to facilitate feeding of a patient with carcinoma of the lip. Flexible tubing connected a mouthpiece to a reservoir containing a liquid diet, with a valve and pump inserted into the circuit. When the patient depressed a button, the pump was activated and a fixed amount of the diet (7.4 ml) was delivered through the mouthpiece. Every activation of the pump was recorded and the time of the event was automatically printed to provide a continuous record of liquid intake. The patient used the device coninuously for 17 days, taking in 2,000 to 3,500 kcals per day, usually in three or four distinct meals. This study demonstrated that drinking liquid provided a pattern of intake suitable for investigations of mechanisms contolling food consumption.

More recently a number of studies have been carried out using variations of the reservoir-type of apparatus in which liquid food is either sucked [20] or pumped at a steady rate during the depression of a button [21]. The technique has been used to investigate the effectiveness of oral and intragastric feeding on intake [21,22], the effects of preloads [23] and caloric dilution [24] on meal size, the hyperphagic and hypophagic responses to stress in normal and obese subjects [25], the onset of biological satiation [26], and the effect of drugs on voluntary intake [27]. The technique certainly provides an objective method for studying certain parameters of ingestion, but the dependence of the procedure on liquid food with consequent restriction of variety of taste and texture obviously limits the extent to which results can be generalized to more natural eating circumstances and situations. In summary, the technique scores high for internal validity, but somewhat lower for external validity.

2. *Automatic monitoring via eating utensils (BITE).* The major disadvantage of the reservoir system—limiting the variety of foods that can be monitored—is directly confronted by the development of a device for continuous monitoring of the consumption of solid and semisolid foods. The technique is based on recognition that human eating is composed of a sequence of contacts between the mouth and the eating utensil and that the number of contacts is proportional to the amount consumed. Therefore, by continuously monitoring these contacts it becomes possible to track the temporal course of food consumption.

The system operates through specially constructed spoons and forks [28] with handles that contain miniaturized telemetering equipment. Each portion of food placed in the mouth with the utensil makes a contact that permits a current to flow through the circuit. The passage of current constitutes a signal that is telemetered to recording equipment by a battery-powered transmitter within the utensil. Consequently, the technique is not encumbered by wires. The device is known as a Bite-Indicating Telemetering Eatometer, or BITE. Studies with a nontelemetering prototype of BITE have shown that the device provides good records of two parameters: the number of bites and the interbite interval. In fact, since the test food used was a semisolid yogurt, the bite actually refers to a spoonful of yogurt. The data indicated large individual differences in the interbite internal (pauses between mouthfuls) and that in most subjects interbite intervals were larger in the last quarter of the meal than the first, which in turn, means that subjects tended to slow the rate of ingestion during the consumption of this yogurt.

Studies on the most sophistocated version of this bite, or mouthful-measuring, technique have not yet been published. Moreover, it remains to be shown that the device can provide an accurate record of the eating of semisolid foods with a fork similar to the way in which it monitors the consumption of a thick liquid (yogurt) with a spoon. In addition, the value of the technique will be lessened if it is discovered that mouthfuls or bites (mouth-utensil contacts) vary in size during the course of a meal. It is also not yet clear if bite or interbite intervals give a valid response to changes in palatability of food, motivation to eat, or the operation of satiation mechanisms. At the moment, the full potential of this system is unknown, but it could prove useful in certain clinical settings or, as seems more likely, in studies on the consumption of new products manufactured by food companies.

3. *Monitoring of intake via the plate.* In attempting to measure intrameal events by analyzing the structure of eating behavior (eg, mouthfuls and intervals) the BITE procedure sacrifices the requirement to monitor changes in the actual weight of food being eaten. Another technique adopts the alternative approach—that is, accurate measurement of alterations in the weight of food being eaten while ignoring the physical elements of eating behavior. This is achieved by the continuous weighing of the subject's plate (or other vessel) with a concealed electronic balance on which the plate rest. The device is called the Universal Eating Monitor (UEM), and it can be used with either solid food on plates or liquid foods such as soups in dishes.

This technique should combine the accurate monitoring of intake found with the reservoir method with the advantage of being able to cope with normal solid foods. Therefore, in the first description and test of the procedure, a comparison was made between foods cut up into pieces and placed on a plate and the same foods liquified in a blender and served in a bowl [29]. The test foods were yogurt, apples, bananas, tofu (bean curd), and soy nuts. For the solid, chewable version of the meal the fruit and tofu were cut into small disks and mixed with the yogurt and soy bean (powder form). For the liquid meal all the elements were blended together in stages.

The foods were served on a plate or bowl placed on a panel set into a table and covered by a cloth. Beneath the panel was an electronic weighing instrument that was connected to a digital computer. Readings of the weight of the plate were made and stored every three seconds during the course of the meal and for some time afterward. From these readings a cumulative intake curve (weight of food removed from plate over time) was plotted. This curve is the major parameter of eating provided by this technique.

For the initial investigation with the technique, intake of the two types of foods was measured following either three or six hours of food deprivation. Results indicated that total amount consumed did not vary with the length of deprivation, nor did it depend on the consistency of the food. However, differences were apparent in the rate of ingestion. The liquified food was eaten faster (108 g/min) than the solid food (71 g/min). Differences were also apparent in the initial rate of consumption and in the rate of deceleration. The initial rate was higher for the liquified food (148.7 g/min) than for the solid food (95.6 g/min), and the rate of deceleration was greater (8.6 g/min compared with 1.9 g/min). Accordingly, the negatively accelerated intake curve, regarded by some as an indicator of biological satiation [26], was displayed only with the liquified version of the food.

The pilot study with the technique illustrated that it could accurately and precisely track intake of both liquid and solid food. Moreover, the subtle differences in the cumulative intake curves for the two diets indicated that the device is sensitive to at least some of the factors influencing overall food consumption.

More recently the device has been used to evaluate the effect of the gut hormone cholecystokinin (CCK-8) on eating [30]. It was found that CCK-8 significantly reduced the total amount of food consumed (average decrease 125.5 g) and shortened the duration of the meal by 2.6 minutes. Although the food used in this study was a liquified blend of yogurt and fruit, the cumulative intake curve did not reveal any effect of CCK-8 on either the rate of ingestion or on the shape of the curve. Consequently, CCK-8 shortened this somewhat artificial meal without changing the rate of eating.

This alteration in amount consumed and duration of the meal show that the technique can be usefully employed and may be particularly valuable in investigating the effects of potential anorexic substances. The accurate readout of adjustments in the weight of liquid consumed is similar to that which could be obtained with the reservoir method: The great advantage of this technique, however, is that the food can be eaten normally from a bowl instead of being sucked or pumped through a pipe. In addition, the continuous tracking of intake by the computer gives the cumulative curve a sensitivity to certain factors influencing different processes underlying consumption.

