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Chapter 2

The Psychology of the Meal

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The meal is a very real psychological entity. It is a virtually universal physical and behavioral feature of human life. It does not depend on any particular theories or point of view. Any reasonable criterion for some kind of clustering of eating will show that humans binge; they do most of their eating in relatively short periods of time, separated by periods of minimal if any consumption. Finns do it, Russians do it, Malays do it, Chinese do it, Zambians do it, Brazilians do it. And even hunter-gatherers do it. Not only do all adults eat meals, but all children do too, and they do so from the first day of postnatal life. Their constant placental food infusion ends abruptly, and they seek and receive milk periodically, that is, in meals. The meal is a meaningful unit of life for most animals: virtually all nongrazing mammals, including most primates and that best investigated of all eaters, the laboratory rat.

Of course, other important or "physical/behavioral" units of eating exist: bites, dishes or courses, daily intakes, long-term patterns. But we think it is fair to say, that from both the lay and scientific perspective, the meal is a privileged unit. We will provide evidence for this claim throughout this chapter.

Why is meal eating so common? Most likely, this results from an ecological influence. Animals have many things to do, including sleep, watch for predators, and find mates. Eating is critical, but it competes with other activities; surely, one's vigilance is not maxinum while gobbling up food. And sleep, that [redacted] eating by humans in natural situations over a period of days, drinking without eating occurred only rarely, and the best predictors of the occurrence of a drinking bout were food and meal-related factors, rather than self-rated thirst (de Castro, 1988).

A major force would favor a rather continuous, even eating pattern. Regulation of the internal environment, Claude Bernard's "milieu interne," and Walter Cannon's homeostasis, is a fundamental condition of life. A great deal of the physiological and behavioral machinery of animals is devoted to buffering them against stresses that threaten to dysregulate the internal environment. The meal is one of the great threats to homeostasis. A large load of nutrients is dropped into the system at one time, causing a flood of glucose and other nutrients to enter the system. Regulated parameters, including temperature and blood glucose level, are challenged. Meal-taking accounts for many anatomical and physiological adaptations: large stomachs, gradual delivery of food from stomach to intestine, insulin secretion, glycogen as a short-term energy store (see Smith, 1982, for a general discussion of the meal from the physiological point of view).

There are a surprising number of behavioral/psychological adaptations to the stress of meals, as described by Woods and Strubbe (1994). They point out that under conditions where meals are predicted by either specific environmental events or time, the organism has the opportunity to anticipate and prepare for a nutrient onslaught. Based primarily on data from rats, premeal adaptations include elevated body temperature (presumably to facilitate the energy-expending processes of digestion and assimilation) and a slow decline in blood glucose and metabolic rate, both in the service of compensating for substantial increases in both after ingestion. These "cephalic phase" responses operate, in some cases (e.g., increases in body temperature), to prepare the system to handle the load, and in others (e.g., decreases in glucose and metabolic rate), to compensate for some of the consequences of ingestion. In either event, they operate to smooth out the perturbation produced by the meal nutrient load. In the case of blood glucose, it is known that a component of the anticipatory glucose drop is secretion of insulin.

Just as the discussion of the meal, in some cases, pits physiological (e.g., metabolic) against psychological factors (e.g., learning), the study of premeal physiological changes has two competing accounts: the more traditional account sees at least some of these changes (e.g., the drop in blood glucose and metabolic rate) as purely metabolic signals of a decreasing fuel supply (e.g., see Campfield & Smith, 1990), whereas others interpret these same events as conditioned compensations in anticipation of the meal load (Woods & Strubbe, 1994). It is, of course, possible that both processes are at work as are both physiological and psychological determinants of meal onset, size, and offset.

THE MEAL AS A FOOD INTAKE PATTERN

The Rat Meal

Dating from Richter's (1927) classical analysis of rat feeding patterns, the rat meal has been a focus of research efforts—the focus of analysis of how rats regulate their food intake. Richter identified the diurnal pattern, including predominant meal eating during the dark phase of the light cycle. Under laboratory conditions, in individual cages, rats consume somewhere between 5 and 15 meals per day. There are many schemes for parsing meals; a common one is to define a meal as a

period of ingestion bounded by a period of at least 10 to 20 minutes without eating (Panskepp, 1978). Typically, rats become active before a feeding bout and usually drink some (Fitzsimons & LeMagnen, 1969); after a meal, usually a thorough bout of grooming, a short period of investigatory activity, and then sleep occur. Somnolence may be a good criterion for meal termination.

A great deal of research has been done on the role of metabolic events, status of the stomach, palatability, and conditioning factors in determining the onset and termination of rat meals. These factors have been shown to influence meal size. However, there is another major determinant: the availability of competing activities. Nicolaidis, Danguir, & Mather (1979) made an important observation about the rat meal pattern. When rats were provided with a "chambre de coucher," a niche expansion of the typical small cage in which they could curl up and sleep, the number of meals they ate over 10 to 15 consecutive days dropped from a mean of 9.3 to a mean of 6.8. There is good reason to believe that the sleep cycle may drive the meal cycle.

The Nicolaidis et al. study reminds us that the meal pattern of a domesticated rat in a cage smaller than 1 foot on a side may be a function of the cage as much as the rat. We do not have extensive data on meal patterns of either domestic or wild rats in larger, more natural enclosures or in real world settings (for wild rats).

The Human Meal

The Human Infant

The pattern of infant food ingestion is well reviewed by Hammer (1992) and Birch, Fisher & Grimm-Thomas (1996). From these accounts, we extract some of the basic descriptive features appropriate for this review. From birth, infants adopt a meal eating/nursing pattern that is at least in part internally generated, perhaps in relation to the sleep cycle. Over the first week of life, the number of daily meals increases, on average from about 5 to about 7, with both meal size and frequency increasing over the early days of life. Meal size is probably limited by gastric capacity. Young infants (8 weeks) tend to take the largest meal on arising after their longest (overnight) fast, whereas by 6 months of age, there is a shift to the adult pattern of a largest meal at night. The shift to solid foods may well engage a somewhat different control system. Birch and others have tracked the development of basic aspects of adult regulation in human infants. As with rats, aspects of physiological regulation come in separately over time. Opportunities for the child to develop conditioned anticipations of meals and so forth vary in terms of the predictability of food availability, as in the demand-feeding option. In some cultures, demand feeding is the only option.

The Adult Human Meal

The three-meal-a-day pattern is widespread among adults around the world. This is suggested by the existence of words for precisely three distinct meals in many (but not all) languages (Rozin, Pliner, & Berman, 1999). This general human characteristic could be a result of ecological pressures and compromises with competing behavioral/motivational systems, or it could represent a natural feeding rhythm in humans. Booth and Mather's (1978) mathematical model of human eating assumes that the onset and offset of eating are determined by particular values of the rate of flow of energy into body cells; feeding begins when energy flow falls below a certain value and ends when it rises above another. When several parameters are entered into this model (e.g., daily activity pattern, body weight, energy density, gastric emptying time), the model predicts three meals per day. Most likely, humans are predisposed to a pattern of about three meals a day and are not optimally served by delivery of energy and nutrients in fewer than three occasions. However, the prevalence of three as opposed to four or five meals per day may result from competing pressures. We have only minimal data on the free-running meal patterns of humans, and none, of course, from humans not already enculturated to the three-meal-a-day pattern.

Perhaps the most natural yet well-controlled study of spontaneous human meal eating comes from research by Green, Pollak, & Smith (1986). Eight adults lived individually for several weeks under continuous illumination in a one- or two-room apartment without windows, clocks, or other means of telling time of day. Subjects could call for breakfast, lunch, dinner, or snacks from a computer-displayed menu. Subjects had a definite tendency to eat 3 meals for each sleep-wake period (to some extent, perhaps, prompted by the availability of meals labeled as breakfast, lunch, and dinner). These varied from an average of 25 hours early in the study to a mean of 33 hours later in the sessions. This work, along with the rat studies of Nicolaidis et al. (1979), links the eating cycle to the sleep cycle.

