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UMI
THE EFFECTS OF PRE-EXPOSURE TO FOOD CUES ON THE EATING BEHAVIOR
OF RESTRAINED AND UNRESTRAINED EATERS

by

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A thesis submitted in conformity with the requirements
for the degree of Doctor of Philosophy,
Graduate Department of Psychology
University of Toronto

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Three studies were conducted to examine the response of restrained and unrestrained eaters to pre-eating exposure to food cues. Study one investigated the effect of pre-exposure to two types of food cues (olfactory and cognitive) on food intake by restrained and unrestrained eaters. Subjects were exposed to either no cue, an olfactory cue, a cognitive cue, or a combination of the two food cues for ten minutes prior to eating. Restrained eaters ate significantly more than did unrestrained eaters after exposure to the food cues. Study two found that restrained eaters responded to pre-eating exposure to food cues by eating more, but only when the food they eat is the same as that to which they have been exposed. Intake of a food that differed from the pre-eating food cue was not significantly different from food intake after no prior exposure. Unrestrained eaters showed little differential eating response to either food cue. Study three tested whether the specificity of response to a food cue is controlled by what subjects are led to expect about the foods that they will be tasting. Expectancies played a significant role in determining food intake as indicated by the finding that restrained eaters ate significantly more when they were expecting to taste the same food as the preceding cue relative to restrained eaters who were expecting to taste a different food, even though the food that they eventually ate, chocolate chip cookies, was the same in both conditions. Unrestrained eaters'
food intake was not significantly affected by these manipulations.

Pre-eating exposure to food cues evoked increased food intake in restrained subjects. This effect may be due to a history of classically conditioned responses to food-associated cues formed during critical periods of food deprivation (dieting). Unrestrained eaters, who do not restrict their food intake, are less likely to form such strongly conditioned associations and therefore are not as influenced by external food stimuli. Food cues may act as a signal to eat and also convey a message of what to eat to receptive individuals such as those with a history of food deprivation.
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Chapter 1

General Introduction

Early studies on eating behavior have hypothesized that physiological responses to food deprivation signal the individual to eat. There is little question that energy depletion induces food ingestion (Bolles, 1965; Epstein, Nicolaides & Miselis, 1975), but eating behavior in both humans and animals is also responsive to cues in the external environment. Individual differences in body weight were found to have a significant impact on how much behavior was influenced by external stimuli in the environment; normal weight individuals' eating was not influenced by exposure to external cues whereas obese individuals' eating responded to exposure to external cues (Schachter, 1968, 1971). Herman and Polivy (1975) later argued that dieting (which is common among the obese) is the critical factor in the "obese" pattern of eating.

It is apparent from both animal and human studies that food-associated cues can significantly influence subsequent food consumption. However, it is not clear what mechanisms control such effects. This thesis aims to explore the psychological determinants of cue-induced eating. More specifically, this thesis examines the role of restraint in the relationship between eating and food-associated cues. It is proposed that a history of learned associations between external stimuli and eating, formed during episodes of food deprivation, lead to subsequent overeating by restrained eaters following exposure to cognitive and sensory food cues.
External Cues and Eating

Food-associated external cues can be potent enhancers of food consumption. Several studies have demonstrated that an individual's food consumption can be affected by a period of pre-eating exposure to sensory aspects of food prior to eating. The combination of a brief taste and sight of a particular food presented a few minutes prior to eating stimulated young adults to eat beyond the point of satiety (Cornell, Rodin, & Weingarten, 1989). Priming with a highly preferred food increased the amount consumed of that food relative to a nonprimed food. Psychiatric patients who were chronic "meal missers" were found to skip fewer meals following a three-week treatment phase of being exposed to visual cues (watching others eat) or oral cues (tasting food) (Sobell, Schaefer, Sobell, & Kremer, 1970). Finally, a 90-second pre-eating exposure to a food-related cue, either a taste or a picture of a palatable food, increased desire to eat that food (though no corresponding increase in subsequent food consumption was evident) (Lambert, Neal, Noyes, Parker, & Worrel, 1991).

Food cues are also effective in motivating food-related activities and ingestion in animals, even in those with little or no caloric depletion. Conditioned food cues can motivate sated rats to eat a substantial amount of food (Grant & Milgram, 1973; Weingarten, 1983, 1984). Food-reinforced operant responses such as lever-pressing are enhanced following exposure to food cues (Deluty, 1976; Eiserer, 1978; Konorski, 1967). Furthermore, previously extinguished food-reinforced operant behaviors can be reinstated by exposure to food cues (Eiserer, 1978; Eiserer & Hoffman, 1973; Panskepp & Trawill, 1967).
Individual Differences and External Cues

Application of animal studies to human behavior is complicated by the finding that some people are more likely than others to be influenced by external stimuli. Schachter (1968, 1971) proposed that obese individuals are relatively insensitive to internal physiological events; instead, their behavior is governed by external stimuli in their environment. A series of lab studies was conducted which studied the eating response of obese and normal weight subjects after food loading, fear induction or adrenalin injections (Schachter, 1967; Schachter, Goldman, & Gordon, 1968).

Normal weight subjects ate more when they were calm than when they were frightened, or when given adrenalin, and ate more when they were food deprived than when they were full. The manipulations had no effect on the amount eaten by obese subjects. Schachter and colleagues concluded that the eating of the obese is not governed by the same bodily symptoms as is the eating of normal weight individuals. Two other studies showed that after an experimental manipulation of anxiety, normal weight subjects ate less while obese subjects ate the same amount in the low and high fear/anxiety conditions (McKenna, 1972; Abramson & Wunderlich, 1972), suggesting that the eating response of the obese was not primarily dictated by internal sensations.
Moreover, manipulations of presumed ‘dinner time,’ palatability, smell, sight, and visual prominence of food cues demonstrated that the eating behavior of obese individuals was primarily externally controlled (Goldman, Jaffa, & Schachter, 1968; Johnson, 1970; Nisbett, 1968; Schachter & Gross, 1968). It was from these observations that the externality hypothesis was formulated. It states that “eating by the obese seems unrelated to any internal visceral state, but is determined by external food-relevant cues such as the sight, smell and taste of food” (Schachter, 1971, p. 130). The eating behavior of normal weight individuals, on the other hand, appears to be mainly controlled by their internal physiological state.

As research progressed in this area, it became apparent that the dichotomy of overweight-external versus normal weight-internal did not always hold. Some later replication studies failed to demonstrate that overweight individuals were more responsive to external food and nonfood cues than were their normal weight peers (e.g., Goldman, 1969; Nisbett & Storms, 1975; Nisbett & Temoshok, 1976; Pudel, 1975; Price, Sheposh, & Tiano, 1975). Problems with inconsistent findings have arisen from the failure to develop a good definition of external responsiveness, nor have clear cut measures of internal sensitivity (i.e., reliable measures of hunger and satiety) been developed (Rodin, 1981).

1 It is important to recognize that there is not always a strict demarcation between external and internal stimuli. With regard to food intake, external and internal cues can be closely related. External cues such as the sight, smell, and taste of food can trigger internal physiological responses such as insulin secretion, which stimulates the appetite to eat (Powley, 1977; Rodin, 1985). In this thesis I will refer to external cues as those cues which originate from outside the body with the understanding that these cues may very well trigger internal physiological responses.
Another issue is one of sampling. Not all overweight individuals have been found to be externally responsive and neither were all normal weight individuals internally sensitive. Researchers found that in every weight category there were people who were not externally responsive (e.g., Nisbett & Storms, 1975; Nisbett & Temoshok, 1976; Rodin & Slochower, 1976; Tom & Rucker, 1975) and people who were not internally sensitive (Nisbett, 1972; Price & Grinker, 1973; Speigel, 1973; Wooley, 1972). The degree of overweight has not been found to be strongly related to the degree of externality or internality in these studies (Nisbett, 1972; Price & Grinker, 1973; Rodin, Slochower & Fleming, 1977).

**Restraint**

Attention subsequently shifted from a focus on body weight as a determinant of eating style to the role of food deprivation. Nisbett (1972) proposed that deprivation was the key factor in the determination of eating responses. Some overweight individuals, through chronic food deprivation (i.e., dieting), are below their biological set point for body weight. Being below one's body weight set point induces a state of chronic hunger which heightens responsiveness to external food cues, Nisbett argued.