4. *Food dispensing machines.* Many of the techniques now used to study human eating derived from strategies used to monitor feeding patterns in animals. The use of pellet dispensers and eatometers have been instrumental in understanding the effects of pharmacological manipulations on feeding behavior in animals [31]. This principle has subsequently been taken up for the study of the effect of anorectic drugs on food intake in humans [32,33].

The solid-food dispenser is basically a commerical food vending machine modified to provide small food units (quarter sandwiches) with weight, nutrient content, and calorific value that are accurately controlled. The removal of each food unit from the dispenser can be monitored, and consequently, a cumulative record can be obtained of the subject's behavior (feeding profile) and the weight of food consumed (calorie intake).

Some advantages of this device are that it uses common solid foods that are likely to be regularly consumed, and the act of eating does not have to be specially modified. The resolving power of the device—or its capacity to detect subtle or small adjustments in intake—is obviously restricted by the size of the individual food units. Consequently, the sensitivity to mild intrameal influences is much lower than in the UEM and in comparable animal eatometers in which the individual units are tiny (45 mg) pellets. However, the solid food dispenser can detect alterations in eating profiles induced by drugs with anoretic properties and can be used to compare temporal patterns of hunger ratings and food intake [34].

One further major advantage of this type of device is that it can be used to monitor not only food intake but also food selection. By stocking the machine with items varying in macro-nutrient composition, it becomes possible to measure protein and carbohydrate intakes separately and also to assess a subject's preference for particular nutrients or tastes. This strategy has been used to evaluate the effect of serotonin manipulations on nutrient selection in normal subjects [35] and to measure the suppression of carbohydrate craving in obese people [36].

5. *Monitoring of chewing and swallowing—the edogram.* The methods described have attempted to track human eating in two ways—either by monitoring and measuring the volume or weight of food as it is consumed, or by detecting and recording the actual behavior of subjects as they eat. The analysis of behavior can focus on the macrostructure or microstructure of eating. Of course, the structure of behavior can be recorded and analyzed using observational methods, but the special feature of the edogram is that it provides an automated and objective method for describing the microstructure of eating, particularly the rate of chewing, duration of chewing between successive swallowing movements, and intrameal pauses without chewing.

The initial work with this technique was carried out by Pierson and Le Magnen [37], and the edogram was composed from the electromyographic recordings of masseter muscles together with the record of swallowing movements. In more recent studies, swallowing—or deglutition—has been measured by changes in pressure in a balloon resting on the Adam's apple and kept in place by an elastic collar, while chewing has been measured by a strain gauge that monitors jaw movements [38,39].

The standardized test food used in these studies is normally a number of small open sandwiches—a 4-cm square piece of bread covered with a distinctively flavored food. Consequently, this procedure provides a sensitive technique for the continuous monitoring of the important elements that make up eating behavior. In addition, since the test food is composed of small consumable units of known weight, volume, and caloric value, the procedure allows continuous tracking of caloric intake. Consequently, the technique combines some of the best aspects of BITE and UEM. With a sensitive device such as this it becomes possible to describe the way in which eating behavior and food intake is influenced by such variables as palatability of the food, level of deprivation, and body weight of the subjects, and to detect the changes in structure of eating that take place during the course of a meal (as long as the meal is composed of the standard food units).

In an initial study using normal weight subjects, increasing the palatability of the food items (assessed by visual analogue rating scales) brought about an increase in meal size and meal duration. That is, subjects ate more of the foods they preferred. Less obvious was the finding that the more palatable the food, the less time subjects spent chewing it. It was also shown that chewing time per food unit and the interval between food units increased from the beginning to the end of the meal [38]. This reduction in the rate of eating across the course of a meal has been observed in other investigations and reflects the decline in appetite, or the development of satiation, as the meal proceeds [40]. Interestingly, in a subsequent study comparing eating patterns of lean and obese subjects, neither eating rate nor any other parameter changed during the course of the meal in obese subjects [39]. A more recent investigation indicates that eating parameters appear to be influenced similarly by food deprivation and palatability [41]. When strong deprivation (15 hours) and high palatability are combined, their effects are generally additive, not synergistic. The sensitivity of the edogram with the food unit system permitting the consumption of single and mixed-flavor meals means that this technique is a valuable tool for investigating the functional relationships between factors influencing food intake.

THE MEASUREMENT OF TRAITS

The terms "trait" and "state" have been borrowed from the study and measurement of personality. They distinguish those individual characteristics that are enduring from those that are more short-lived. A "trait," which may reflect ability, temperament, or motivation, is an underlying feature that contributes to behavior and remains relatively stable over time. "States," on the other hand, are short-term and especially liable to change. For example, the level of anxiety experienced at any given time if composed of both state and trait anxiety [42]. Similarly, eating can be seen to reflect long-term relatively stable characteristics (traits) and short-term moment-to-moment influences (states).

The description and measurement of what we shall call "eating traits" are invariably carried out using some form of questionnaire. Little will be said here about the processes involved in questionnaire design or about the variety of rating or weighting technique subsumed under this method. This information is available elsewhere [43]. The intention is to outline the uses of questionnaires and to describe some of those most frequently used. The review of "eating traits" may be organized into three categories: (1) food habits, (2) dieting, restraint, and attitudes to weight, and (3) eating attitudes and behavior.

Food Habits

There have been many published accounts of the food habits and eating habits of groups of people, particularly of younger people [44-48]. In general, the methods used are broad surveys encompassing intake diaries and detailed questionnaires. The type of information that these questionnaires are designed to provide include the following:

1. Food consumption data—often complementary to that of intake diaries.
2. Details of purchasing—amount of money spent, where brought, where consumed.
3. Classification of foods eaten—health foods, fast foods, confectionary, and alcohol consumption.
4. Structure of food intake—meal frequency, missed meals, structuring of meals, snacking, dieting to lose weight.
5. Food preferences and dislikes.

The last category, food preferences and dislikes, has been the focus of special investigation under the auspices of the American Armed Forces [49]. The procedure elicited ratings of preference for a large sample of foods (375) from a large sample of respondents (nearly 4,000), together with estimates of the frequency of consumption of each item. The items were then grouped into food classes and hierarchies of preference plotted both within each class and between classes. Items appearing very low in the hedonic scale, and so generally disliked, could be identified as could those particularly liked.

This information has not only been used for institutional menu planning, but has been used to characterize the preferences of particular groups within the general population. Differences in preferences have been described between white and black personnel, between overweight and underweight individuals [50], and between men and women [51]. These data are of particular value for industrial food service systems, because they describe the average tendencies of particular classes of people. However, this type of survey procedure, designed to reveal the patterns of food choice of specific groups, offers little information concerning individual profiles of preference, In addition, the findings will be limited to the nature of the population being studied (eg, US Armed Forces personnel) and the types of products (culturally defined foods) available.