As with the rat research, serious questions need to be asked about the meaningfulness of meal consumption by humans in laboratory settings. Green et al. came a long way in producing a naturalistic setting in the laboratory, but, of course, many normal meal-related activities, such as company for eating and activities competing with eating, were missing. Kissileff, Guss, & Nolan (1996) report some comparability of meal sizes in laboratory or cafeteria settings; also, in both cases, the presence of others increased intake.

Microstructure of the Meal

The meal is a highly structured event, in terms of an orchestrated presentation of feeding opportunities and a variety of food choices and detailed patterns of ingestion. A number of studies have sought to describe these events in humans, using either videotape technology or direct measurements of chewing and swallowing. A major focus of this work, not relevant to this review, is the comparison of eating patterns of obese and normal-weight people.

Hill (1974) pioneered in this area, using analysis of videotaped meals eaten by normal subjects in the laboratory. His main focus was changes in meal structure (bite and chew sequence) as a function of palatability and hunger and will be discussed later under palatability as a determinant of meals. Rogers and Blundell (1979), using video records, reported a steady decline in eating rate across each quarter of the meal. Surprisingly, especially in light of major advances in video technology, this useful technique has not been applied much in subsequent work on the events in human meals.

Stunkard, Coll, Lundquist, and Meyers (1980) used an even more basic approach, direct observation of eating under natural conditions. Observations were made on obese and normal-weight women eating in a fast food restaurant. The women were given a coupon entitling them to a free meal of either 985 or 1800 calories. They reported lower eating rates and fewer chews per mouthful for the larger meal. In contrast to results from some laboratory studies, they found the highest rate of intake in the middle third of the meal and the lowest in the last third.

From 1980 onward, much of the work on meal structure was carried out with direct measurement of chewing and swallowing by means of sensors attached to the body. Some of the early studies, following up on prior work in LeMagnen's laboratory, reported the general pattern of chewing and swallowing in French adult subjects, using foods of varying palatability (Bellisle & LeMagnen, 1980; Bellisle, Lucas, Amrani, & LeMagnen, 1984). Results indicated a decrease in eating rate from the beginning to the end of the meal, as manifested by gradual increases in chewing time per food unit and in the interval between food units. Water sips increased as the meal progressed (Bellisle & LeMagnen, 1981). In addition, there was evidence that eating rate was a stable individual difference variable.

Stellar and Shrager (1985) used a different oral sensor system, mounted like a retainer against the palate. Using small, 15-kcal sandwich rolls (their SFU or solid food unit), they reported a characteristic pattern of 14 to 16 chews per bite, followed by a swallow. This cycle averaged 12 to 13 seconds in length. A large bite can be followed by several smaller chew-swallow cycles before another bite.

Kissileff and Thornton (1982a) used Kissileff's universal eating monitor to obtain a fine-grained record of intake of a liquid diet of yogurt and fruit consumed through a straw. They found that a quadratic equation accounts for almost all the variation in the cumulative food intake curve in single-course meals in nonobese men and women. The linear coefficient is the initial rate of eating, and the quadratic is half the rate of deceleration (in absolute value). Men exhibited a higher initial rate of eating but also decelerated faster than women. As with all studies, these results no doubt depend on the particular food being offered, as well as other aspects of the setting. Kissileff and Thornton (1982a) reported some correspondence between these results and real world intake patterns; subjects kept food diaries, and intake from the diaries correlated .60 with intake in the laboratory.

THE MEAL AS A NATURAL UNIT

Semantic Recognition of the Meal Category

The meal is a recognized semantic category, and across languages, there is a modest set of words designated to describe meals or their subdivisions. Interviews about meal terminology with native speakers (in English) of 18 languages were carried out (Rozin et al., 1999). The languages covered a wide geographical area and included many different language groups: English, French, Spanish, Swedish, Icelandic, Polish, Russian, Finnish, Turkish, Arabic, Ibo, Hindi, Vietnamese, Thai, Tagalog, Cantonese, Mandarin, and Japanese. Seventeen of the 18 languages have a term for meal, 16 have unique words for breakfast and for lunch, all have a word for a main meal eaten later in the day, and 16 have a word corresponding to snack. Approximately half of the languages have single words for parts of the major meal, or courses (none had corresponding words for lunch or breakfast). The words, when present, correspond generally to the English appetizer, entree, and dessert. As might be expected, the French seem to have the largest meal- (and food-) related vocabulary. The French identify a specific fromage (cheese) course, and, at least for elaborate meals, include "amuse gueule" as a preappetizer, a (typically sorbet) palate cleanser between two main courses, and a mignardise, a delicacy after dessert. And then, of course, there is that French monument to variety seeking, the degustation.

This is typically a sampling of small servings of the highlights of foods from various courses at a restaurant.

The Meal as a Unit of Day Segmentation

We typically punctuate or segment our days in terms of stable key events, such as waking up, breakfast, lunch, supper, and going to bed or sleep. That is, meals are important in organizing and remembering our days. We suspect that when people remember their intake of the prior day, they spontaneously organize it by meals. We also suspect that in recounting the day's events, people will be inclined to use meals as time markers, as in reporting that "after lunch, I went shopping." The prominence of meals in thinking about food is also illustrated by research on free associations to either specific foods or arrangements of food sequences into meals (Rappaport, Peters, Downey, McCann, & Huff-Corzine, 1993; Rozin, Kurzer, & Cohen, 1999). Meal terms occur prominently in both types of free associations.

The Meal as a Unit of Social Interaction

Meals, especially the dinner meal, are usually taken in a social setting. For many families, the evening meal is the main time for the whole family to interact. Meals often serve, as well, as occasions for meetings, for dating, business, or general social interaction. They offer a period of time long enough to accomplish something but short enough to provide a fixed time commitment, and they offer a ready subject for discussion, even as the main topic for discussion. Major life occasions, such as marriages, and important holidays, such as Christmas, are typically associated with an elaborate meal or banquet. This association is surely not a peculiar feature of Western cultures; rather, the banquet or feast is an important part of celebrations in many cultures.

Co-presence at a meal establishes a minimal bond. Typically, there is some sharing of food. The great majority of meals (virtually all, in some traditional cultures) are shared with relatives. The meal is an opportunity for exchange of information and experiences and, at the same time, a much more substantial sharing of substance, as represented in the food. Sharing food is a homogenizing act, just as not sharing it is a form of social distancing. This contrast is particularly clear in Hindu India, where food-sharing rules are more explicit (Appadurai, 1981). In this and some other traditional contexts, the sharing of food at meals establishes and reaffirms closeness, and the ritualized practices in the meals express and affirm particular relationships. Who eats first, who eats the choice foods, and who can eat foods already sampled by others; all of these affirm hierarchical family relations. A central concern is "consubstantiation," actual sharing of substance, as when two individuals eat from the same pot, trade food, or even when one person makes the food that another person eats. Such matters figure heavily in Hindu Indian food exchanges and, as well, in the elaborate contagion-dominated food experiences of the Hua of Papua New Guinea (Meigs, 1984).

In Western-developed cultures, some of these explicit functions of meals are muted. However, they are still present, just as an invitation to share a family dinner with a person is an indication of liking and ease in a relationship. Even among Americans, modest acts of food sharing during a meal carry major implications for type of relationship between the eaters (Miller, Rozin, & Fiske, 1998). Sharing of food in a restaurant implies a close personal relationship; feeding by one or the other eater implies (if their ages and genders are appropriate) a romantic relationship. Consubstantiation seems to enhance the perceived closeness of eating partners as viewed by others.