Herman and Polivy (1975) extended these observations by proposing that dietary restraint rather than body weight per se is the critical factor in the “obese” pattern of eating. Restrained eating is defined as the deliberate effort to combat the physiologically-based urge to eat, in order to lose weight or to maintain a reduced weight. Highly restrained eaters (dieters), on one end of the continuum, constantly try to restrict
their food intake, and are concerned about how much they eat. At the other end of the continuum, low restrained eaters (non-dieters) eat whatever they like and do not worry about what they eat (Herman & Mack, 1975; Herman & Polivy, 1980).

Relative food deprivation as a consequence of the deliberate restriction of food intake (i.e., dieting) is independent of weight: both overweight and normal weight individuals may be dieters. The possibility arose that the inconsistency of the above-mentioned findings on the externality of the obese could be due to differences in the level of restraint rather than differences in weight. Externality could be a characteristic of restraint rather than of obesity.

The emergence of the concept of restraint was accompanied by the formulation of a new hypothesis concerning the relationship between weight, externality and eating patterns. It was argued that those individuals who rated themselves as restrained eaters, regardless of body weight, showed the pattern of eating that sometimes characterized obese individuals. Research findings indicate that restrained eaters resemble obese individuals in their insensitivity to internal signals (Herman & Mack, 1975; Hibscher & Herman, 1977) and other, noneating ways, including greater distractibility (Herman, Polivy, Pliner, Thelkeld, & Munic, 1978) and hyperemotionality (Herman et al., 1978; Polivy, Herman, & Warsh, 1978).

Moreover, restrained eaters were not only characterized by dieting but also by periods of overeating (Herman & Polivy, 1980). It seems that self-control of dieters can temporarily be released by "disinhibitors." Numerous studies have been performed investigating the type of stimuli which induce restrained eaters to overeat (eat beyond the allowance of their diet quotas and beyond "normal" amounts).
Research Examining the Disinhibition Hypothesis for Restrained Eaters

To maintain dietary inhibition, dieters must ignore internal cues of hunger and adhere to the externally-imposed demands (caloric restriction) of the diet (Hatherton, Polivy, & Herman, 1989; Herman & Polivy, 1988). This unresponsiveness to physiologically-generated hunger signals may generalize to other internal cues, including those of satiety. Herman and Mack (1975) developed a paradigmatic experimental protocol in which subjects were categorized into restrained or unrestrained according to their scores on the Restraint Scale (see Herman & Polivy, 1980) and were given a preload of either 2 milkshakes, 1 milkshake, or no preload. Next, subjects participated in a “taste test” of 3 types of ice cream and the amount of ice cream eaten was recorded. The unrestrained eaters ate less following a caloric preload, thus calorically regulating their consumption, whereas the restrained eaters showed the opposite pattern, eating more ice cream after the preloads than after no preload. This pattern of consumption, termed counterregulation, has been replicated in several subsequent studies (e.g., Hibscher & Herman, 1977; Knight & Boland, 1989; Polivy, 1976; Spencer & Fremouw, 1979). Others have found that dieters non-regulated instead of counterregulating, that is, dieters ate the same amount regardless of preload condition (Ruderman & Christensen, 1983). The important point is that dieters appear not to rely on internal sensations of satiety (as unrestrained eaters presumably do) to regulate their food intake.

A further consequence of chronically ignoring internal cues may be a compensatory overdependence upon cognitive cues and/or external signals originating from the environment. Manipulation of cognitive cues significantly influences
dieters' eating, at least over the short term. For example, restrained eaters ate more when they consumed what they believed to be a high calorie preload than after what they believed to be a low calorie preload, regardless of the actual caloric content (Polivy, 1976; Spencer & Fremouw, 1979; Woody, Constanzo, Leifer, & Conger, 1981). Beliefs that the preload is a “forbidden” type of food, regardless of perceived number of calories, promote disinhibited eating (Knight & Boland, 1989) and guilt in dieters (King, Herman & Polivy, 1987). What dieters are led to believe or anticipate prior to eating significantly influences subsequent eating. Being told that they would feel hungry induced restrained subjects to eat significantly more ice cream than being told that they would feel satisfied or being told nothing at all (Heatherton, Polivy, & Herman, 1989).

Anticipated consumption also has a disinhibiting effect on restrained eaters. When anticipating eating high-calorie food (i.e., a milkshake or a high-calorie dinner), restrained eaters ate more in a subsequent taste-test relative to when anticipating low-calorie food or no food (Ruderman, Belzer, & Halperin, 1985; Robinson, Hill, & Rogers, 1983; Tomarken & Kirschenbaum, 1984).

Overeating by dieters can also be influenced by non-food manipulations. Polivy and Herman (1976) manipulated subjects' beliefs about the alcoholic content of a drink (alcohol or a vitamin C drink). When restrained eaters drank alcohol and they knew that they were receiving alcohol, they subsequently ate more ice cream than if they believed that they had consumed a vitamin C drink. Unrestrained eaters, on the other hand, ate less when they thought that they had ingested alcohol relative to when they believed that they had consumed vitamin C. The induction of certain emotional
states (such as anxiety) also elicits an overeating response in dieters (Herman & Polivy, 1975; Heatherton, Herman & Polivy, 1991; Baucom & Aiken, 1981; Frost, Goolkasian, Ely, & Blanchard, 1982; Ruderman, 1985; Herman, Polivy, Lank, & Heatherton, 1987).

In summary, laboratory research indicates that restrained eaters overeat in response to a variety of stimuli. Overeating, i.e. - non regulation of eating or counterregulation, can be induced in dieters by a variety of disinhibitors such as preloads, cognitions, and emotions. The question then arises as to why this happens. Several explanations have been proposed from both physiological and cognitive orientations.

**Physiological Theories**

**Set Point Theory**

The set point hypothesis proposes that, like many biological parameters, body fat is controlled by a homeostatic mechanism (Nisbett, 1972). According to the theory, every organism possesses a particular amount of fat. The absolute level of body fat may differ in individuals of the same height and bone structure depending on heredity or early feeding experiences. Through feedback processes, the amount of body fat actually present in the organism is conveyed to a homeostatic control mechanism. Should body fat change from what the set point requires, processes will be initiated to restore the amount of fat to the set point level.

This argument applies to the case of the obese, who may have a high set point for weight which does not fit with the current socio-cultural ideals of slenderness of
today's society. By restricting their food intake in order to lose weight, obese people come to resemble starved organisms (Nisbett, 1972). An obese individual’s body weight may actually be below his or her set point. Habitual dieters who successfully lose weight may be in a state of chronic hunger and energy deficit, particularly if this weight loss results in the dieter being at a weight below her biological set-point (Polivy & Herman, 1985). Dietary restraint may trigger a cascade of reactions to counteract the resulting energy deficit via the biological determinants of hunger and satiety and by increasing responsiveness to alimentary stimuli.

To varying degrees, several avenues of research lend support to the set point theory. Cabanac and colleagues (Cabanac, Duclaux & Spector, 1971) proposed the term "ponderostat" for the mechanism responsible for detecting when the organism is above or below set point and providing feedback to restore it to this weight level. They proposed that through sensory feedback processes, the body is able to regulate food intake. A series of experiments revealed that subjects rated the pleasantness of a sucrose solution less pleasant, after consuming a glucose preload whereas, fasting subjects and some obese subjects showed no decrease in pleasantness ratings for the sucrose solution (Cabanac & Duclaux, 1970; Cabanac, Duclaux & Spector, 1971).

Negative alliesthesia (the taste becoming less pleasant after a glucose preload) was proposed to be functional in determining when people stop eating. This process depends on the match between actual body weight and set point weight. When an individual is below his or her set point weight, negative alliesthesia does not occur, resulting in impaired satiety (Cabanac, 1971).

Support for the concept of set point also comes from experiments by Keys and
colleagues (Keys, Brozek, Henschel, Mickelsen, & Taylor, 1950). This relatively long-term study restricted normal males' regular food intake by approximately 1/2 in order for them to lose about 25% of their body weight. The experimenters documented extensive physical, psychological and social changes as a result of the subjects' starvation. Reinstatement of regular caloric intake resulted in the men eventually attaining their previous weight levels.