Dieting, Restraint, and Attitudes to Weight

Questionnaire surveys of attitudes toward weight show dissatisfaction with present weight to be prevalent in late- adolescent girls; in one instance, 80% gave their desired weight as lower than their present weight [52]. In a separate study, over half the sample (females aged 14 to 20) said they had felt fat at some time, and about a third had actively dieted to lose weight [53]. The frequency of dieting together with the variety of effects that restricting food intake may have on physiological, psychological, and behavioral parameters [2], means that the assessment of attitudes about dietary restriction is of considerable social importance.

The first method to go beyond the simple question, "Are you on a diet?", was a short rating scale devised by Herman and Mack [54]. It consisted of five questions relating to dieting, eating behavior and associated emotions, and short-term weight change. The rating scale was regarded as measuring the factor of "dietary restraint". The score achieved on this set of questions was found to predict the outcome of behavioral studies in the laboratory. In various experiments the food consumption of subjects classified as highly concerned with dieting (highly restrained) was markedly different from that of low-restraint subjects.

At about the same time, Pudel et al. [55] developed a 40-item questionnaire that identified people of normal weight who remained at that weight by restricting their food intake—the so-called "latent obese." Unfortunately however, this questionnaire has never been published in English. Herman et al later extended the restraint questionnaire to ten items in length but of essentially similar content [56]. While this version of the restraint questionnaire has been widely used, concern has been expressed about the combination of questions relating to eating behavior with those concerning weight changes. Factor analyses of responses to the restraint questionnaire have consistently yielded two, although not necessarily unrelated, factors—dietary concern and weight fluctuation [57-59]. These have been found to differ from each other in their relationship with variables such as weight status, self-consciousness, and social anxiety. However, Herman and Policy [60] have argued in response that body weight changes are symptomatic of, and are an integral part of, a concern with dieting. In this regard, it seems surprising that no account is taken of subjects' "success" in dieting and that the present state of weight loss or gain is ignored. The latter factor may constitute one of the state variables that interacts with the trait variable of restraint to determine the behavioral outcome of experiments.

Criticism has come from another direction, with Ruderman [61] arguing that the questionnaire has a different meaning for normal weight and overweight individuals. The obese typically score higher (ie, show more restraint) than normal-weight subjects, and there is evidence that they may use different constructs in doing so. However, although these psychometric analyses are informative and provide useful notes of caution about the use of the questionnaire, they do not undermine the principles of this scale. Nor should they be seen as invalidating the concept of restraint (recently further developed by Herman and Polivy) [62].

An alternative measure of restraint has been devised by Stunkard [63]. The questionnaire items were initially a combination of Herman's longer restraint scale, a translation of Pudel et al's latent-obesity questionnaire, together with a number of new items. Factor analysis of a large number of responses, validation, and a second factor analysis left a questionnaire containing 58 items within a three-factor structure. The principal factors have been termed "cognitive restraint," "tendency toward disinhibition" or "emotional lability" and "perceived hunger." Further assessments of reliability and validity have caused the authors to revise the questionnaire and to change or omit a number of items [64]. Most notably, the four items relating to weight fluctuation in Herman's revised scale have been omitted in this revision.

The final 51-item questionnaire has also changed slightly in the interpretation of the three factors. Factor 1 is now seen as "cognitive control leading to behavioral restraint in eating," while factor 2 is a more general dimension of "disinhibited eating," indicative of a susceptibility to disinhibition of restraint [65]. Factor 3 remains as "susceptibility to hunger."

It remains to be seen how useful the three-factor structure of this questionnaire will be. The score on factor 1 will be particularly useful in the quantification of the trait of dietary restaint. As such it may become more

Table 8.1 Published questionnaires assessing eating attitudes and behaviors

Test	Number and type of items	Variables measured	Target population and other comments
Anorectic Attitude Scale (66)	63 items, self-rated on a 4-point scale (scored 1-4)	Factor analysis: Denial Psychosexual immaturity Loss of appetite Interpersonal control Thin body ideal Hypothermia Compulsivity Hyperactivity Purgatives	Anorexic nervosa Unbalanced number of items per category, ranging from 2-19
Anorectic Behavior Scale (68)	22 items, observer-rated No/Not sure/Yes (scored 0-2)	Behaviors arranged under categories: Resistance to eating Disposing of food Activity	Anorexia nervosa
Binge Eating Scale (69)	16 items, self-rated on a 4-point scale (scored 0-3)	Severity of binge-eating problems	Binge eaters; only obese subjects considered during development
Binge Scale Questionnaire (70)	9 items, self-rated, choice of 3 or 4 alternatives (scored 0-2,3)	Severity of binge-eating	Binge eaters; subjects of many weight groups used during development
Eating Attitudes Test (73)	40 items, self-rated on a 6-point scale (scored 0-3)	Severity of anorexia nervosa/symptom index	Anorexia nervosa although has been used with nonclinical populations
Eating Attitudes Test—Revision (74)	26 items, self-rated on a 6-point scale (scored 0-3)	Factor Analyzed: Dieting Bulimia and food preoccupation Oral control	Anorexia nervosa
Eating Behavior Inventory (71)	26 items, self-rated on a 5-point scale (scored 1-5)	Measure of behaviors implicated in weight loss	Overweight subjects in a behavioral weight program
Eating Disorder Inventory (67)	64 items, self-rated on a 6-point scale (scored 0-3)	Predetermined subscales: Drive for thinness Bulimia Body dissatisfaction Ineffectiveness Perfectionism Interpersonal distrust Interoceptive awareness Maturity fears	Anorexia nervosa both"restrictors" and "bulimics;" has also been used with other weight and feeding disordered populations
Master Questionnaire (72)	56 items, self-rated, True/False (scoring unspecified)	Cluster and factor analyses: Hopelessness Physical attribution Motivation Stimulus control Energy balance knowledge	Obesity; authors express some reservations about internal consistency

widely used as a clinical and research tool than Herman's revised restraint questionnaire. At present, the trait of restraint appears to be a powerful predictor of behavior, and its measurement has considerable theoretical and practical significance.

Eating Attitudes and Behavior

Questionnaire assessments of an individual's eating behavior and associated attitudes have more frequently arisen from the need to objectively describe the characteristics of disordered eaters or people with weight problems. Most of the individual items are intended to indicate deviations from normal attitudes or behavior, although no existing catalogue of "normal" eating attitudes and behavior exists. A range of scales and tests are currently available, which have been validated and tested for reliability to varying degrees. These scales are set out in table 1, where some details are given of the source of each questionnaire, it's extent, completion and scoring, what it measures, and the target subject group.