The Meal as a Memory: Retrospective Meals

At any given point in time, we are likely not to be eating a meal. But, at the same time, we are frequently thinking about meals, past or anticipated. The average person surely has a repertoire of many meal memories. Studies on diet recall suggest a rather accurate recall of the previous day's meals, with accuracy fading rapidly beyond that. But we all remember special meals, either because of their very high or low culinary quality, their unusual nature, or important nonculinary events that occurred at the meal (first dates, proposals of marriage, and the like).

Because we live with so many meals in our minds, it would seem reasonable to ask about the relation between the memorial representation of the meal and the actual experience of the meal. This is of particular importance because when we make a food choice now, it is based on our memories of relevant past experiences with the same or similar foods, not our actual experience with the foods. Insofar as the memories differ from the actual experience, it is the memories that are relevant.

Of particular interest are our memories for the quality of the meal, that is, the pleasure we experienced. Recent work by Daniel Kahneman and his colleagues (reviewed in Kahneman, Wakker, & Sarin, 1997) on experienced and remembered hedonic episodes makes this issue more compelling and interesting. Kahneman distinguishes between remembered and experienced pleasure and pain and asks what principles relate the experience with the memory; the relationship is quite complex but lawful. The empirical work centers on experienced and remembered pain. Kahneman and colleagues report two aspects of a pain experience that powerfully determine memories for it: the peak level (disproportionately large contribution to the remembered pain) and the rapidity of the offset (sharp offsets are remembered as more painful). On the other hand, they report one important aspect of a pain episode that is not well represented in memory: duration. Five versus ten minutes of pain are represented in memory as about equally unpleasant.

Kahneman's work suggests a series of questions about memories for meals.

1. Are certain parts of the meal (e.g., first, last, main course) disproportionately determinative of our evaluation of the meal? (Note that a postmeal evaluation, even if made right after a meal, is based on memory of experience, not direct experience.)
2. Is the peak (low, high, or both, depending on the meal) disproportionately represented in the hedonic representation carried in memory?
3. Is there duration neglect? Do we rate meals that had, say, 4 versus 8 ounces of our favorite food (certainly a big difference in experienced pleasure) as equally pleasurable?

Only a few studies shed light on these questions. One study obtained a primacy effect ("onset dominance"). Subjects provided ratings of many foods, from which a meal sequence of food was constructed. The two "halves" of the hypothetical meal each consisted of three items, each previously rated high (H) or low (L). Subjects were read a list of the six foods (e.g., HHH-LLL, LLL-HHH) and provided a rating of how much they would like this meal. Primacy effects were found; that is, subjects generally rated meals beginning with three highly rated foods (followed by three low-rated foods) as better than those presented in the reverse order (Anderson & Norman, 1964).

Rogozenski & Moskowitz (1982) developed a regression model for predicting meal liking from a weighted linear combination of liking for the components. Subjects first rated 140 foods and then rated meals (menus) composed of sequences of these foods. The meals consisted of a main dish, starch, vegetable, salad, and dessert. The model was applied to average ratings of components and meals across many subjects. Under these conditions, the main dish (entree) had a disproportionately strong contribution to the total meal rating. Turner and Collison (1988) used a similar procedure but used ratings of actual meal components and meals in a student training restaurant. Nine different meals were tested. The entree had the largest coefficient in the multiple regression for seven of the nine meals, displaying an average correlation of .74 with total meal rating. The second most important component was the sweet/dessert (correlation of .64).

Hedderley & Meiselman (1995), in keeping with Meiselman's general emphasis on studying food choice and intake in natural settings, tried to model meal acceptability in a student cafeteria in the United Kingdom. After completing a self-selected meal, students provided ratings of the components and of the overall meal. More than previous investigators, these researchers are aware of the problem of combining multiple regressions from meals with different components and of aggregating data across subjects. In this study, multiple regression equations were computed for individual subjects (at least three meals/subject) and combined only across meals with similar structures. Concordant with prior results, the main dish had the major predictive value (highest for pizza, then sandwich, and then other main dish). As with Turner and Collison, the next highest regression coefficient went with dessert.

The disproportionate effect of the main dish in these studies could be accounted for in a number of ways. It is usually the largest amount of food, and hence consumes the most time. It is often the most palatable part of the meal. It is usually the most expensive part of the meal. It is located in the temporal center of the meal; according to Kahneman this might decrease its contribution to meal memory, but for meals, the central position might be most salient.

With respect to Kahneman's findings, these studies provide some general support in that total meal liking is not a simple unweighted linear function of components. Furthermore, there is evidence for dominance of the entree, which may, in many cases, also represent the peak of liking. Finally, the finding that dessert is the second most predictive meal component is compatible with the idea that the end of a sequence contributes disproportionately to memory for that sequence. Duration neglect was not tested in these studies. However, we have recent data on this subject from actual mini-meals we constructed from three flavors of jelly beans in sequence. Under these circumstances, rating of the overall jelly bean meal was best predicted by the average liking for the component jelly beans, a finding that is not consistent with Kahneman's results. On the other hand, doubling the number of one of the jelly bean flavors (from the standard two to four jelly beans) did *not* increase the contribution of this bean to the total sequence rating, a finding arguing in favor of duration neglect (Rozin, Rode, & Ostovich, 1999).

As Meiselman has indicated, it is difficult to do this type of study. Besides measurement problems (including the subject's memory for ratings for the components when rating the whole meal), problems are due to the complexity of the meal as a stimulus. Compatibility of items (Schutz's [1989] appropriateness) and context effects and interactions (as described by Rozin and Tuorila [1993] and Meiselman [1996]) make rating of components a poor substitute for the on-line experience of pleasure. Perhaps more appropriate, in line with Kahneman's studies on pain, would be a moment-to-moment pleasure rating during the meal, although this could be quite disruptive of the meal itself.

PSYCHOLOGICAL DETERMINANTS OF MEAL INITIATION, TERMINATION, AND SIZE

Visibility/Availability of Food

It seems likely that, given an appropriate situation, palatable food, and at least a moderate degree of hunger, a major determinant of amount eaten in a meal would be the amount of food served. Supporting this idea, Edelman, Engell, Bronstein, and Hirsch (1986) provided participants with small (225 g), medium (426 g), or large (1000 g) portions of lasagna, finding greater intake of the large portion than of the other two, which did not differ. However, the increases in intake were modest (about 20% from the medium to the large portion) compared with the differences in portion size (more than 100%). Booth, Fuller, and Lewis (1981) increased the size of the sandwiches they served by a factor of 1.5 and found increases in caloric intake on the order of 1.2 or 1.3.

Most of the other evidence relevant to the effect of food availability on amount consumed has been collected in the context of evaluating the relative importance of food presence or salience for obese versus normal individuals in accordance with the predictions of Schachter's (1971) externality hypothesis. This hypothesis predicted that overweight individuals would eat more than those of normal weight in the presence of salient or prominent external cues. Accordingly, a number of studies was conducted to test that notion. In those studies, salience was operationalized in two rather different ways: (1) by varying conditions so that the physical visibility or availability of food was altered, and (2) by varying the extent to which subjects were thinking about food. With both kinds of manipulations, overweight individuals ate more under conditions of high salience, whereas the manipulation had little or no effect on their leaner peers (Johnson, 1974; Nisbett, 1968; Ross, 1974; Tom & Rucker, 1975). For example, Ross (1974) manipulated the salience of food by brightly illuminating it in one condition by means of an unshaded 40-watt bulb and dimly illuminating it in another by means of a shaded 7½-watt bulb and permitted obese and normal weight subjects to eat *ad lib*. The salience manipulation had a large and dramatic effect on the amount eaten by overweight subjects and virtually no effect on those of normal weight. Thus, when food was prominent, overweight subjects increased their meal size considerably. Other studies have shown an effect of salient food cues independent of body weight. Wooley and Wooley (1973), measuring salivation as a stand-in for quantity consumed, found that both obese and normal subjects salivated more when thinking about or looking at food than during control periods.