There is also evidence for the body preventing weight levels from becoming too high. Normal weight students trying to gain weight had difficulty attaining a 10% weight increase and it was even more difficult to maintain the weight gain (Sims, 1974). More and more food intake was necessary to maintain the excess weight. After returning to their former caloric intake, subjects' weights rapidly returned to their initial levels. Observations of relatively long-term stability of body weight despite variability in caloric intake and energy expenditure over time also suggest that some homeostatic mechanism is operative (Keesey, 1980, 1986).

The concept of set point figures prominently in discussions of counterregulatory eating behavior and bingeing in dieters. Several authors have suggested that when an individual diets and loses weight to below her set point, the body tries to restore body weight by promoting binge eating (Polivy & Herman, 1985; Wardle, 1980). This is demonstrated by survey findings which indicate a strong relationship between dieting and binge eating (Clark & Palmer, 1983; Wardle, 1980). Compelling evidence that severe dietary restriction causes binge eating comes from the classic study of semistarvation by Keys and colleagues (Keys et al., 1950). Many of the participants experienced bouts of gorging which persisted many months after they
had free access to food. This may also be what is occurring when dieters overeat following a preload (Herman & Mack, 1975; Hibscher & Herman, 1977; Knight & Boland, 1989; Polivy, 1976; Spencer & Fremouw, 1979). It is theorized that dieters are below their setpoint weights and when they are released from their diet (i.e., by consuming a high calorie preload), they overeat in response to their need for nourishment.

Evidence from the clinical literature further supports the link between dieting and bingeing. A majority of patients with bulimia nervosa report trying to lose weight by strict dieting prior to their eating disorder (Boskind-Lodahl, 1976; Fairburn & Cooper, 1982; Fairburn, Cooper, & Cooper, 1986; Garfinkel, Moldofsky, & Garner, 1980; Pyle, Mitchell, & Eckert, 1981; Rossiter, Wilson, & Goldstein, 1989; Streigel-Moore, Silberstein & Rodin, 1986). In samples of bulimic-anorexic women, dieting preceded bingeing by anywhere from 9 months to 1 1/2 years (Garfinkel et al, 1980).

However, there have been some criticisms lodged against some of the supporting evidence for set point theory as a complete explanation for counterregulation or binge eating. Esses and Herman (1984) compared dieters and nondieters in a test for negative alliesthesia and found that both groups showed negative alliesthesia. After a glucose preload, dieters actually evaluated the sucrose solutions as less pleasant than did nondieters. Secondly, the idea that negative alliesthesia is functional in regulating body weight has been questioned (Wooley, Wooley, & Dunham, 1972). These investigators found that ratings of sucrose solutions declined following a non-nutritive sweet glucose preload. Furthermore, they argue that it is unlikely that a 200 ml load of glucose (approximately 200 calories) would signal that no more food is necessary.
Later evidence indicates that the set point for body weight can be altered by a more or less varied and palatable diet (Bennet & Gurin, 1982; Sclafani, 1980). High fat diets can reset weight to higher levels (Van Itallie, 1984). Exercise can also lower set point levels (Bennet & Gurin, 1982). A regulatory mechanism that can be changed in a variety of ways suggests a lack of preciseness or stability. Some researchers have suggested that the term set point is merely a description of the data and offers little by the way of an explanation for different patterns of eating behavior (Mrosovsky & Powley, 1977).

Data from both experimental and clinical studies support the notion that dieting is an integral facet of binge eating. However, even within the supporting data there is some variability which casts doubt on the set point theory as adequate to explain disinhibited eating. There are some dieters who do not counterregulate in the preload studies. Furthermore, approximately 50% of anorexia nervosa patients do not binge eat despite the fact that they are definitely below their set point (Kassett, Gershon, Gwirtsman, Kaye, Brandt, & Jimerson, 1987). This suggests that being below one's set point is not a sufficient factor for binge eating. Other mediating variables which could trigger binge eating, or at least explain the co-occurrence of dieting and binge eating cannot be ruled out.

Serotonin Hypothesis

The neurotransmitter 5-hydroxytryptamine (5-HT or serotonin) has been implicated as one of the primary modulators in eating behavior (Blundell, 1984; Garattini & Samanin 1984; Leibowitz & Shor-Posner, 1986a) with a specific role in
the regulation of carbohydrate intake (Wurtman & Wurtman, 1977). It has been proposed that serotonin deficiencies may contribute to binge eating (Wurtman & Wurtman, 1977).

This hypothesis is based in part on the observation that diets high in carbohydrate were found to increase the ratio of the 5-HT precursor tryptophan to that of large neutral amino acids (Fernstrom & Wurtman, 1971), which facilitates the transport of more tryptophan across the blood brain barrier through a competitive transport system. Greater amounts of brain tryptophan have the effect of enhancing saturation and activity of tryptophan hydroxylase in serotonin-inducing neurons resulting in an enhanced rate of serotonin synthesis (Fernstrom & Wurtman, 1971). These findings suggest that central serotonin neurons are particularly sensitive to changes in nutrition because tryptophan is an essential amino acid, and its availability is influenced by the presence of macronutrients such as carbohydrates.

Evidence for the role of serotonin in the regulation of carbohydrates has been obtained from animal studies. Direct injections of drugs such as fenfluramine, a serotonin agonist which increases serotonin in the synapse of the serotonin neurons, into the paraventricular nucleus in the hypothalamus of rats produced specific alterations in meal patterns. Decreases in meal size, duration of meals and rate of eating were found (Leibowitz & Shor Posner, 1986a). Macronutrient specificity has been observed with a central injection of serotonin or fenfluramine which decreased carbohydrate intake (Leibowitz & Shor-Posner, 1986b). Peripheral injection studies also show a decrease in total intake but have had mixed effects on specific macronutrient selection (McArthur & Blundell, 1983; Moses & Wurtman, 1984;

It has been hypothesized that obese individuals who diet may have decreased serotonin transmission which may account for the carbohydrate overindulgence and weight gain that often follows dieting in humans. One study found that when obese subjects were placed on a high protein, low carbohydrate diet, a reduction in plasma-tryptophan ratio was measured (Heriaef, Burkhardt, & Mauron, 1983), suggesting lowered serotonin levels. Studies have also been completed on a subgroup of obese individuals who self-report a craving for carbohydrates - labeled “carbohydrate cravers”. These individuals have meal intakes that are similar to noncarbohydrate cravers but they consume a large number of carbohydrate-containing snacks. It is proposed that these individuals have low tryptophan and serotonin levels which drive them to “crave” and consume carbohydrates. An inpatient trial of fenfluramine on carbohydrate cravers found a significant decrease in intake of carbohydrate snacks and of carbohydrates at meals (Wurtman & Wurtman, 1986).

It has been further hypothesized that individuals with bulimia nervosa may have reduced serotonergic activity which causes them to binge eat. If, as reports suggest, a bulimic’s diet is characterized by an avoidance of carbohydrates (Beaumont, Chambers, Rouse, & Abraham, 1981; Johnson, Stuckey, Lewis & Schwartz, 1982; Goldbloom, 1987; Pope & Hudson, 1984) then this could cause lowered central serotonin levels which would lead to a binge on carbohydrates in order to replenish levels of serotonin (Goldbloom, 1987; Goldbloom, Hicks, & Garfinkel, 1988; Kaye & Gwirtsman, 1985; Wurtman & Wurtman, 1984).
Measures of the major serotonin metabolite 5-HIAA in cerebrospinal fluid show evidence for reduced central nervous system (CNS) serotonin activity in individuals with eating disorders (Jimerson, Lesem, Kaye, Hess, & Brewton, 1990; Jimerson, Brandt, & Brewton, 1988; Kaye, Ebert, Raleigh, & Lake, 1984). Moreover, enhancement of central serotonin activity, through the administration of antidepressant drugs such as tricyclic antidepressants, monoamine oxidase inhibitors or fluoxetine, significantly reduce binge eating in bulimics (Agras, Dorian, Kirkley, Arnow, & Bachman, 1987; Hughes, Wells, Cunningham, & Illstrup, 1986; Pope & Hudson, 1982; Walsh, Stewart, Roose, Gladis, & Glassman, 1984; Wilcox, 1990). The demonstration of reduced serotonin levels in bulimics and the finding that serotonin-enhancing agents diminish binge eating provide evidence for the involvement of serotonin in disordered eating.