The questionnaires differ from each other on a number of parameters, which in turn influences the information revealed. This confers a degree of uniqueness on each individual technique. Thus, two questionnaires each designed to describe features of anorexia nervosa may disclose different aspects of the condition. For example, questionnaires may be completed by the subjects themselves or by an outside oberver. Both methods have inherent drawbacks. Self-report questionnaires are open to any bias in the subjects' style of response and even to deliberately inaccurate reporting. Observer-rated judgments reflect the theoretical assumptions of the observer, and there is often a need for prolonged observation before a representative judgement can be made. Secondly, questionnaires differ in their scope. They range from ones that measure a single factor, say severity, to those that are multidimensional in structure, quantifying a series of independent factors or providing information under a diverse series of headings. Thirdly, questionnaires differ in their usage. They may simply form the assessment part of a research enterprise and, as such, numerically identify individuals or groups of subjects. Alternatively, their function may be to quantify attitudes or behaviors that are important for diagnosis, and when shared with the individual, act as a basis for therapeutic intervention. It is essential that these general characteristics of questionnaires be considered before choosing between existing methods or constructing a new questionnaire.

The influence of these features can be seen in the individual tests. For example, The Anorectic Attitude Scale [66] describes nine categories of attitudes typical of anorexia nervosa. The eight factors that make up the Eating Disorder Inventory [67], again originally developed for use with anorexia nervosa patients, are markedly different from those in the Anorectic Attitude Scale. Part of this difference lies in the EDI's broad description of patients' behavioral and cognitive patterns. This makes the questionnaire viable for use with other groups of disordered eaters, eg, normal-weight bulimics. The Anorectic Attitude Scale, on the other hand, is more closely related to diagnostic features of anorexia nervosa and is thus limited in application. Slade's [68] Anoretic Behavior Scale, while dealing with the same population, provides completely different information. Here the presence or absence of behaviors typical of anorexics are observer-rated. In addition, it is particularly selective, dealing with only three categories of behavior, a feature that may limit its usefulness outside a clinical environment.

The Binge Eating Scale [69] is designed to show the severity of binge eating problems. However, its utility is limited by being derived from the study of only obese subjects. While many features of binge eating are shared by people of all weight categories, the validity for non-obese people should be demonstrated before it can be more extensively used. In contrast, the Binge Scale Questionnaire [70] was developed with subjects of varying weights. Containing only nine items, however, it is the most brief of the questionnaires described.

The Eating Behavior Inventory [71] and the Master Questionnaire [72] address characteristics of obesity. The published version of the Master Questionnaire, as acknowledged by the authors, requires revalidation with different groups of obese subjects in a variety of treatment settings to show its potential. The Eating Behavior Inventory was designed to assess behavior implicated in weight loss for use in a behavioral weight-loss program. Each behavior is scored for its "inappropriateness" (in facilitating weight control), and a persons' training program is tailored to the behavior measured in the inventory.

Garner and Garfinkel's Eating Attitudes Test [73] and its revision [74] are undoubtedly the most widely used of the questionnaires. The adopted format, a series of statements requiring the subject to indicate the personal relevance of each, enables the questionnaire to function in a number of ways. It can provide a scale of severity of anorexia nervosa, distinguishing anorexic patients from recovered anorexics and normal subjects [73]. The revised version can distinguish the bulimic and restricter subtypes [74]. As previously described, patients' responses may play an important role during therapeutic intervention. Alternatively, this test may be used in nonclinical populations to study the development of anorexia in high-risk subjects [75] or to screen groups of subjects [76]. A note of caution regarding this latter function, however, has been made on methodological grounds [77], and it is acknowledged that tests such as the EAT and EDI should accompany clinical judgements rather than replace them [67].

MEASUREMENT OF STATES INFLUENCING EATING

The previous section has reviewed ways of measuring long-term, fairly stable and enduring dispositions that influence eating behavior; the habits, cognitions, and attitudes that form part of a person's lifestyle and that tend to characterize the relationship to food. This section will deal with a collection of factors that are labile and that show marked shifts over short periods of time. These factors fluctuate around eating episodes and constitute a set of variables that influence food consumption in the short-term; They do not remain at stable levels over long periods of time. In most cases they not only help to determine food intake but are themselves influenced by the amount and composition of the food consumed. In this way they represent measurable indices of the moment-to-moment tendency to eat.

Ratings of Hunger and Satiety

Before the methods used to quantify experiences of hunger and satiety are discussed, it is appropriate to describe the background to the use of such assessments. A brief glance at the literature indicates the high degree of acceptance that experiences of hunger and satiety play a central role in the control of eating. There is, however, less agreement about the source of such experiences. To what extent are hunger and satiety subjective expressions of physiological need? How dependent are they on the prominence of somatic sensations? To what extent are these experiences set apart from immediate physiological state by conditioning [78,79]? It appears that these experiences do not have universally accepted identities [40], and the data generated from different assessment methods may be conflicting and misleading. Furthermore, the way in which experimental subjects use the term "hunger" may differ from the manner intended by the experimenter. Thus, in declaring a feeling of hunger, a person may be referring to local sensations in the body, the passage of time since the last meal, the presence of salient cues associated with eating, or they may be making an attribution to justify the imminent act of eating [40].

Additional problems include the presumed relationship between such ratings and food intake. Often the correlation between hunger ratings and food consumption is low [80,81], and in certain cases these two measures can be completely dissociated [34]. One reason for this is that these ratings are influenced by variables other than those signaling physiological depletion or repletion. Hunger ratings have been found to vary according to the "apparent" rather than "real" caloric value of food [82]. They may also vary according to the individual's preference for the food being consumed [83]. Even non-food- oriented beliefs can adjust ratings of hunger after food deprivation [84]. Consequently quantifying the subjective experience of hunger is not a simple issue, as often presumed.

The two most common rating methods are fixed-point scales and visual-analogue scales. Fixed-point scales are quick and simple to use, and the data they provide are easy to analyze. However, the scales can vary greatly in complexity. At their most simple they are numerical indications of the presence or absence of hunger [85]. Scales with a wider response range may have every point extensively defined to ensure that the subject understands the meaning of the scale [86]. Alternatively, the scale may have as many as 100 divisions with only a few points anchored by words [87]. The tendency has been for different research groups to construct their own scale, which is unique not only in the number of points used but also in definition of the measured variable. Thus, Jordan and his co-workers often used nine-point scales [20,21], while others have used seven-point scales [88]. In considering the appropriate number of points to be included in this type of scale, the freedom to make a wide range of possible responses (multiple-point scales) has to be balanced against the precision and reliability of the device (scales with few points). Hodson and Greene [87] found that responses on 100-point scales of hunger and enjoyment of food were related to behavioral and physiological parameters, while the same variables measured on five-point scales were not. It therefore seems likely that scales with an insufficient number of fixed points may be insensitive to certain changes in subjective experience.