Salience can also affect food choice within a meal. Stunkard and Levitz (1975) examined dessert choices in a hospital cafeteria under control conditions with high- and low-calorie desserts equally visible and available; then, on one test day they placed high-calorie choices in front and low-calorie choices in the rear, reversing these placements on a second test day. The normal-weight subjects, for whom there were the most observations, consistently selected the desserts that were the most visible and available, increasing their choices of high-calorie desserts on the first test day and increasing their choices of low-calorie desserts on the second day.

Recently, a series of studies appeared that directly tested in normal-weight individuals the role of amount of food available on self-determined portion size. Wansink's (1996) general interest was in the relation between package size of all kinds of consumer goods and amount purchased. In one set of studies, he explored the relationship between package size and the amount selected as an individual portion. When adult subjects were asked to pour out M&Ms into a bowl for watching TV by themselves, they poured an average of 63 from a package of 114 but 103 from a package that was twice as large. An increase to a package three times the size of the original produced only a small and nonsignificant increased increment, to a mean of 122 candies. In another study, the tasks included pouring out Crisco oil for frying chicken and putting a portion of dried spaghetti from a commercial package into a pot for cooking. Wansink reported increases of more than 20% in the portions of oil and spaghetti selected when the source container volumes were doubled. The experiment eliminated the account that this increase is due to the amount of the supply (as opposed to the package size) because it was arranged that the double-sized package was only half full. Participants also estimated the cost of the product they selected as lower when it came from the larger package. Another study found, using bottled or tap water, that the increase in portion size with package size (1-liter vs. 2-liter bottles) occurred only for bottled water. Thus, the results of this study support perceived cost as an explanation for the package-portion effect because it did not appear for cost-free tap water. Yet another study provided more evidence for a determining role for perceived cost; people selected larger portions of Crisco oil for frying from products that were advertised as on sale.

Effort

A number of studies, originally done in the context of Schachter's externality theory of obesity, examined the effects of the effort required to obtain or consume food on meal size. Several studies showed that overweight subjects ate more when food was easily available or easily eaten than when it was difficult to obtain or consume (McArthur & Burstein, 1975; Nisbett & Gurwitz, 1970; Schachter & Friedman, 1974; Singh & Sikes, 1974); the results of the Nisbett (1968) study, cited previously, can also be interpreted in terms of effort. Other studies have found that even normal-weight subjects eat less and change their food choices when effort is high (Lappalainen & Epstein, 1990; Meiselman, Hedderley, Staddon, & Pierson, 1994; Rodin, 1975). For example, in a student cafeteria Meiselman et al. (1994) increased the effort required to obtain candy bars in one study and potato chips in another. Consumption of both decreased, and the students substituted other dessert or starch items, respectively, in the two studies. The Stunkard and Levitz (1975) study described previously can also be interpreted in terms of effort. The U.S. Army has extensively tested a general-purpose ration, the meal, ready to eat (MRE), intended for consumption when hot food is not available. In each of nine studies, in which the MRE was the sole source of subsistence for periods ranging from 5 to 34 days, conducted in a wide variety of environments, soldiers failed to consume enough to maintain body weight. Although many obvious explanations exist for these findings, one possibility is that the effort required to eat these rations (e.g., extracting them from the packages, rehydrating and heating them, cleaning up) can account for at least some of the effect. Consistent with this speculation, in an experiment in which troops received identical MREs in the field or prepared for them in the garrison dining room, the former consumed about 1000 calories per day less than the latter (Hirsch & Kramer, 1993). When Lester and Kramer (1991) provided troops with one of three means of heating their rations in the field, which varied in their perceived convenience of use, group differences in energy intake were positively related to convenience. Engell and Hirsch (1991) varied the relative ease with which subjects could obtain water during a lunch meal, finding that twice as much was consumed when it was on the table than when it was at a more remote location.

Palatability and Preference

It will come as no surprise to learn that people eat larger meals when they are eating food they like. This has been shown to be true whether "liking" is defined in terms of individual preferences (Hill, 1974; Hill & McCutcheon, 1975; Spiegel, Shrager, & Stellar, 1989) or manipulated by "doctoring" the food to alter its palatability (Nisbett, 1968; Yeomans, 1996); it is true for meals consisting of several courses (Guy-Grand, Lehnert, Doassans, & Bellisle, 1994) or a single course (Yeomans, Gray, Mitchell, & True, 1997), as well as sandwich meals (Bellisle & LeMagnen, 1980) and snacks (McKenna, 1972; Decke, 1971); it is true for neonates (Milstein, 1980; Nisbett & Gurwitz, 1970) and children (Ballard, Gipson, Guttenberg, & Ramsey, 1980), as well as for adults; it occurs in the laboratory and when individuals are observed in natural environments (Ballard et al., 1980) or report on their behavior in such environments (Feunekes, de Graaf, & van Staveren, 1995). Some research has suggested that people with certain "aberrant" nutritional statuses (i.e., those who are overweight, hungry, or disinhibited dieters) are more sensitive to variations in palatability than are appropriate controls (see Pliner, Herman, & Polivy, 1990, for a review).

In addition to its effects on meal size, palatability has also been shown to have effects on how people eat meals—on their microstructure. More palatable/preferred meals are eaten faster (i.e., at a higher rate) because people take bigger bites and chew their food for less time and/or more quickly (Bellisle & LeMagnen, 1980; Hill, 1974; Hill & McCutcheon, 1975; Spiegel et al., 1989; Yeomans, 1996). Many studies show that these effects of palatability on rate of intake are confined to the beginning of meals (Bellisle et al., 1984; Bobroff & Kissileff, 1986; Kissileff & Thornton, 1982b; Spiegel et al., 1989). Just as infants show effects analogous to those for adults in terms of the effect of palatability on meal size, so they show similar effects in terms of the microstructure of their eating. In their research on newborn infants, Lipsitt and his colleagues have shown differences in the patterns of sucking responses to solutions varying in palatability (as defined by sweetness). With increasing palatability, the infant increases its overall rate of sucking; although the rate of sucking within sucking bursts decreases, the length of the bursts increases and the infant takes fewer and smaller pauses between them (see Lipsitt & Behl, 1990, for a review).

Mood

There is no lack of theoretical positions positing a relationship between mood and eating. It has been proposed both that moods affect eating and that eating affects mood; in the likely event that there is some truth in both proposals, the meal presents a condition in which both causal arrows are manifested. For this section, with its focus on the psychological determinants of meals, only the effect of mood on meals will be explored. In many theoretical accounts, such a relationship is posited only for a particular subgroup of individuals. A central tenet of many clinical theories of obesity is that overweight people eat in response to emotional distress, especially anxiety and depression (Bruch, 1957; Kaplan & Kaplan, 1957), whereas a more recent rendition of this view suggests that it is only diffuse (i.e., unlabeled) and/or uncontrollable emotional distress that leads to overeating in the obese (Slochower, 1983). Schachter's (1971) theorizing leads to the expectation that anxiety should, by its effects on gastric motility and blood sugar levels, depress eating in individuals of normal weight while having no effect on the obese, who are hypothesized to be unresponsive to such internal cues. A prediction derived from Herman and Polivy's (1975) distinction between restrained and unrestrained eaters is that emotional states such as anxiety (particularly that produced by ego threats) and depression should disrupt the usual control displayed by the restrained eaters, thereby increasing eating.