A number of criticisms have been lodged against the serotonin dysregulation theory for binge eating, however. In animal studies, macronutrient selection is affected by many factors, including the specific pharmacological manipulations, the type of diet offered, the sensory properties of the diet, macronutrient composition (fat content was not always controlled), and the metabolic state of the organisms being tested (Fernstrom, 1987; Fernstrom, Fernstrom, Grubb, & Volk, 1985; McArthur & Blundell, 1983; Orthen-Gambill & Kanarek, 1982). The use of tryptophan to control bingeing in humans has had weak effects. In one double-blind study (Wurtman, Wurtman, Growden, Lipscomb, & Zeigel 1981) tryptophan was given to obese "carbohydrate cravers" and of the eight subjects three decreased carbohydrate intake, one increased carbohydrate snacks while no change was found in the remaining
four subjects. No data on degree of "craving" was presented. Results were interpreted as suggesting two types of people: "tryptophan responders" and "nonresponders". However, a more parsimonious interpretation may be that tryptophan had no real effect on carbohydrate craving.

Despite the indications of serotonergic abnormalities in individuals with eating disorders, it is important to note that the data do not indicate whether the serotonergic abnormalities predate the onset of bulimic symptoms or whether they result from dietary abnormalities or other psychophysiological concomitants of the disorder (e.g., stress, anxiety; Jimerson et al., 1990).

The serotonin model predicts that bulimics will overeat carbohydrate-rich food in order to compensate for their lowered serotonin levels as a consequence of their calorie-reduced diets. However, it has not been demonstrated behaviorally that bulimics actually binge on carbohydrate-rich food to compensate for serotonergic deficiencies (Jansen, van den Hout, & Griez, 1989). Analyses of bulimics' food diaries found no evidence that binges contained more carbohydrates than non binges or more carbohydrates relative to the regular diets of non eating disordered individuals.

The 5-HT hypothesis would be expected to apply to restrained eaters in a similar fashion to eating disordered patients since they, too, restrict their food intake (though not to such a pathological degree). Unfortunately, no laboratory research has specifically focused on the 5-HT hypothesis with regard to the macronutrient composition of dieters' overeating episodes.

5-HT imbalances may be responsible for aberrant eating such as that observed in bulimics, carbohydrate cravers, and dieters. However, it is important to note that
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Despite some overlap in eating- and weight-related behaviors and attitudes, there are significant distinctions in terms of the degree of psychopathology (Garner, Garfinkel, & O'Shaughnessy, 1983; Polivy & Herman, 1987), suggesting a discontinuity between eating disorder patients and “normal dieters” on psychological factors. Dieting behavior may be the common element, engendering a 5-HT imbalance. While restrained eating does not necessarily lead to an eating disorder, most cases of eating disorders are preceded by dieting (Boskind-Lodahl, 1976; Bruch, 1973; Garfinkel et al., 1980; Russell, 1979).

In summary, an exclusive relationship between 5-HT availability and carbohydrate diet selection has not been established. The carbohydrate selectivity hypothesis is debatable, which in turn, questions the idea that serotonin dysregulation is the mechanism for binge eating in either eating disordered patients or normal dieters.

Cognitive Theories

Dysfunctional Beliefs

The association between restraint and disinhibited eating has been hypothesized to be mediated through a cognitive mechanism. Herman & Polivy (1984) propose that the dieter gives herself a diet boundary - a self-imposed quota of food intake. This diet is set by cognitive parameters, not by physiological factors of satiety. It is hypothesized that if the dieter perceives that her diet has been violated, she subsequently believes that there is no point in restricting her food intake any longer. Herman & Polivy call this the “what the hell effect.” This type of reasoning
suggests that dieters have a narrow, inflexible cognitive style characterized by all-or-nothing thinking. Either one is dieting or one is not. Either one eats very little or one eats a lot.

Evidence for the cognitive substrate for disinhibition comes from studies that manipulated dieters' beliefs about the caloric value of a preload. What dieters believed about the preload (whether it was high or low calorie) rather than actual caloric content determined subsequent food consumption (Knight & Boland, 1989; Polivy, 1976; Spencer & Fremouw, 1979; Woody, Constanzo, Leifer, & Conger, 1981).

Further evidence comes from studies which investigated dieters' cognitive responses to receiving a high calorie preload. Ogden and Wardle (1991) suggest that preloading may trigger disinhibition via mood changes and cognitive state. They found that following consumption of a high calorie preload, dieters had increased feelings of rebelliousness and defiance. This style of thinking appears to be similar to the "what the hell effect" that Herman & Polivy (1984) speculated was occurring in dieters. In addition dieters reported feeling more passive and resigned, which the authors suggested indicates a reduction in their motivation to diet. Thus the consumption of a preload may trigger a combination of cognitions in dieters such as rebelliousness, defiance, and resignation which could undermine their motivation to diet and trigger overeating.

Jansen attempted to assess dysfunctional beliefs in dieters (Jansen, Merkelbach, Oosterlaan, Tuiten, & van den Hout, 1988). Restrained and unrestrained eaters' thoughts were recorded after having consumed a high calorie preload (or no preload). Participants spoke their thoughts into a microphone while eating ice cream.
during the taste test. It was hypothesized that restrained eaters would express more disinhibited thoughts (such as “I’ve blown my diet, I might as well continue to eat”). Restrained eaters reported feeling out of control in both the preload and nonpreload conditions but no differences were found in the number of “disinhibited” statements they made. However, there were problems in classifying the statements as disinhibited. Interrater reliability for rating the statements as disinhibited or not was quite low. There is also the question as to whether individuals verbalize all of their thoughts.

Ruderman (1985) found that the degree of restraint and bulimic symptoms were significantly and negatively related to a measure of rationality (the Rational Beliefs Inventory; RBI: Shorkey & Whiteman, 1977). The greater the distorted eating patterns, the more rigid, perfectionistic and irrational were subjects’ beliefs. Dieters have also been found to have attentional biases toward food and body-related words (Mahamed & Heatherton, 1993; Ogden & Greville, 1993). Information processing theory contends that these kinds of cognitive biases around issues of weight, shape, or food perpetuate pathological eating (Vitousek & Ewald, 1992; Vitousek & Hollon, 1990).

Eating disorder patients have also been found to have cognitive and attentional biases to food- and shape-related material (Ben-Tovim, Walker, Fok, & Yap, 1989; Channon, Hemsley, & de Silva, 1988; Perpina, Hemsley, Treasure, & de Silva, 1993). Logical errors such as dichotomous thinking, overgeneralization, personalization, catastrophizing, magnification, and superstitious thinking characterize the cognitive style of bulimics (Garner & Bemis, 1982; Garner 1986; Fairburn, Cooper & Cooper,
Clinical studies also report that bulimics typically have unrealistic thoughts, attitudes and beliefs concerning body weight, shape, and eating patterns (e.g., Chiodo, 1987; Fairburn, Cooper & Cooper 1986). They use low body weight and lean shape as standards to evaluate attractiveness and desirability as well as success and failure in life.

The data from both laboratory and clinical studies indicate the presence of dysfunctional beliefs in dieting individuals and eating disordered patients. However, it still remains unclear what role these cognitive biases have in disinhibited eating. Jansen (1988) was unable to find any evidence of "disinhibited self-statements" in dieters while they were participating in a taste test. In this study dieters ate the same amount of ice cream regardless of whether they had previously consumed a preload or not. Thus they did not actually counterregulate, which may explain why they did not report any disinhibited thoughts: they may not have been disinhibited in the first place.

The studies which reported finding cognitive biases in dieters following consumption of a preload hypothesize that these biases may mediate the transition from restraint to disinhibited eating. However, to date there has been no evaluation of information processing styles or cognitive biases and their relation to eating behavior. Such an experiment could tell us if these cognitive biases are the mechanism through which dieters become disinhibited, abandoning their dietary restraint and overeating.