A variant of fixed-point scales are graphic-ratings scales, or scales with points marked on a straight line. A study of their use in expressing pain, however, reveals some of the deficiencies shared by all fixed-point methods. The distribution of ratings was found to be influenced by a variety of factors, including the familiarity of patients with the scales, the nature of the experiment, the orientation of the line (horizontal or vertical), how the line was graduated, and by the fixed points themselves [89].

One way of overcoming some of the failings of fixed-point scales is to abolish the points completely. Thus, visual-analogue scales are horizontal lines (often 10 cm long), unbroken and unmarked except for word anchors at each end [32]. The user of the scale is instructed to mark the line at a point that most accurately represents the intensity of the subjective feeling at that time. The experimenter measures the distance to that mark in millimetres from one end, thus yielding a score of 0 to 100. By doing away with all the verbal labels except the end definitions, visual-analogue scales have retained the advantages of fixed- point scales while avoiding the effects on the mid-range of the distribution of either descriptive terms or preferred numbers [89]. Indeed, in a direct comparison of the two methods, it was found that the visual-analogue scale was as accurate and reliable as a fixed-point scale but more sensitive in registering the intensity of chronic pain [90]. However, this would appear to be the case only if the scale is 10 cm or more in length [91].

Visual-analogue scales are not, however, entirely devoid of abnormalities in their distribution of responses. For example, Bond and Lader [92] found that responses on a number of mood visual-analogue scales showed evidence of results being skewed to the positive end and of a peak at the center on a number of scales. Much of this deviation from a normal distribution is a result of using bipolar scales (eg, tired/alert; hungry/satiated) rather than unipolar scales (eg, very tired/not at all tired; very hungry/not at all hungry). The latter require subjects to make their assessment only on a single construct, rather than on a compound of two, which may vary independently and differently for different subjects. The formulation of scales with hunger and satiety at opposite ends probably lead to errors that may be exaggerated when attempts are made to define points along this artificial continuum [93]. Subjects may be unable to reliably discriminate between the points when referring to their own personal experience [94].

One particularly revealing way of using visual-analogue scales in the study of experiences accompanying eating has been to administer scales of hunger and other experiences at particular times before, during, and after a meal. This method of "temporal tracking" has disclosed previously unpredicted effects of physiological and sensory manipulations. Thus, ratings of hunger return to control levels during eating after being lowered by anorectic drugs before eating [95]. In addition, the palatability of food influences hunger ratings when the food is seen, during the first part of the meal, and two hours after the food was eaten [83].

Bodily Sensations

Certain bodily sensations are well associated with states of hunger and satiety. Commonplace experience associates gastric motility with hunger and gastric fullness with satiation. However, experimental evidence shows only a "weak and inconsistent influence" of gastric motility on hunger ratings [96]. Furthermore, while sensations originating from the area of the stomach may be particularly prominent, they form only one component of a range of accompanying sensations.

The first systematic study of premeal and postmeal bodily sensations was conducted using a checklist format [97]. A range of sensations was described and localized according to various bodily areas: the stomach, mouth, throat and head, together with more general physical sensations. Subjects read through the lists and recorded the presence of sensations at various times before, at the beginning of, and at the end of a meal. These records allowed changes in the incidence and location of the sensations to be plotted and were successful in describing clear shifts in sensory experience.

A similar methodology was employed in a study of the premeal and postmeal bodily sensations experienced by anorexic nervosa patients [98]. Again, the technique was successful in revealing a difference in response, but on this occasion the patients differed from a control group in the variability of their response. There appeared to be a greater variation in the way the anorexics perceived the gastric component after eating. Gastric sensation was either absent, present as bloating, or alternated with no sensation.

Bodily sensation checklist data presented as frequency counts have been used to compare the effects of anorectic drugs before and after meals [81], to compare the percentages of subjects experiencing a sensation within particular groups [99], and to provide statements of variability in response [98]. However, data conforming to a nominal scale obviously has limitations. An alternative method therefore has been to scale the intensity of each individual sensation in order to provide data on an interval scale. This permits the reporting of a greater range of response than assessing presence or absence of a sensation. Factor analysis and cluster analysis of such ratings have yielded a complex set of sensation clusters, the structure of which changes before and after a meal [100]. However, further analysis of this type is necessary, under a range of experimental conditions, before the most meaningful components can be extracted.

An obvious way of reducing the complexity involved with multiple sensations is to monitor and rate the salience of a single sensation. Indeed, this has been viewed as a way of describing hunger and satiety and has taken the form of requesting subjects to report the presence of a (any) hunger or satiety sensation [101]. Alternatively, the sensation may be specified and, for example, satiety described as ratings of gastric fullness. There are two problems with this type of strategy, however. First, the distillation of a complex experience such as satiety into a single sensation may be conceptually erroneous. Second, the use of psychophysical methods for scaling an experience like satiety may be misleading. A psychophysical procedure really requires a firm physical or physiological parameter varying along a dimension in order to calibrate the subjective sensation. Even cross-modal matching, requiring subjects to match their feeling of gastric fullness to the length of a tape measure [102], does not increase the power of the technique.

A further problem is that while psychophysical procedures have been shown to be accurate for visual and auditory sensations, somatic sense modalities are known to be perceptually vague and to have concomitant aversive qualities that may influence the scaling of intensity [103]. The separation of an affective dimension of a sensation from the dimension of intensity is recognized in the study of pain sensations [104,105] and has been incorporated into methods of measurement. Moreover, the independence of these dimensions has been demonstrated experimentally [106,107]. A description of the affective nature of bodily sensations, in addition to that of their strength, would more fully define the sensations characteristic of energy depletion and repletion.

Taste Hedonics

As with bodily sensations, taste stimuli have clearly distinguishable qualities. A taste stimulus may be judged according to its intensity (strength) and to its hedonic (pleasantness) properties. However, little will be said here about taste sensitivity. It is known that people vary in their ability to perceive particular tastes. The reasons for this are various and include adrenal cortical insufficiency [108], diabetes [109], cancer [110], taste bud pathology [111], nutrition [112], and age [113]. The methodological issues concerning taste sensitivity have been extensively reviewed elsewhere [114]. Instead, attention will be directed to the description of taste hedonics and in particular to short-term changes in hedonics.

One way of ordering the pleasantness of a range of solutions is to present the subject with a series of paired comparisons [115,116]. The subject is simply required to say which of the pair is preferred. A forced-choice requirement may also be imposed, whereby the subject must indicate a preference for one over the other and is not allowed to make judgements of equality. The presentation of all the possible pairings from a series of stimulus concentrations allows preference to be expressed on a scale against concentration.