Whether the hypothesized increases or decreases in eating predicted by these theories should occur in the form of changes in meal size, meal frequency, or both is not addressed in any of them, although nearly all the experimental work examines quantity consumed in single test meals scheduled by the experimenter. In that context, all the positions described previously have received some empirical support. Slochower (1976) produced "diffuse" arousal by exposing subjects to what they believed were the sounds of their own heartbeats; some heard fast (84–92 bpm) and others heard slow (66–74 bpm) heart rates, and to reinforce this aural feedback, she provided written feedback indicating that their heart rates were either "very high" or "slightly slow." This manipulation affected both actual heart rate and reported anxiety. Subsequently, half of each group received information that could provide a neutral explanation for any heart rate effects, whereas the remainder did not. Afterwards, the subjects, obese and normal, were given the opportunity to eat. The results indicated that overweight subjects increased their eating significantly when they were both aroused and had no label for their arousal, whereas normal-weight subjects were unaffected by these manipulations.

Schachter, Goldman, and Gordon (1968) threatened obese and normal-weight subjects with either strong or mild electric shock and found that high fear markedly decreased the amount eaten by normal subjects but had no effect on the amount eaten by the obese. Heatherton, Herman, & Polivy (1991) produced ego-related anxiety in restrained and unrestrained eaters by informing some they would be required to make a speech and others that they had failed an easy task. These manipulations had large effects on restrained eaters, both groups of high-anxiety subjects eating significantly more than those in a low-anxiety condition; unrestrained eaters were not affected by the manipulations. In another study, Polivy and Herman (1976) demonstrated that, although a period of clinical depression produced weight loss (the "typical" effect of depression) in unrestrained eaters, it produced weight gain in restrained eaters.

Yet another theoretical view predicts a change in the macronutrient composition of meals (or snacks) as a function of mood and is based on the notion that ingestion of carbohydrate increases brain serotonin and may, therefore, elevate mood. Wurtman and Wurtman have suggested that among obese carbohydrate cravers and individuals with seasonal affective disorder, consumption of sweet or starchy snacks may serve as a form of self-medication, reducing depression by increasing brain serotonin levels (J.J. Wurtman, 1987; R.J. Wurtman & J.J. Wurtman, 1986). A study by de Castro (1987b), in which subjects recorded all food ingested for 9 consecutive days, as well as rating three mood dimensions (tired-energetic, anxious-tranquil, elated-depressed) before each meal, enables us to examine mood-meal relationships. When correlations between premeal moods and proportions of the three macronutrients ingested were computed, no relationships were found between any of the three mood dimensions and intake of any of the macronutrients. These findings do not provide any support for the Wurtman and Wurtman position, although they do not contradict it either because the mood-macronutrient relationship is posited to exist only for certain individuals (obese carbohydrate cravers and individuals with seasonal affective disorder) and perhaps for snacks only (Wurtman et al., 1985).

Variety and Sensory-Specific Satiety

LeMagnen (1956) demonstrated that if rats successively received, for 30 minutes each, four distinctively flavored versions of their diet, they ate 72% again as much as they ate in a comparable period with only one flavor available. Rolls and her colleagues (1981) and others (Pliner, Herman, Polivy, & Zakalusny, 1980; Spiegel & Stellar, 1990) have shown that presenting humans with a variety of foods within a meal can increase meal size. The magnitude of this effect varies with the distinctiveness of the foods; for example, varying the flavor of cream cheese–based sandwich fillings enhanced intake by 15% over intake of the favorite food only (Rolls, Rowe, & Rolls, 1982b), whereas presenting four very different foods (sausages, bread and butter, chocolate desert, and bananas), which obviously varied on many dimensions, increased intake by 60% (Rolls, van Duijvenvoorde, & Rolls, 1984). The variety effect occurs whether the foods are presented sequentially, as in a many-course meal (Rolls, Hetherington, Burley, and van Duijvenvoorde, 1986), or simultaneously, as at a smorgasbord (Bellisle & LeMagnen, 1981; Pliner et al., 1980; Spiegel & Stellar, 1990).

This enhancement of meal size by a variety of foods suggests that satiety is to some degree "sensory specific" (LeMagnen, 1971). Rolls and her colleagues (1986) have shown that the variety effect is accompanied by decreases in the palatability of foods that are eaten, and Birch and Deysher (1986) have replicated the decline in palatability in young children. Furthermore, foods that are similar to the eaten foods on sensory dimensions such as sweetness and savoriness also decline somewhat in pleasantness, whereas dissimilar foods do not, although similarity in macronutrient composition produces no such effect (Rolls et al., 1984). It seems likely that these changes in palatability mediate the variety effect. That is, if it is assumed that an individual will eat less of a food as its palatability declines (and the section on palatability indicates that amount consumed is certainly affected by palatability), then the provision of a variety of foods should delay the occurrence of such decreases in palatability, thereby increasing intake.

The decrease in palatability that follows ingestion of a food should be distinguished from the negative alliesthesia described by Cabanac (1971; 1979), to which it appears, at first glance, to be similar. In Cabanac's work, previously fasted subjects who ingest a glucose or sucrose load report a decline in the pleasantness of sweet taste. In Cabanac's view, the pleasantness or palatability of a food depends on its physiological usefulness; when people are in a fasted state, glucose is more useful than it is after a glucose load, and for that reason, sweet taste is more pleasant in the former state than in the latter. Thus, for Cabanac, the nutritional consequences of ingestion are responsible for the changes in hedonic responses. However, the time courses of the two phenomena (sensory-specific satiety and negative alliesthesia) appear to be different; sensory-specific satiety is greatest within 2 minutes after ingestion of a food and decreases gradually over the hour after eating (Rolls, 1990), whereas in the Cabanac studies, the largest changes in pleasantness are seen 45 to 60 minutes after sucrose ingestion begins (Cabanac, 1979).

The data on sensory-specific satiety suggest that a decrease in the hedonic value of food may play a role in meal termination, and a small literature exists that is relevant to individuals' reported reasons for ending meals, which examines this notion. Mook and Votaw (1992) had subjects respond to the item, "I usually stop eating a meal when...," including as options: "everyone else is finished" (social alternative), "I've had all I'm allowed" (restrained alternative), "the food stops tasting good" (hedonic alternative), "the food is all gone" (external alternative), and "I feel full" (internal alternative). Of the reasons given, the feeling of fullness was the overwhelming favorite (61% of subjects), and subjects rarely indicated that they stopped eating when the food stopped tasting good (9%). A replication with a larger sample (Zylan, 1996), which also examined sex differences, again showed fullness to be the most common response for both men and women (44% and 47%, respectively) with a decrease in taste far behind (10% and 17% for men and women, respectively).

If we take these reports at face value, it appears that hedonic factors are relatively unimportant in meal termination. However, some data suggesting that these studies may have underestimated the importance of hedonic factors come from a study by Hetherington (1996), who provided subjects with a two-course meal and assessed reasons for stopping after each of the courses. In addition, she added a second "hedonic" alternative, "I got tired of eating that food." The two hedonic alternatives combined were cited more frequently as the most important reason for terminating the first course ("...got tired of that food": 40%; "...food tasted less pleasant": 11%) than was feeling full (25%). More than half of the subjects did not have a second course; among those who did, feeling full was cited more frequently (48%) than were the two hedonic alternatives combined (15% and 18%) as reasons for terminating the second course. In this study, hedonic reasons assumed more importance than in the previous ones. This may be attributable to the addition of the second hedonic alternative; it is possible that changes in the hedonic value of a food are perceived as getting tired of it rather than finding its taste less pleasant. It is also possible that having subjects provide reasons immediately after they stop eating promotes recall of the more subtle and transient hedonic changes that may be forgotten more quickly than the more obvious and longer lasting feelings of fullness. Finally, it is likely that the reasons for stopping the first course might not be the same as those for stopping the second, with fullness a more reasonable account for the second course.