In summary, several stimuli have been identified as disrupting dieters' dietary restraint which leads them to overeat. These theories are valuable to the
extent that dieting and eating disorders share similar phenomena. There is a common theme to the previous studies, in that the dieter's restraint has been disrupted by having to eat a diet-breaking preload, thus taking away her control over her diet. It has been hypothesized that the key to disinhibition for a dieter is the subjective perception of whether the diet is intact or broken. If the diet has been broken, it is proposed that due to her rigid cognitive style the dieter sees no purpose in trying to keep her diet intact and goes on to eat above and beyond her diet quota.

However, a few studies have shown that a dieter will engage in disinhibited eating even though she has not been required to break her diet. Emotion-induced overeating has already been mentioned. Exposure to a variety of food stimuli (with no requirement to eat a diet-breaking preload) has also resulted in dieters eating substantially more than when exposed to no cues and more than do unrestrained eaters exposed to the same cues (Rogers & Hill, 1989; Jansen & van den Hout, 1991). Since no preload has been consumed (or anticipated), the dieter is not responding to a diet violation in these circumstances. This suggests that the previously proposed dysfunctional thinking pattern regarding blowing her diet should not be operative. Theoretically, the dieter is still in control of her diet. What is it that entices the dieter to abandon her restraint? First the evidence for this phenomenon will be reviewed, and then theories will be proposed to explain its occurrence.

**Evidence of Disinhibited Eating by Restrained Eaters in Response to Food Cues (No Diet Violation)**

A line of research has investigated the response of restrained and unrestrained
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Evidence of Disinhibited Eating by Restrained Eaters in Response to Food Cues (No Diet Violation)

A line of research has investigated the response of restrained and unrestrained
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correlated with restraint or food intake. A second experiment in this series compared responses to preferred and nonpreferred foods. During the exposure period, previously identified preferred or nonpreferred foods were placed in front of the subjects, who were instructed to smell the foods, to imagine the foods' taste and texture, and to imagine eating the foods. Salivation measures were taken at baseline and during the exposure phase. Subjects were specifically told that they would not be required to eat these foods. A selection of biscuits was subsequently served, which subjects tasted and rated on their sensory qualities. Restrained eaters ate significantly more biscuits following pre-eating exposure to preferred foods as compared to pre-eating exposure to nonpreferred foods. Unrestrained subjects ate slightly less after pre-eating exposure to preferred foods as compared to nonpreferred foods.

A more recent study conducted by Jansen and van den Hout (1991) found that a combination of visual, olfactory and cognitive cues during a 12-minute exposure period prior to eating stimulated disinhibited eating in dieters. After seeing and concentrating on the smell of an array of palatable foods, dieters ate significantly more of these foods than they did after no prior exposure. The pattern of consumption was in the opposite direction for nondieters, who ate (nonsignificantly) less after pre-eating exposure to the food cues than after no exposure.

Together, these studies indicate that pre-eating exposure to food cues originating from external sources (i.e., outside the person's body) has a significant impact on subsequent food consumption, particularly for restrained eaters. Seeing, smelling and thinking about preferred foods prior to eating increases consumption for
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been associated with disturbances in the past. This model of anticipatory responding is founded on Pavlovian classical conditioning. Such conditioning allows the organism to "make preparatory adjustments for an oncoming stimulus" (Culler, 1938). In this case, food consumption normally produces elevations in blood sugar levels, so repeated associations of stimuli associated with eating large amounts of food may result in preparatory declines in blood sugar. Furthermore, Jansen proposes that this conditioned compensatory response may be cognitively labeled as "craving" as previously described by Seigel and colleagues (Siegel, 1983; Macrae, Scoles, & Siegel, 1987). Presently, this proposed response in dieters is speculative since blood sugar levels were not measured after exposure to food cues and no assessment was made of craving. However, the notion of conditioning is not a new one in the eating literature and researchers have advocated that conditioning can be a significant factor in food ingestion.

It has been hypothesized that the sensation of hunger is a learned response. Most people eat meals and feel hungry at approximately the same time on a day to day basis. Rats given only one opportunity to eat during the day begin to secrete insulin at that precise time (Wiley & Leveille, 1970). It has also been shown that through repeated pairings with food stimuli previously neutral stimuli can come to initiate hypoglycemia (Woods & Kulkosky, 1976). Conditioned hypoglycemia can be extinguished quite rapidly (Woods, Makous & Hutton, 1969).

Cephalic reflexes, those metabolic responses which prepare the digestive system and related organs for the ingestion of a meal, appear to become conditioned to the anticipation of eating (Powley, 1977; Weingarten & Powley, 1981). Exposure to
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studies suggesting that during periods of deprivation, associations made between food-related cues and eating have an even greater effect on subsequent food intake, presumably because elevated drive produces stronger conditioning (Grant & Milgram, 1973; Schallert, Pendergrass & Farrar, 1982; Weingarten, 1985). A parallel could be drawn between the conditioning experiences of the animals and those of restrained eaters. Since restrained eaters periodically undergo periods of deprivation (while dieting) and additionally are generally more responsive to stimuli from the environment, it is possible that the connections made between food-associated cues and eating are stronger, driving their increased food consumption. Those cues that immediately precede or are contiguous with eating begin to act as conditioned stimuli, which in turn, are capable of inducing specific conditional responses, such as an appetite to eat and subsequent eating. A combination of enhanced physiological reactivity to food stimuli and previous associations between food stimuli and eating may account for dieters' increased eating in response to food cues.

There is a suggestion that an important factor determining an individual's conditioned response to food stimuli is not dieting per se but a particular dieting style. Salivation to olfactory food stimuli was measured in anorexics, bulimics and noneating disordered controls (Legoff, Leichner, & Spigelman, 1988). Anorexics salivated less to olfactory food stimuli than did bulimics or noneating disordered controls. Bulimics, on the other hand, salivated significantly more to the food cues than did the other groups. It is possible that the anorexics' lack of response to food stimuli occurred because of their extreme food restriction; for these self-starvers, food cues no longer signal eating. Bulimics' pattern of bingeing may have resulted in
strong associations of food cues and the possibility of eating large amounts of food.

A recent study compared fasting and dieting obese subjects (subjects consumed 200 and 1200-1600 calories per day, respectively, for three weeks) and found that hunger, craving and reactivity to food stimuli declined over time only for the fasting subjects (Lappalainen, Sjoden, Hursti, & Vesa, 1990). The authors suggested that conditioned hunger and craving were extinguished by fasting but that the dieting group was still being partially reinforced so their responses to food cues did not diminish.

In summary, a combination of enhanced physiological reactivity (from food deprivation) and previous associations between food stimuli and eating may account for dieters' increased eating in response to food cues. During dieting bouts, dieters, who are generally more responsive to stimuli from the environment, form strong connections between food stimuli (smelling, or even thinking about food) and subsequent eating, which may then influence their eating behavior even in situations when the dieters are not food deprived. Unrestrained eaters, who do not restrict their food intake, are less likely to form such strong associations and therefore are not as influenced by external food stimuli.

**Evidence of Cue-Induced Consumption in Addictions**

Research in the field of addictions has generated similar findings to those in the eating literature with regard to the role of cues and alcohol and drug use. Although this thesis does not consider pathological eating to be an addiction, it is interesting to note that dieters and alcohol and drug abusers share a similar endeavor, gaining control over a behavior. Dieters are attempting to restrict their food intake and
alcohol and drug abusers (at least those trying to change) are attempting to control their substance use. And as has been found with eating, alcohol or drug-associated cues often undermine attempts to control the use of these substances.

A brief taste of alcohol or exposure to alcohol-related cues (i.e., smell of alcohol, presence of liquor bottles) induces increased alcohol intake, greater speed of drinking, more operant responses for alcohol as well as self-reports of a greater desire to drink and craving for alcohol (Engle & Williams, 1972; Funderburk & Allen, 1977; Hodgson, Rankin, & Stockwell, 1979; Ludwig, Wikler, & Stark, 1974; Marlatt, Demming, & Reid, 1973; Pomerleau, Fertig, Baker, & Cooney, 1983). Similar responses to drug-related cues of enhanced consumption and craving have been reported for smokers and drug abusers (Ludwig & Lyle, 1964; Meyer & Mirin, 1979; Shiffman, 1979).