The rank ordering of sitmuli is an extension of the paired- comparison method and arranges the three or more stimuli in order of preference or pleasantness. The subject should be allowed to "back-check" and taste solutions encountered earlier to make accurate judgements. One way of displaying these data is to tabulate the number of subjects who ranked each solution as the most pleasant [117].

The methods described have the disadvantage that the pleasantness of a solution is defined relative to other solutions. The scaling is ordinal; in other words, no absolute value of pleasantness is obtained. This may be remedied by rating pleasantness by assigning some type of physical value to each stimulus. Magnitude estimation requires subjects to make their estimates of pleasantness on a ratio scale. Category scaling, which is more common, provides intervals of pleasantness. The most common example of the latter is the nine-point hedonic scale and is usually attributed to Peryam and Pilgrim [118]. It is still widely used [119] and provides a range of response from 1—"extremely unpleasant" or "as unpleasant as anything ever tasted,"—to 9—"extremely pleasant" or "as pleasant as anything ever tasted,"—with 5 being defined as "neutral" or "neither pleasant nor unpleasant." While this is the standard hedonic scale, there are numerous others, which differ in the number of categories and wording used. Visual-analogue scales may even be used, anchored by words such as "like—dislike" [120].

The usual way of eliciting hedonic responses to a taste is to present a range of concentrations of the taste stimulus and to plot hedonic appreciation as a function of increasing concentration. The parallel measurement of intensity enables detection and recognition thresholds to be computed and has shown taste stimuli to have unforeseen hedonic properties even when they are apparently undetectable. Moreover, these so-called "expectancy ratings" (the procedural details mean that the subject usually knows what modality they are tasting even though they can't taste the individual solution) differ according to weight status [121]. It may be that adult-onset obese subjects differ from juvenile-onset or never-obese subjects in how they anticipate the pleasurable quality of a taste. Further study is required to amplify this matter. However, it does point to the crucial role of methodology in this type of research. Accurate assessments of the hedonic properties of taste stimuli share a number of methodological features with descriptions of intensity. For example, the subjects' mouth should be untainted by prior ingestion or smoking for some specified time (eg, previous two hours). Subjects should be provided with a neutral mouthwash (eg, tap water) between each trial, the presentation of stimuli carefully counterbalanced, and the study conducted double-blind (ie, without either subject or experimenter aware of the identity of each stimulus).

Data collected in this fashion have shown three important properties of taste hedonics. First, the relationship between pleasantness and the concentration of a solution is different to that of intensity [122]. Second, this relationship varies from subject to subject, with two characteristic pleasantness- concentration profiles emerging [123,124]. Type-I responders show a decrease in preference for very sweet stimuli, while type-II responders show a monotonic rise in pleasantness as sweetness increases. These two profiles do not simply reflect the hedonic patterns of obese and normal-weight subjects. The relationship between weight and taste perception is not a simple one. Both types of responders are found in all weight categories, but there is evidence that a greater proportion of the obese are type-I responders [123]. However, this categorization only applies to the hedonic response to a sweet taste, not to any other taste modality [121].

Third, subjects' hedonic response to a sweet stimulus depends in part on their physiological or nutritional state. *Alliesthesia*, a word coined by Cabanac [125] and meaning "changed sensation," describes the dependence of hedonic experience on the internal milieu. It is best shown by the decrease in pleasantness of a sweet solution after ingestion of a nutritive glucose meal. This is an example of negative alliesthesia [126]. The opposite, positive alliesthesia, or increase in pleasantness, has been shown following injected insulin, but it is much less robust and limited to a short period over half an hour after administration [127].

The methods used to describe this shift in hedonic appreciation are extensions of those previously detailed. There are two basic methods. In one, a range of concentrations of a sweet solution are tasted and rated on a numerical hedonic scale (often using only five points). The range of solutions (normally five different concentrations) covers a broad spectrum of sweetness. Ratings are made twice, once before the load and again 45 or 60 minutes later. The alternative method is to track on the same scale the pleasantness of a single moderately sweet solution. The standard solution is rated first before ingestion of the load and at regular intervals after ingestion (as frequently as every three minutes to every 15 minutes) for the next hour. Although alliesthesia appears consistent and replicable, the hedonic shift itself may be fairly small so that data are often plotted as cumulative changes in order to emphasize the response.

Research into the mechanisms underlying alliesthesia has prompted a shift away from a simple interpretation in order to account for the hedonic changes brought about by noncaloric sweeteners such as cyclamate [128] and mannitol [129], and has led to the introduction of mediating physiological features such as putative duodenal osmotic receptors [129]. The real importance of alliesthesia is its likely functional properties; that is, the decline in preference in the sweet taste modality leading to decreased food intake and so being part of the process of satiation [130]. The consumption of real foods has indeed been shown to produce alliesthesia to a sweet solution, and solid foods are more effective in this regard than liquid foods [131]. However, two notes of caution should be made here. First, although there is evidence that loads of different nutrient composition (eg, high in protein), reduce the pleasantness of a sweet taste [132], the reasoning behind alliesthesia is that the hedonic value of a taste serves as an indicator of the physiologic need for the substrate signified by the taste. A high protein load should therefore alter subjective preferences for savory stimuli [133]. It is necessary to show that alliesthesia is related to nutritional needs and is not simply a particular phenomenon relating to changes in pleasantness of sweet solutions. Second, experiments that study changes in taste hedonics following the consumption of real foods confound comparisons across treatments by not controlling for the overall macronutrient composition of the load or its fiber content. Changing the nature of the dietary fiber in a food may effect physiological and subjective response [93]. Indeed, other factors may be involved in the development of alliesthesia in these circumstances [134].

Food Preferences

Apart from the total amount of food eaten, the most obvious factor that distinguishes between the eating patterns of individuals or groups is the type of food eaten. It is normally supposed that the type of food selected is determined by subjective preferences. Indeed, the expressed preference for a food is one of a handful of factors that strongly predict the nature and quantity of food consumed [135]. In other words, disclosing preferences about particular foods appears to correlate with actual food consumed. Consequently, an instrument for assessing food preferences could be profitable used in clinical and commercial situations. Surprisingly, food preferences are only rarely assessed in investigations of mechanisms controlling feeding.

Certain techniques are frequently used in the sensory evaluation of foods and beverages [136]. However, it should not be assumed that taste preferences and food preferences are identical. The preference for a food is not simply the sum of the preferences for the individual tastes that make up that food; other qualities may be crucial including odor, texture, temperature, specific culturally-derived influences, and metabolic and neurochemical effects. Food preference is a multidimensional composite of all these factors [133].