Learning, Experience, and Expectations

Meal Initiation

Given that many, if not most, meals eaten by humans are eaten in accordance with relatively fixed schedules, it is unlikely that a threshold level of energy depletion is the principal cause of eating. This would require that all meal sizes be precisely predicted by the size of the prior meal, the interval since the last meal, and energy expenditure during this interval. In fact, in free-living animals (rat data from LeMagnen & Tallon, 1966; human data from Bernstein, Zimmerman, Czeisler, & Weitzman, 1981), meal size is a better predictor of time to next meal as opposed to time since last meal. But with a fixed meal schedule, the latter prediction cannot hold.

Under these conditions, it has been argued, people may eat because hunger signals become conditioned to cues (including temporal ones) predicting the imminence of a meal, and eating is a response to this conditioned hunger (Bellisle, 1979). In a series of elegant studies, Weingarten (1983; 1984; 1985) taught rats an association between a specific exteroceptive cue and food availability by signaling meals with a tone/buzzer compound (CS+) and nonmeals with a different pure tone (CS-). Subsequent presentation of the conditioned stimulus reliably induced meal initiation, even when the animals were tested under sated conditions. Birch, McPhee, Sullivan, and Johnson (1989) conducted a pair of similar studies with preschool children as subjects. The children received 10 pairs of conditioning trials in which a distinctive stimulus compound was presented just before access to snacks (CS+), whereas a different one was presented in the absence of access to snacks (CS-). During testing, which occurred in a sated state (children had just finished eating a snack), the children showed a quicker latency to eat and ate more after presentation of the CS+ than of the CS-. Consumption at the snack cued by the CS+ averaged 10 to 15% of the recommended daily allowance for calories. Of course, another interpretation of reliable meal eating at specific times by humans is that it has little to do with hunger of any sort and has rather to do with custom and the availability and appetizing quality of the food.

Meal Termination

Conditioning also appears to have an effect on meal termination. Many years ago LeMagnen (1955) noted that, by the end of a meal, absorption is not great enough to explain the cessation of feeding and invoked a conditioning explanation to account for the paradox. The notion is that conditioning arises from the delayed aftereffects of eating a particular food on earlier occasions; thus, intake can be adjusted to the nutritive value of a familiar food. In this conditioning, the postingestive effects of a food serve as an unconditioned stimulus with which the sensory aspects of the food become associated as a conditioned stimulus. Booth has demonstrated this phenomenon empirically in rats (Booth, 1972; Booth & Davis, 1973) and in humans (Booth, Lee, & McAleavey, 1976; Booth, Mather, & Fuller, 1982). In the last-named study, after one experience with a meal beginning with a distinctively flavored soup of high caloric density, on subsequent days when the same soup was served, subjects decreased their intake of food later in the meal; with one experience, they increased intake of later courses after ingestion of a soup with low caloric density. Again, a comparable study with young children as subjects has come from Birch's laboratory (Birch & Deysher, 1985). The children showed evidence of conditioned satiety, eating less after the flavor that was paired with the high-calorie (vs. low) preload after experience with the flavor-calorie pairing.

This anticipatory control may be unconscious, but it need not be so. Certainly, individuals make quite deliberate decisions about what to eat later in a meal based on what they have eaten earlier, or make decisions about what to eat earlier based on what they would like to eat later (e.g., "I'll skip an appetizer because the desserts look really good"). What has been learned in the past about the postingestional consequences of various foods can be conscious and it can operate symbolically. One need not actually see or even taste a particular food to adjust intake to its postingestional effects—its name alone will suffice. Booth (1977) asked subjects, both before and after they ate a meal, to indicate how pleasant it would be to ingest various foods. High-calorie foods showed the greatest decline from before to after the meal. However, some very rich foods, usually served at the end of the meal, remained highly palatable even for replete subjects (so maybe it is not necessary to forgo a nice appetizer in order to "have room" for dessert).

Several studies have shown that meal size is regulated in part by individuals' beliefs about the caloric content of what they have previously eaten, what they are currently eating, or what they will be eating. S.C. Wooley (1972) preloaded obese and normal-weight subjects with drinks that were actually high or low in caloric density (containing 600 vs. 200 kcal) and, crosscutting actual caloric content, that appeared to be high or low in calories. Subsequent meal intake for both weight groups was unaffected by actual caloric density, but subjects ate significantly more (about 10%) when they believed they had consumed a drink low (vs. high) in calories. Nisbett and Storms (1974) obtained a similar effect of perceived calories. O.W. Wooley, S. C. Wooley, and Dunham (1972) found that subjects' judgments about the caloric content of their liquid meals were better predictors of the amounts they consumed than was the actual caloric content.

A more complicated prediction about the effects of caloric beliefs on consumption comes from Herman and Polivy's (1980) research on dieting. In their view, eating a large amount should increase subsequent eating in dieters. Although dieters ordinarily restrict their eating, a "forced" high-calorie preload should cause a dieter to throw in the towel, the diet being blown for the day, and allow him or her to succumb to chronic hunger and overeat. A low-calorie preload would leave the dieter's restraint intact; thus, paradoxically, restrained eaters should "counter-regulate," eating less after a preload low (vs. high) in calories. This prediction has been confirmed in many studies (see Herman & Polivy, 1980, for a review). More interesting in the present context are the results of several studies in which the *perceived* caloric content of a preload was manipulated; dieters responded to the manipulation by eating less when they thought they had eaten a low-calorie than when they thought they had eaten a high-calorie preload (Polivy, 1976; Spencer & Fremouw, 1979; Woody, Costanzo, Leifer, & Conger 1981).

It might also be expected that meal size should be regulated by individuals' beliefs about what they will be eating in the future. Plans concerning subsequent meals later in the day should affect intake in the here and now. For example, someone expecting to eat a particularly large dinner might purposely eat a light lunch, compensating in advance for the large meal. Similarly, someone anticipating a late dinner might have a late afternoon snack, again compensating in advance—this time for the extended deprivation. When Lowe (1982) told some of his subjects, before they ate, that they would have to wait 4 hours before eating again, they ate more than those who were not expecting a period of deprivation (but see Tomarken and Kirshenbaum [1984] for puzzling evidence that both dieters and nondieters increase intake when told of a high-calorie "postload").

Much of the research described in this section was motivated by LeMagnen's observation that correction of an energy deficit could not account for meal termination because the latter occurs before the former. Much of the research, as with that on meal initiation research, has focused on some form of conditioning. But other work, such as that cited previously, invokes higher order units of regulation, cognitively imposed. It is also likely that cultural constraints on meal composition and meal size, manifested both in serving sizes and by internalized standards, are the principal determinants of meal termination. These are, of course, also learned responses.

Social Factors

Most meals are eaten in the presence of others. Using eating diary data, de Castro and his colleagues have shown that nondieting males and females eat more when they are in the presence of others than when they are alone. Furthermore, there is an orderly increase in meal size as a function of the number of others present (de Castro & Brewer, 1992). This "social correlation" is evident for all meals of the day, as well as snacks; on weekdays and weekends; for meals eaten at home, in restaurants, and in other locations; and for meals ingested with and without alcohol (de Castro, 1991; de Castro, Brewer, Elmore, & Orozco, 1990). When subjects were instructed to eat alone for 5 days, intake decreased significantly, suggesting a causal role for the presence of others (Redd & de Castro, 1992). Feunekes et al. (1995) and de Castro (1990) present data indicating that the social enhancement of eating is mediated primarily by the fact that people eating together spend a longer time eating.