Several models have been offered within learning theory to account for the above findings. Models based on conditioning theory propose that substance abusers may develop conditioned responses to cues previously associated with drug or alcohol use and that these learned responses may increase the risk of resuming substance use (Niaura et al., 1988; Rosenhow, et al., 1994). These models include conditioned withdrawal relief theories (Wikler, 1973), conditioned compensatory response theories (Siegel, 1983), social learning formulations (e.g., Marlatt & Gordon, 1985) and conditioned appetitive motivational theories, (Stewart, de Wit, & Eikelboom, 1984). These models differ when considering the role of affect as a conditioned stimulus, (whether negative or positive states evoke the conditioned response) and the emphasis placed on conditioning as the primary mechanism for substance use.
However, all models agree that a wide variety of exteroceptive and interoceptive cues can come to elicit conditioned responses which result in increased craving for and use of the particular substance.

**Summary of a Learning Theory for Disinhibited Eating**

Evidence indicates that restrained eaters sometimes engage in disinhibited eating even when no diet violation has occurred. Mere exposure to food-related cues results in restrained eaters eating significantly more than when exposed to no cues. The powerful effect of cues on initiating alcohol and drug consumption has been extensively investigated in the addictions literature. A learning paradigm is proposed as a model to understand disinhibited eating in response to food cue exposure.

Experiences of food deprivation have been found to result in stronger associative links between food stimuli and subsequent food intake in animals. An elevated hunger drive (produced by food deprivation) may produce stronger conditioning. Restrained eaters also undergo periods of food deprivation while actively dieting. They also tend to rely more on external cues rather than on internal signals of satiety to guide their eating. The combination of an enhanced drive and the tendency to be more responsive to stimuli from the environment may forge stronger connections between food-associated cues and eating. Those cues that precede eating begin to act as conditioned stimuli which induce conditioned responses such as subjective hunger and subsequent eating. The presence of food-associated cues creates an appetitive response which can control meal initiation. A combination of a
history of food deprivation, sensitivity to food-associated stimuli and previously learned associations between food stimuli and eating may account for dieters' disinhibited eating in response to food cues.

Studies

Previous research indicates that the eating behavior of restrained eaters is strongly influenced by external cues such as cognitive manipulations or exposure to sensory food stimuli. It has been proposed that the presence of food-associated cues induces a motivation to eat and perhaps a craving for that food (Weingarten, 1985). This thesis investigates the effect of food cues on restrained and unrestrained eaters' subsequent eating behavior. Restrained eaters may be more influenced by pre-eating exposure to food cues and will respond by eating more and reporting an enhanced appetite and craving. The possibility will be explored that restrained eaters' enhanced responses to food cues can be explained by Weingarten's theory of incentive-induced hunger.

The present review of evidence for cue-induced eating and of possible theories to explain this phenomenon indicates that there are a number of avenues requiring further study. Three studies have been formulated to investigate some parameters of cue-induced eating in restrained and unrestrained eaters. The parameters include single versus multiple cues, cue specificity, and expectations.

Study one addresses the effect of pre-eating exposure to food cues on subsequent food consumption by restrained and unrestrained eaters. Previous studies indicate that exposure to food cues originating from external sources has a
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Chapter 2
Study 1

As described above, eating behavior is not only influenced by internal physiological signs signalling energy depletion and the need to eat but also by cues originating from the external environment.

The two previous studies on pre-eating exposure to external food cues found a significant effect of such cues on subsequent food consumption, particularly for restrained eaters. The studies by Rogers and Hill (1989) and Jansen and van den Hout (1991) demonstrated that seeing, smelling and thinking about preferred foods prior to eating increases consumption for dieters but not for nondieters. However, it is not clear from these or from an earlier study (Ross, 1974) whether all of these external cues (visual, olfactory, and cognitive) must be present in order to increase consumption, or whether any one alone would be sufficient. Before we can determine the mechanisms underlying the effect of external cues on intake, it is necessary first to determine what specific sorts of external cues exert the effect. The present study attempted to determine the effects of a single cue and combined cues on intake in restrained and unrestrained eaters.

It was predicted that restrained eaters, who are particularly sensitive to external food cues, would respond to even a single cue by increasing their consumption, though possibly not to as great an extent as when exposed to multiple cues. The presumably internally responsive unrestrained eaters were expected to
respond only minimally (if at all) to the olfactory and cognitive food cue manipulations, possibly responding more in the stronger dual-cue condition.

Method

Subjects

Ninety-one female subjects with an age range of 17 - 43 years ($M = 20.86, SD = 5.13$) were recruited from a first-year Psychology course. Subjects gave written informed consent agreeing to participate in a study of food preferences.

Questionnaires

Restrain was determined by the Revised Restraint Scale (Polivy, Herman, & Howard, 1988). Subjects with scores of 14 or less were classified as unrestrained eaters and those with scores of 15 or more were classified as restrained eaters. Subjects were also given a post-experimental questionnaire (designed for the experiment) that asked about food cravings. In addition, subjects were asked to report their food intake for the 24 hours preceding the study.

Experimental Design

Subjects were randomly assigned to one of four cue conditions: no cue, olfactory cue, cognitive cue, or a combination of the two types of food cues. All conditions were crossed with restraint. This yielded a 2 (olfactory cue) by 2 (cognitive cue) by 2 (high versus low restraint) design.

Procedure

Subjects were scheduled for a 60-minute individual session between the hours of 11:00 am and 6:00 pm. They were instructed to refrain from eating for 2 hours prior
to their appointment. This was done to prevent subjects from eating just before the experiment and to keep hunger levels similar. Mean initial hunger ratings were found to be equivalent, clustering in the moderate range (45 – 55 on a 100-point scale), for all groups of subjects.

Subjects were told that they were participants in a study of food preference and that they would be asked to taste and give their opinion of various foods. They were not informed about which foods would be sampled.

Upon arrival at the lab, the subject was seated at a table in a private room. The subject first completed a series of visual analog scales (VAS) rating “hunger,” “fullness,” and “desire to eat.” She also rated her “liking,” “desire to eat,” and “craving” for 3 different foods: chicken wings, pizza, and tuna salad. The scales were anchored by “not at all” and “extremely” on a 100-mm line. The ratings for the non-targeted foods were included in order to divert the subjects’ attention from the experimenter's interest in the target food, pizza. After completing the VAS, the subject was exposed at random to one of the cue conditions. In the “smell” conditions the smell of baking pizza wafted into the testing room (the pizza was baked in the next room and the door to the experimental room was kept ajar). In the “no smell” condition, the door to the testing room was kept closed. In the “pizza thoughts” condition, subjects were instructed to think about pizza for 10 minutes and to write down their thoughts on a piece of paper provided for that purpose. In the “free thoughts” condition, subjects were instructed to think about whatever they chose for 10 minutes and to write down their thoughts.
After 10 minutes of exposure to the cue condition, the subject filled out a second set of visual analog scales (described above). She was then given a plate of 4 freshly-baked individual pizzas (6 " in diameter) cut into quarters (16 pieces in total; 2.38 kcal/gram) and instructed to help herself to the pizza. Unlike the Rogers and Hill study, in the present study subjects were presented with the same ad lib food as the pre-eating cue, to maintain consistency. The subject was asked to rate the pizza using visual analog scales that included questions about her liking of the pizza, her desire to eat it, and her craving for it. In addition, she rated the sensory qualities of the pizza, including taste, texture, smell, spiciness, and saltiness. She was told that she had 10 minutes to complete the ratings and that if she finished early she could help herself to more pizza if she wished, as there was plenty. Following the taste test, the subject completed a final set of visual analog scales as well as the questionnaires described previously. The subject's height and weight were recorded, and the subject was debriefed and asked not to tell others about the experiment.

Results

Data analyses were performed using analyses of variance (ANOVA) or multivariate analyses of variance (MANOVA) and, where significant effects were found, post-hoc Newman-Keuls tests ($p < .05$) were performed to determine differences between means. All discussed differences between means are supported by significant Newman-Keuls post-hoc tests unless stated otherwise.
Manipulation Check

The post-experimental questionnaire asked subjects to indicate (yes or no) if they had suspected that they would receive pizza to eat and if so why. This was asked to ensure that the smell of pizza was noticeable in the smell conditions and not noticeable in the no smell conditions. Of the subjects in the smell conditions, 84% thought they would receive pizza (because they could smell it) whereas 81% of subjects in the no smell conditions did not suspect that they would receive pizza. Of the subjects in the pizza thoughts condition, 60% thought that they would receive pizza to eat and 57% of subjects in the free thoughts condition did not expect pizza.