The most simple technique that is sensitive to short-term changes in preference is a checklist of basic food items. The subjects' task is to check the items that they would like to eat, considering each one independently of the others. The overall score constitutes a range of food preferences. In addition, the food items may be ranked in order of preference to give a hierarchy of preference. Alternatively, the frequency of checking of food items may be compared between two or more predetermined categories such as high calorie-low calorie or high protein-high carbohydrate. Fluctuations in recorded food preferences can therefore reveal aberrant or idiosyncratic eating patterns such as salt preference, carbohydrate craving, or meat avoidance. Variants of this checklist method often include hedonic scales or visual- analogue scales associated with each item. On these, subjects may indicate how pleasant they find each food item, or they may give an estimate of the amount of each item they think they would like to eat.

The methods described have been used to investigate whether particular preferences are associated with changes in hunger and satiety. For example, the number of both high-protein and high- carbohydrate foods selected from a checklist has been found to decrease after a meal, high-protein foods showing the largest decrease in selection, while the selection of low-calorie foods do not decrease [83,95]. This type of checklist has also been used to disclose the relationships between neurotransmitter alterations brought about by various drugs and preferences for foods rich in protein and carbohydrate [81]. Interestingly, changes in the checklist recording of nutrient- specific items was noted for a dose of one drug (fenfluramine) that exerted no measureable effect on food intake or subjective hunger. A food preference checklist is a sensitive device. Assessments of the pleasantness of checklist food items, and of the quantities of each that subjects think they could eat, are also capable of distinguishing the satiating effects of soups of different caloric densities [101]. Rating the pleasantness of a range of foods has yielded a particularly stable laboratory phenomenon—sensory specific satiety. This refers to the decline in pleasantness of foods eaten in large quantities compared with those not eaten [137] (see Chapter 10, this volume).

An alternative to the checklist methods of quantifying preference is provided by a forced-choice procedure. In this subjects are obliged to choose only one of a pair of food items, the one they would most like to eat. The items are included on the basis that they are representative of specified categories (eg, high protein-high carbohydrate). The presentation of a list of all possible pairings of items from category A versus items from category B affords a measure of the relative preference of A over B and also provides a hierarchy of preference of the individual items used. This forced-choice procedure has been used to describe how the distribution of carbohydrate versus protein food choices changes before and after eating [95] and to give additional weight to evidence of the superior satiating capacity of protein over carbohydrate.*

Although many of the examples given of the use of food preference assessments are based on nutritional comparisons, foods vary according to many other parameters. The methods described are suitable for other classifications (eg, sweet versus savory). Indeed, it is likely that the relative importance of these parameters changes according to physiological or environmental circumstances. Described above are basic methods that may be tailored to suit the purposes of individual studies. It is also important to acknowledge that the mode of presentation of the food item may influence the response and that a real food may be perceived as more pleasant, or at least differently, to a food name [138].

Lastly, some comment should be made about the relationship between food preference measures and food consumption. It is interesting to note that the relationship between the dislike of a food item and nonuse is stronger than that between liking for and consumption [139]. This may be because food dislikes are better understood and the mechanisms involved in their acquisition more easily identifiable. Thus a food-rejection taxonomy may be developed [140], and nausea identified as a potent instigator of dislike [141]. It appears to be far less easy to describe food likes or preferences in a similar way [142]. Considering the attention that is now being directed to mechanisms controlling the selection of foods in addition to the control of total calories, the measurement of food preferences will figure more prominently in future investigations.

Salivation

The secretion of saliva is, like a range of other physiological processes, an involuntary accompaniment to eating. However, what makes salivation of particular interest in the present context is its capacity to be conditioned to the arrival of food and to anticipate eating. These anticipatory responses are known as cephalic reflexes and are sensitive to the sight and smell of food [143,144]. Functionally they act to prepare the digestive system to receive food [145]. A number of findings have prompted this physiological response to be viewed as a reliable index of appetite. First, it is apparently uncontaminated by the cognitive and methodological variables that influence pencil-and-paper ratings. Second, anticipatory salivation is modulated by palatability and deprivation and correlates significantly with ratings of hunger and food appeal [88; see 146 for review]. In addition, one characteristic distinguishes salivation from the other cephalic reflexes—the ease of measurement.

There are three basic measurement techniques. The most widely used is the SHP (Strongin, Hinsie and Peck) method [147].One to three preweighed dental rolls are placed under the tongue and left there for a short period of time (eg, two minutes). They are then collected and placed in a sealed container to be weighed

* Hill AJ, Blundell JE. The relationship between protein intake, ratings of hunger and satiety and food preferences. Paper presented to the Eating Habits Symposium, Sussex University, UK. April, 1984.

at the end of the experiment. Normally, two or three measures are taken, with a suitable period between each, to establish an accurate mean level of response. In contrast to this procedure, which requires very little specialized equipment, the Lashley suction cup monitors saliva flow rate from a single group of salivary glands. This device takes the form of a plastic cup positioned unilaterally or bilaterally over Stensen's duct and held to the inside of the cheek by negative pressure, which draws the saliva to a recording device [148]. The advantage of this method is that it is very accurate and may be used to provide continuous records of saliva flow over a relatively long period of time, such as an hour [149]. However, both methods suffer from being intrusive and somewhat uncomfortable. The alternative is to collect the total salivary output from the mouth. This may be done by suction using a dental fluid ejector continuously or at the end of a timed period [150], or by simply voiding the accumulated secretions into a preweighed specimen jar [144,148]. The latter method may be further distinguished by whether it was "working" (subjects move their mouth and jaw in a continuous chewing motion) or "quiet" (no movement).

Comparisons of these methods have shown them to be significantly intercorrelated, and it has been concluded that, "considerations other than greater precision may be used to dictate the choice of an appropriate procedure" [148]. One of the major considerations is the design of the experiment. There are two basic ways in which salivation is studied. One way is to measure salivation in a range of subjects and to correlate it with another variable such as weight or dieting status. The other method, and more commonly used, is to establish a baseline of responding and to compare this with the level of salivation elicited by a food-related stimulus or some experimental manipulation. The stimulus used in "stimulus-induced salivation" may be the sight or smell of real food, a food word, or thinking about food.