In his extensive program of research, de Castro has used eating diaries as a method for studying the effect of the presence of others on meal size. However, social facilitation has been also documented in observational studies (Klesges, Bartsch, Norwood, Kautzman & Haugrud, 1984; Krantz, 1979) and in the laboratory (Berry, Beatty, & Klesges, 1985; Clendenen, Herman, & Polivy, 1994; Edelman et al., 1986). In a field evaluation of the U.S. Army's T-ration, daily caloric consumption increased as a function of the number of meals soldiers reported eating socially (Salter et al., 1991). It is clear that under many circumstances people eat more when they are in the company of others than when they are alone.

However, the effects of the presence of others on meal size are much more complex than a simple social facilitation notion would suggest. A substantial body of research can be understood in the context of the notion that people see eating "lightly" as a means of making a good impression in a social situation (Chaiken & Pliner, 1987; Pliner & Chaiken, 1990). Aspects of the situation that increase the importance of impression management or the salience of a norm of minimal consumption decrease meal size. People eat smaller meals when they are with strangers or coworkers than with family or friends (Clendenen et al., 1994; de Castro, 1994). Soldiers eat smaller meals when they are eating with a noncommissioned officer who eats a small (vs. large) amount (Engell, Kramer, Luther, & Adams, 1990). Women and men eat less when they are with a member of the opposite sex (Conger, Conger, Costanzo, Wright, & Matter, 1980; Pliner & Chaiken, 1990), especially one of high social desirability (Mori, Chaiken, & Pliner, 1987). People eat less when they are implicitly or explicitly under observation (Herman, Polivy, & Silver, 1979; Polivy, Herman, Hackett, & Kuleshnyk, 1986) and when they are eating in the presence of a dieter (Polivy, Herman, Younger, & Erskine, 1979) or someone who eats minimally or not at all (Conger et al., 1980; Nisbett & Storms, 1974; Rosenthal & Marx, 1979). Indeed, social modeling of minimal consumption can be powerful enough to override 24-hour deprivation-induced hunger (Goldman, Herman, & Polivy, 1991). Those who are particularly sensitive about their weight (i.e., dieting or overweight) are particularly affected by the presence of others. Obese individuals eat less when eating with others (Krantz, 1979) than when alone, especially when their eating companions are of normal weight (De Luca & Spigelman, 1979). The inhibiting effect of a noneating companion is particularly strong for dieters (Herman et al., 1979).

Cultural Standards and Memory

A major determinant of meal size and meal content is the cultural definition of an appropriate meal. In the United States, a dinner with two entrees or two desserts is excessive. Fried eggs are appropriate for breakfast but not for dinner. Cultural standards surely influence the amount eaten. For example, after finishing a main course, it is inappropriate to eat another; after eating dessert, it is inappropriate to return to a main course item. Most generally, having just eaten what is defined as a culturally complete meal, one is by virtue of this memory discouraged from further ingestion. Little research has been done to verify these reasonable claims. We would predict that a person who ate a high-calorie meal without dessert would be more likely to continue to eat than a person who ate a meal of substantially lower calories but that was a complete meal with dessert. Pliner (1999) had participants observe a videotaped target person eating either while engaging in behaviors associated with meals (e.g., warming food, using dishes and utensils, sitting down to eat) or not associated with meals (e.g., eating food cold, eating out of containers without utensils, eating while standing); the amount of food eaten was identical in the two conditions. Participants' ratings of the target's likelihood of eating in the next 2 hours and the degree of hunger were lower in the meal than in the nonmeal condition. These findings suggest that, at least from an observer's perspective, if someone has eaten a meal, he or she is not expected to eat again or be hungry in the near future.

One recent study on densely amnesic people confirms the importance of memory as a determinant of meal continuation or initiation (Rozin, Dow, Moscovitch, & Rajaram, 1998). Amnesic subjects who do not distinctly remember that they have just eaten will eat a second and even third full lunch, if these are served in sequence with intervals of 10 to 30 minutes. What is absent from these people is the memory that they have just eaten. Apparently, this is a really important piece of information and, hence, determinant of eating. Apparently, physiological satiety signals after a first meal are insufficient to completely inhibit ingestion as well.

Location

Although location is not mentioned in most discussions of how much people eat, after a moment's thought, one realizes how important location is in determining both what and how much people eat. Because most human meal studies are in the laboratory, location has not emerged as a major variable. Meiselman and his colleagues have consistently argued for the importance of location and context in general. Many of the studies by Meiselman and his collaborators at Natick are done in natural eating settings, allowing for evaluation of location effects. A number of studies demonstrate important effects and interactions among palatability, appropriateness, and location. Bell & Meiselman (1995) reviewed the effects of location, and conclude by supporting its major importance. For example, arrangement of food on a serving line affects choice. The characteristics of the meal occasion significantly affect acceptability and choice (Bell & Meiselman, 1995), and the ethnic setting (type of restaurant, restaurant decor) influences selection (Bell, Meiselman, Pierson, & Reeve, 1994).

Coll, Meyer, & Stunkard (1979) observed Americans eating at eating establishments, from restaurants, to cafeterias, to ice cream parlors and fast food establishments. They reported that the particular location strongly influences both the amount and type of food consumed and suggested that for eating in public places, location may be the most powerful determinant of amount consumed. For example, intake in kilocalories was about twice as high in a restaurant as in a cafeteria. Similarly, intake patterns of airline meals are different when served in the air or on the ground (Green & Butts, 1945).

In the marketing literature and the food retail industry, it is well known that location of food in a food store influences food purchase and, ultimately, consumption. Locations including end of aisle and eye level enhance the likelihood of purchase (Kahn & McAlister, 1997). Because more than 50% of consumer food store purchases are unplanned, such local environmental factors have a large amount of potential variance to explain.

THE ANOMALIES OF BREAKFAST

Breakfast is literally the first meal of the day, that which breaks the overnight fast. For most individuals, it is eaten shortly after rising. It is known that (perceived) time of day, per se, can influence amount eaten. A classic study by Schachter and Gross (1968) manipulated subjects' perceptions of time of day by means of a clock "gimmicked" to run either at twice normal speed or at half normal speed. Subjects arriving at 5:00 PM, were given instructions for 5 minutes and then occupied for 30 minutes in the presence of the clock. At that point, those in the "fast-clock" condition were under the impression that it was 6:05, whereas those in the "slow-clock" condition believed it to be 5:20. All were then given the opportunity to snack on crackers. Obese subjects, behaving in conformity with Schachter's external hypothesis, ate more when they believed it was past dinner time (6:05) than when they believed it was before dinner time (5:20); normal weight subjects showed the reverse pattern, eating less in the fast-clock condition than in the slow-clock condition.

Several interesting anomalies exist about breakfast compared with other meals. It is the smallest meal, following the longest fast, and, in Western cultures, its culinary makeup is qualitatively different from other meals. We also suspect, although we know of no relevant data, that many people eat the same breakfast every day; breakfast items do not seem to show the decrease in palatability with repetition shown by other food items.

Breakfast as the Smallest Meal

In Western cultures meal size increases from breakfast to lunch to dinner (de Castro, 1987a). It is also the meal that is most likely to be skipped, at least among young people (Schachter, 1971; Singleton & Rhoads, 1982). As the first meal of the day after what is usually the longest period of deprivation (break fast), it should be the largest meal. The equivalent of breakfast for free-running rats (first meal of the dark cycle) *is* the largest meal. Yet, characteristically, for humans, across cultures, breakfast is the smallest meal. There are two perspectives on this paradox. One is a metabolic account. Although breakfast follows the longest fast, it also usually follows the largest meal. The actual state of energy depletion is presumably some function of time since the last meal, the size of the last meal, and the energy expenditure since the last meal (Booth & Mather, 1978). Evidence from rat research is abundant, dating from LeMagnen & Tallon (1966), that meal size is better predicted by time to next meal than to time from last meal. In this context, the larger size of supper makes sense. The second perspective on the smallness of breakfast is cultural. The surprising smallness of breakfast is a distinctive feature of *human* meal patterns and promotes a distinctively human account. Cuisine is also a distinctively human occurrence and is characterized by elaborate meal preparations. It may be that the metabolic and work-cycle pressures to eat promptly on awakening and get to work to maximize daylight hours conflict with the food preparation traditions and encourage a small breakfast. Of course, in modern society, with microwaves and the like, an elaborate breakfast can be created in minutes. Perhaps some sort of cultural conservatism discourages this modernization of breakfast.