Food Intake

A three-way (restraint by smell cue by thought cue) analysis of variance was performed on pizza intake. The analysis revealed a significant main effect for each cue condition; smell, $F(1, 83) = 10.04, p < .002$, and thought, $F(1, 83) = 5.70, p < .02$. Intake was greater if, prior to eating, subjects could smell pizza or spent time thinking about pizza. A significant interaction of restraint and smell $F(1, 83) = 4.16, p < .05$, qualified the main effect for smell; post-hoc tests indicate that restrained eaters ate significantly more than unrestrained eaters in the smell condition (Figure 1). The interaction of restraint and thought was marginally significant $F(1, 83) = 3.71, p < .06$ indicating that thoughts about pizza prior to eating were associated with somewhat higher intake in the restrained eaters (Figure 2). Restrained and unrestrained eaters ate equivalent amounts in the general thoughts condition. The interaction of smell and thought was also significant $F(1, 83) = 5.40, p < .03$; intake was
significantly lower in the control condition (no cues) as compared to the cued conditions. This indicates that all subjects were influenced by the food cues to some extent. However, the restraint by smell or by thought interactions indicate that the restrained eaters responded more strongly to the cue manipulations. The three-way interaction was not significant but the means show that restrained eaters tended to eat the most in the condition where they had both smelled and thought about pizza prior to eating (Table 1). In order to gain ideas for future research, this interaction was investigated with post-hoc tests which found that restrained eaters in the double cue condition ate significantly more ($p < .05$) than did unrestrained eaters in this condition. All subjects ate at least one piece of pizza.

**Visual Analog Scale Ratings**

Ratings of hunger, and desire to eat, as well as liking, desire to eat and craving for three specific foods (chicken wings, pizza and tuna salad) were made three times during the experiment - before cue exposure, after cue exposure, and after the taste test. Before cue exposure, there were no significant differences between restrained and unrestrained eaters. Since the period after cue exposure was of primary interest, analyses were conducted specifically for this time point. Multivariate analyses of variance with the between subject factors, restraint, smell cue and thought cue were conducted for the subjective ratings. Wilke's Lambda statistic is reported.

**Hunger and Desire to Eat.** There was a trend for the MANOVA to be significant for the interaction of restraint and smell $F(2,82) = 2.65, p < .07$. The univariate analyses
indicate a significant interaction of restraint and smell for desire to eat, $F_{(1,83)} = 4.83$, $p < .04$, and a trend towards a similar interaction for hunger, $F_{(1,83)} = 2.78$, $p < .1$. Post-hoc tests show that restrained eaters' ratings of desire to eat was significantly greater in the smell condition relative to unrestrained eaters in this condition and greater than both restrained and unrestrained eaters in the no smell condition (Figure 3). The means followed the same pattern for ratings of hunger.

**Liking, Desire to Eat and Craving for Pizza:** The MANOVA was significant for restraint $F_{(3,81)} = 3.00$, $p < .04$ which was qualified by a marginally significant interaction of restraint and smell, $F_{(3,81)} = 2.45$, $p < .06$. Univariate analyses indicated that there was a significant interaction of restraint and smell for craving for pizza $F_{(1,83)} = 4.14$, $p < .05$. Post-hoc tests indicated that the restrained eaters in the smell cue condition rated their craving for pizza somewhat higher than did unrestrained eaters in this condition ($p < .1$) and significantly higher relative to restrained and marginally higher than unrestrained eaters in the no smell condition ($p < .05$ and $p < .1$, respectively). A main effect for thought, $F_{(1,83)} = 4.55$, $p < .04$, indicated that greater craving for pizza was associated with pre-eating time spent thinking about pizza.

For desire to eat pizza, there was a marginally significant main effect for restraint, $F_{(1,83)} = 3.83$, $p < .06$, and a trend towards an interaction of restraint and smell, $F_{(1,83)} = 2.20$, $p < .2$. The means showed that restrained eaters rated their desire to eat pizza higher in the smell condition than did unrestrained eaters in this condition and higher than restrained and unrestrained eaters in the no smell condition. There was a trend towards a main effect for thought, $F_{(1,83)} = 3.13$, $p < .09$, respectively.
indicating that thinking about pizza beforehand increased subjects' desire to eat it. A significant main effect for liking for pizza $F(1,83) = 9.13, p < .004$ indicated that restrained eaters had more positive ratings of the pizza.

**Taste Ratings**

Analyses were also conducted for the ratings that the subjects made while eating the pizza. Subjective ratings from the taste test were divided into two categories: sensory, which includes the ratings of pleasantness of taste, smell and texture; and the appetite category, which includes the ratings of desire to eat and craving.

**Sensory:** The MANOVA was significant for the three-way interaction of restraint, smell and thought $F(3,80) = 3.76, p < .02$. Univariate analyses indicated a main effect for restraint for the pleasantness of the smell of the food $F(1,82) = 5.87, p < .02$ such that restrained eaters rated the smell of the food as more pleasant than did the unrestrained eaters (Ms = 86.8, 76.9, respectively). No other analyses reached significance.

**Appetite:** The MANOVA was significant for restraint $F(2,82) = 5.90, p < .004$ which was qualified by a three-way interaction of restraint, smell and thought, $F(2,82) = 4.34, p < .02$. The univariate analyses indicated a main effect for restraint for desire to eat $F(1,83) = 5.43, p < .03$, indicating that restrained eaters rated their desire to eat the food that they were tasting as greater than did unrestrained eaters. For ratings of craving for pizza there was a main effect of restraint $F(1,83) = 11.49, p < .002$, again showing that restrained eaters reported greater craving relative to unrestrained
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thoughts, pizza thoughts), the content of the thoughts questionnaire was analyzed. The content was coded into several categories which included: total words, positive words (e.g. good tasting, yummy), negative words (e.g. bad tasting), pizza words, and general food words. A ratio was obtained by dividing the number of words in each category by the total number of words written. The content categories were analyzed using multivariate analysis of variance (MANOVA) with restraint and smell and thought cue conditions as factors.

Restrained and unrestrained eaters wrote an equal number of words in total (M = 139.04 and 139.43 respectively). The MANOVA for positive and negative words was significant for thought $F(2,82) = 28.66, p < .001$ and there was a marginally significant interaction of restraint and smell and thought $F(2,82) = 2.97, p < .06$. The univariate analyses showed a main effect for thought for the positive words $F(1,83) = 56.23, p < .0001$ such that more positive words were written in the pizza thoughts cue condition. The interaction of restraint and smell and thought was significant for positive words $F(2,82) = 4.0, p < .05$. In the no smell condition, restrained and unrestrained eaters wrote an equivalent number of positive words in the free thoughts condition and restrained eaters wrote significantly more positive words in the pizza thoughts condition. Whereas in the smell condition, both restrained and unrestrained eaters showed the same pattern of writing more positive thoughts in the pizza thoughts condition relative to the free thoughts condition. A main effect of thought for negative words $F(2,82) = 6.65, p < .02$ indicated that fewer negative words were written in the pizza thoughts cue condition.
The MANOVA for pizza and general food words was significant for thought $F(2,82) = 50.74, p < .0001$. There was a trend for the interactions of restraint and thought and restraint and smell to be significant ($F(2,82) = 2.40, p < .1$ and $F(2,82) = 2.52, p < .09$, respectively). The univariate analyses showed a main effect of thought for pizza words, $F(1,83) = 72.7, p < .0001$, such that more pizza words were written in the pizza thoughts cue condition. For general food words, there was a significant main effect of thought $F(1,83) = 17.99, p < .0001$; more general food words were written in the free thoughts condition as compared to the pizza thoughts cue condition. This was qualified by an interaction of restraint and thought $F(1,83) = 4.77, p < .04$, that indicated that the restrained eaters wrote significantly fewer general food words in the pizza thoughts condition as compared to restrained eaters in the free thoughts condition. Unrestrained eaters wrote equivalent numbers of general food words in each condition. The interaction of restraint and smell was significant $F(1,83) = 4.56, p < .04$. This indicates that the restrained eaters wrote significantly more general food words in the smell condition relative to unrestrained eaters in this same condition and significantly more than the restrained and unrestrained eaters in the no smell condition.