Stimulus-induced salivation (SIS) does not lack sensitivity. For example, a low dose (10 mg) of an anorectic drug (amphetamine) reduced SIS while leaving hunger ratings unaffected [151]. In addition to deprivation and palatability [88], SIS has also been shown to be influenced by body weight [152], by dieting to lose weight [153], and is even dependent on the time of day [146]. Indeed, it appears that salivation is a supersensitive response. This may account for the inconsistent relationship found between salivation and hunger ratings in studies varying in methodology and experimental design [154]. It remains to be confirmed whether salivation represents a global index of hunger or appetite. Other studies suggest a more specific role for salivation. For example, Blundell and Freeman [155] found the degree of salivation brought about by particular odors could be modified by prior administration of a nutritional load. In particular, a glucose load selectively suppressed subsequent salivation to a sweet (honey-flavored) odor. This finding indicates that SIS may be used as a measure of alliesthesia and of sensory-specific satiety. The influence of the macronutrient composition of particular loads awaits investigation.

OTHER TECHNIQUES

There are a few techniques which either do not fit easily into one of the previous sections or whose characteristics are sufficiently specialized to warrant separate consideration. Research on feeding in young children is one area in which original methods of study have been developed. The consideration of multiple attributions in preference and food choice is another. Some of the techniques used in these two areas are described below.

Working With Young Children

Indications of the taste and food preferences of young children (less than 4 years of age) have in the past relied on food selection and food intake as their sole measures [156,157]. More recently however, experimental strategies have been developed that have enabled researchers to study these issues in more detail, either by careful observation or by harnessing the child's developing but limited verbal skills.

The first of these originated in an attempt to describe the facial expressions of newborn babies to various tastes and odors. In a study of 3- to 7-day-old infants, Steiner [158] found patterns of gustofacial responses characteristic of the basic taste modalities. He found the responses to a sweet taste to be typified by retracted mouth corners, a "smiling" expression and vigorous sucks and licking. In contrast, the responses to a sour taste included lip pursing, nose wrinkling, and blinking. Bitter tastes and a number of smells also had their own associated responses. Research into the origin and nature of these responses has shown them to occur in premature babies, in neonates before their first feeding, and even in babies born without a cerebral cortex. Steiner concludes that this discrimination of stimuli in hedonic terms, ie, pleasant or aversive, has biological significance in conveying information about the acceptability of a food. Whatever their origin or function, these gustofacial reflexes clearly have potential as nonverbal indicators of preference. Moreover, their stability is typified by their endurance into adulthood.

A method for obtaining food preference data from slightly older children has been devised by Birch [159]. She uses three cartoon drawings of faces that describe three categories of hedonic response: like, dislike, and neutral. The children (age range from 2 years and older) first spend time learning the meaning of the faces; the smiling face signifies someone who had "just eaten something liked", while the face with the down-turned mouth is of someone who had "just eaten something disliked." Having learned these categories, the children are presented with a cup containing small pieces of food and are asked to taste the food. They are then asked whether they liked it, disliked it, or whether it was just okay, and to put the cup in front of the face showing the appropriate response. Having completed this for a number of foods the child's attention may be focused on the individual categories and questions such as, "Tell me the food you liked the best," to elicit a rank order of preferences for the foods in each category. This method has been used to study a range of cognitive and social factors that contribute to food preferences. The foods chosen by peers, foods followed by a contingent reward, and the social rules governing the appropriateness of foods at particular times of day have all been shown to influence the expressed liking for foods by children [160-162].

Multidimensional Analyses

As research has progressed, it has become apparent that many processes are under the control of a group of influences rather than a single controlling factor. This being so, a complete account of the antecedents of a behavior cannot be made without dealing with multiple sources of information. Thus, the determinants of what is chosen to be eaten in a single meal will include not only physiological needs and the nutritional content of the food, but also pleasantness, taste, perceived health value of the food, and even its price [163]. Procedures have been developed specifically to describe the interplay of two or more such determinants. These techniques had their origins in the study of psychophysics and in the analysis of factors making up personality. In the present context they have been used to analyze taste preference and to describe the relationship between food beliefs and food intake.

Multidimensional scaling is a mathematical technique that plots individual sitmuli according to ratings made on scales of the perceived attributes of foods or tastes. The plots can be regarded as maps, which are two-dimensional graphical representations using the two most important attributes as axes. In the resulting spatial arrangement, the closer the individual stimuli (foods or tastes), the more similar they are in terms of those qualities. There are many ways in which the stimuli may be rated. Schiffman [164] gives four examples of the way "preference space" may be described. Stimuli may be rated according to their similarity, according to which of a pair of stimuli is preferred, the degree to which one is preferred over another, or according to their ratings over a large range of attributes. A related procedure—the response surface method—has been used to determine preferences for combinations of fatty and sweet substances [165]. It has been demonstrated that preferences for sweetness and dietary fat combined in a complex food system are interdependent.

The technique used in studies of food beliefs and of the ways people construe foods has many features in common with multidimensional scaling, although the theoretical background is quite different. The basic instrument, the repertory grid, originated in the study of personal constructs [166]. Fundamental to this theory is the idea that people have cognitive features that are shaped by, and in turn determine, the world in which they live. These features, or constructs, may be shared by many people or be relatively uncommon, and they may vary in their complexity and stability. In the present context, the idea is that particular perceived qualities of food, eg, how fattening it is, determine selection and consumption. The repertory grid provides a format within which a range of foods (elements) may be assessed along a range of individually-relevant properties (constucts) and be portrayed graphically in a way similar to that for multidimensional scaling.

One use of multidimensional analyses has been to examine the hierarchy of constructs for individual subjects. The structure of these food belief systems may then be related to other aspects of the subject's background or be used to distinguish the subject from others [167,168]. Interestingly, measures afforded by such an analysis have been found to be significantly correlated with the frequency of intake of the foods mentioned, so establishing a link between food beliefs and usage [167]. A second way is to average the grids of a group of individuals and to compare the conceptual structure of one group with that of another. A common basis for comparison has been that of weight, with obese and slim 10-year-olds differing in their conceptions of energy density, tastiness, and preference [169]. Weight differences are not always apparent, however, as obese and normal-weight adults were found not to differ in their perception of a variety of soft drinks [170]. Variables such as restraint may prove to be more potent in this regard.

It is important to recognize that multidimensional scaling procedures are in the relatively early stages of development for use in this area of research. The power of these techniques to derive orderly relations from a complex network of interrelated variables suggests that they will have an increasingly important role to play in determining the relative importance of multiple variables influencing the processes controlling food selection and consumption.

POSTSCRIPT

This chapter has brought together various procedures used to measure and monitor eating behavior applicable to a wide variety of circumstances. In compiling this battery of techniques it has been necessary to include instruments devised to measure aspects of subjective experience as well as overt behavior. Together these provide research tools for investigating mechanisms underlying normal and abnormal eating in quite different situations and over distinctive spans of time. The techniques stand as a testimony to the inventiveness and technical skill of researchers. In addition, they illustrate clearly that the understanding of eating and its disorders proceeds not only by the advancement of good ideas but also through the development of instruments for the precise and reliable description of the basic phenomena under study.

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