Breakfast as Culinarily Unique

Breakfast is distinct in its contents as well as its size; it tends to be different from lunch and dinner. In many instances, different foods are considered suitable for breakfast compared with lunch and dinner. Indeed, tacit acknowledgment of this distinction can be seen in a recent campaign by the Canadian Egg Marketing Board to induce consumers to "eat breakfast for dinner."

Pliner (1999) showed subjects videotapes in which a "target person" was shown eating a meal containing soup, fried chicken, and an apple and asked them for their "best guess" as to whether she was eating breakfast, lunch, dinner, or a snack. Only 4% of participants guessed she was eating breakfast. Birch, Billman, and Richards (1984) predicted that the "acceptability" of a food would be related to cultural beliefs about its appropriateness for particular mealtimes. The strength of these cultural beliefs can be seen in the fact that all their adult subjects sorted eight foods identically: orange juice, scrambled eggs, and Cheerios were seen as appropriate for breakfast but not dinner; frozen green beans, cheese pizza, and macaroni and cheese were seen as appropriate for dinner but not for breakfast; bread and banana were seen as appropriate for either. When 3- to 5-year-old children sorted the foods, 70% of their categorizations conformed to those of the adults. Participants tasted the set of foods twice—once between 8 and 10 AM and once at 3:30 and 5:30 PM—and provided preference assessments on each occasion. For both children and adults, the "breakfast" foods were liked better in the morning than in the afternoon, whereas the reverse was true for "dinner" foods. However, different results were obtained by Kramer, Rock, and Engell (1992). Subjects ate four meals, two consisting of breakfast-type foods (e.g., bacon and eggs) and two consisting of lunch-type foods (e.g., turkey sandwich). One meal of each type was eaten at breakfast time (8:00 AM) and one at lunch time (noon). Hedonic ratings showed no hint of the predicted statistical interaction between food type and meal time; rather, the lunch foods were rated more positively at both mealtimes. Furthermore, amounts consumed showed no evidence of a food type–mealtime interaction. Instead, there were two main effects; participants ate more of the lunch foods, and they ate more at lunch time.

In terms of notions of cuisine, such as flavor principles (E. Rozin, 1973), breakfast is the anomalous meal. That is, if one attempted to assign someone to their culture on the basis of information about a particular meal they consumed, breakfast would be the least informative. The French, German, or American breakfasts differ less than their other meals. The evolution of Western breakfast foods is a major topic for research—research that has not been done. Suffice it to say that breakfast foods seem to involve minimal preparation and often center on a warm beverage, typically tea or coffee. The culinary anomaly of breakfast is largely a Western phenomenon. For most peoples of the world, in traditional cultures, breakfast is simply warmed over supper. There are not distinctive breakfast foods, and the warming over reduces the preparation time.

CONCLUSIONS: THE MEAL AS THE PRIVILEGED PSYCHOLOGICAL OR PHYSIOLOGICAL UNIT

We have reviewed abundant evidence, linguistic, culinary, practical, and memorial, that the meal is a special unit of eating at the psychological level. It is the basic or privileged unit, in that smaller units are described as subdivisions of meals, and there is no particular designation of higher units (e.g., daily or monthly intake). Both our day and our thinking are organized in terms of meals.

This said, the great preponderance of research on meals has to do with their physiological basis as opposed to their psychological reality. The extensive body of research on regulation of food intake, primarily in rats and humans, has used the meal as the unit. The focal question has been: what initiates a meal, what terminates a meal, and what determines the size of meals? The "what" in these questions almost always refers to physiological events, such as stomach fill, blood glucose levels, body temperature, flow of some nutrient metabolite from one body compartment or brain area to another. Although general schemes of food regulation, from Stellar (1954) on, have given appropriate attention to nonmetabolic factors, the focus has been metabolism. Research on rats and humans, under appropriately controlled conditions, has indicated roles for many physiological factors, from gastric fill to levels and flows of nutrients in liver, brain, and other tissues, in the determination of meal size, initiation, and termination. These findings constitute a major literature that is covered elsewhere in this volume. One of the most important findings in this area is that, all other things being equal (*ceteris parebis*), changes in the caloric density of a diet lead to compensatory changes in volume consumed. *Ceteris parebis*, meal size is controlled by various indices of nutritional status. But *ceteris parebis*, especially for humans, means extracting a meal from its natural context and holding constant what *we* take to be the principal determinants of meal size. This is most clearly illustrated by the multiple meal-taking of amnesics, who should be receiving normal physiological satiety signals, but whose failure to recall having recently eaten seems a sufficient stimulus for ingestion of a full meal (Rozin et al., 1998).

Let us consider, in a natural eating context, what are the principal determinants of whether someone will eat and how much he or she will eat. We believe that in natural conditions, the principal determinants are predominantly nonmetabolic. People will eat if it is a culturally appropriate mealtime, if they do not remember having just eaten, and if presented with food. The amount they eat will probably be primarily affected by the palatability and appropriateness of the food and the amount available. Secondary effects would include cultural constraints (e.g., how much it is appropriate to eat for this particular type of meal), degree of hunger, social setting, and location. The perceived energy density of the food may be a more important determinant of intake than the actual energy density (Wooley, 1972).

The remarkable phenomenon is that although intake in any given meal is predominantly controlled by nonmetabolic factors, people's weight varies very little from week to week, or even year to year. We take this remarkable fact to mean that the focus of action of metabolic factors may be over a "unit" that is much longer than a meal, perhaps a daily or even weekly intake. A recent study by Leann Birch and her colleagues (Birch, Johnson, Andresen, Petersen, & Schulte, 1991) on successive meal sizes of children over 6 days supports this idea. Birch concludes that although individual meals may vary greatly from day to day for the same child with the same choices, the 24-hour intake is relatively constant. The mean coefficient of variation for meal size is 33.6%, but for 24 hours it is only 10.4%. In most cases, Birch reports adjustment from meal to meal. Many laboratory studies indicate that rats (e.g., Carlisle & Stellar, 1969), human adults (Kissileff & Thornton, 1982b; Spiegel, 1973) and children (Birch & Deysher, 1985) regulate energy intake in meals in that they increase bulk intake when the caloric density of the diet is reduced. Some studies report effects on the first meal, but anything close to full compensation, if it occurs, takes place over a number of meals or even days. Louis-Sylvestre, Tournier, Chapelot, & Chabert (1994) found nearly complete energy adjustment in the 24 hours after the low-calorie dish was served and a return to the baseline level once the energy content of the dish was restored. Along the same lines, eating diary studies show small but significant negative correlations between the size of a meal and the size of the subsequent meal in both adults and children (Birch et al., 1991; de Castro & Kreitzman, 1985).

This is not to say that physiological factors do not exert their influences on meal size—there is little else for them to operate on! Rather, it means that physiological factors may often operate in a modulatory way, exerting their net effect over a sequence of meals. The metabolic compensation one pays for a highly palatable meal indulgence will be seen over the coming meals and days, not in the meal itself.

We conclude that it is reasonable to be very interested in meals, and if that *is* our interest, we need to pay much more attention to determinants of meal initiation, meal size, and meal termination in natural situations, in context.

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