Discussion

As predicted, pre-exposure to palatable food cues significantly increased the food consumption of restrained eaters, but not that of unrestrained eaters. Baseline
ratings confirmed that restrained and unrestrained subjects did not differ in their initial hunger and satiety sensations nor in their ratings of liking, desire to eat, or craving for foods. Restrained eaters, after exposure to the cue manipulations reported greater subjective sensations of a general desire to eat, hunger (to a less significant degree) liking and craving for pizza and a specific desire to eat it. The smell cue in particular evoked a greater general desire to eat and a craving for pizza in restrained eaters. The thought cue had a significant impact on food intake and a slight influence on subjective ratings of desire to eat and craving for pizza. During the taste test (when the cued food was in front of them), regardless of previous cue conditions, restrained eaters reported the smell of the food to be more pleasant and rated their desire to eat and craving as significantly greater than did unrestrained eaters.

These data are in accordance with a model proposed for incentive-induced hunger (Weingarten, 1985). The presence of food-associated cues creates a motivational state which can control meal initiation and meal size. In the present study, exposure to food cues prior to eating evoked an appetitive response (as measured by ratings of liking, desire to eat, and craving) as well as increased intake in the subjects. The effect on dieters was especially pronounced, disrupting their customary restraint and inducing significantly more eating.

Olfactory and thought cues were both effective in generating greater food consumption in dieters. However, the smell cue appears to be a stronger cue as evidenced by the convergence of subjective sensations and food intake. The heightened response of the restrained eaters to the olfactory cue supports previously reported
findings that dieters both salivate more to food odors (Klajner et al., 1981; Legoff & Spigelman, 1987) and overeat in response to such odors (Jansen & van den Hout, 1991; Rogers & Hill, 1989).

Craving has been proposed as a possible mediator of disinhibited eating in restrained eaters (Jansen & van den Hout, 1991) and of eating in the absence of physiological need (Cornell et al., 1989). However, neither of these studies specifically measured craving, so this proposal has remained merely speculation. Previous studies have found that in general, dieters do not experience cravings more often than do nondieters (Hill, Weaver & Blundell, 1991; Rodin, Mancuso, Granger & Nelbach, 1991; Weingarten & Elston, 1991). This was the case in the present study: Ratings of craving for pizza (and the noncued foods) prior to cue exposure were similar for restrained and unrestrained eaters. Also, there were no differences between unrestrained and restrained eaters in reported frequency of craving in general, in attempts to deny oneself the craved food, or in attempts to substitute a different food for the craved food (although restrained eaters reported that a substitute is less satisfying). In the present study, after pre-exposure to food cues, dieters reported experiencing an enhanced appetite to eat, as evidenced by their subjective ratings of desire to eat, hunger (to a less significant degree) and desire to eat and craving for the cued food, pizza. These subjective ratings were highly correlated, suggesting that the food cues may have generated an appetitive urge to eat rather than a particular craving.

The specificity of the desire to eat food after being exposed to a food cue is an intriguing issue. Weingarten (1985) points out that when conditioned food cues are
presented, the animal often waits for the specific food signalled by those cues, even if other food is available. The cues conditioned to a particular food may produce a motivation for that specific food. Restrained eaters' increased appetite for the cued food and their self-described reaction to cravings in general (of not being satisfied by a substitute food) fit well with Weingarten's proposal. An earlier study (Cornell et al., 1991) found that of two foods equally liked, a cued food (compared to a non-cued food) was eaten in larger amounts, suggesting that exposure to food cues induces a specific desire for that particular food. However, the data from the present study suggest that there may be some differences between restrained and unrestrained eaters in this tendency. The restrained eaters expressed a greater desire to eat the cued foods than did the unrestrained eaters, while the unrestrained eaters indicated a significantly stronger desire to eat one of the noncued foods. After the smell cue exposure, unrestrained eaters indicated a greater desire to eat chicken wings than did restrained eaters, \( F(1,83) = 4.71, p < .04 \), although there had been no differences prior to cue exposure. The unrestrained eaters reported (on the post-experimental questionnaire) that substitutions of alternate foods satisfied their cravings, whereas the restrained eaters reported that their cravings were not satisfied by substitutes. The nature of specificity of response to a food cue in restrained and unrestrained individuals needs to be explored further.

In conclusion, the present study demonstrates that pre-exposure to two types of food cues (olfactory and cognitive), enhances subsequent food consumption and an appetite to eat by restrained eaters. These findings generated an enquiry into whether food cues activate a general desire to eat or a specific appetite for a particular food.
A question not addressed by previous studies concerns the degree of specificity of the appetite stimulated by food cue exposure. Does a food cue generate a specific desire for the cued food or a more general appetite to eat? Studies from the animal literature have shown the significant impact of learned external controls on meal initiation (Weingarten, 1983; Weingarten, 1984; Weingarten, 1985). When previously learned food cues are presented, the animals' eating is directed specifically at the previously conditioned food source (e.g., food chute in an operant chamber), even if the same food is currently available in the cage elsewhere (e.g., food dish) (Neuringer, 1969; Osborne, 1977; Weingarten, 1981). Similarly, animals conditioned with food as a reinforcer do not substitute another consummatory behavior (such as drinking) in a later test situation (Grant & Milgram, 1973; Guild, 1980). Cue specificity has also been demonstrated following prior exposure to a reinforcing stimulus such as food, water, or electrical brain stimulation (Deutsch, Adams, & Metzner, 1964; Konorski, 1967). For example, a brief taste of food facilitated running that was rewarded by food but inhibited running that was rewarded by water (Terry, 1983). After receiving a short burst of electrical brain stimulation, animals are more likely to approach the source of the electrical stimulation than a water source (Deutsch et al., 1964). Even social transmission of an animal's diet preferences appears to be cue specific. When choosing between two novel diets, rats will choose
the same food eaten by other rats with whom they have previously interacted (Galef, Kennett, & Wigmore, 1984; Galef & Wigmore, 1983).

Similar findings have been reported in studies of food cue specificity in humans. Cornell and colleagues (1989) found that of two palatable foods, subjects ate more of a food that they had previously tasted relative to a food they had not previously tasted, supporting the hypothesis that exposure to specific food cues is associated with an increased desire for the same food rather than with an increased appetite for all foods. It has been proposed that the motivational state induced by external food stimuli (incentive-induced hunger) may be manifested as a food craving and furthermore, may be specific to the food expected (Cornell, et al., 1989; Weingarten, 1985).

Given the general finding of a relationship between specific food cues and subsequent specific eating behavior in both animals and humans, the question now arises as to how these findings might be affected by the introduction of the restrained eating factor. In the first study there is a suggestion that there may be differences between restrained and unrestrained eaters in the specificity of response to food cues. Following pre-exposure to food cues, restrained eaters not only ate more, but they also expressed a greater "desire to eat," "liking" and "craving" for the cued food than did the unrestrained eaters. In contrast, unrestrained subjects indicated a significantly stronger desire to eat one of the noncued foods mentioned to them. However, it was not possible to determine from behavioral measures (food intake) in that study whether restrained eaters would exhibit a more specific response to the
food cues, since the subjects all received the same food as the food cue and were not offered a different food.

The purpose of this study was to test more directly the specificity of responses to food cues in restrained and unrestrained eaters. Subjects were exposed to the smell and thought of one of two different, highly palatable, foods (either a sweet dessert or a savory main course food) and were later offered either the same food as the cue or a different food.

It was predicted that, as in the earlier study, pre-exposure to food cues in restrained subjects would result in more eating than in the no pre-exposure condition. Moreover, a food cue may act not only as a signal to eat but may also act as a message indicating what to eat, creating a specific desire to eat that particular food. This sort of message, or "external cue", should be particularly potent for restrained eaters, who have been shown to be more sensitive to external cues to eat (Heatherton et al., 1989). It was hypothesized that restrained eaters would eat significantly more of the food only when it was the same as the preceding food cue but not when the food was different from the food cue. Unrestrained eaters, on the other hand, were predicted to be less influenced by exposure to food cues. They would eat the same amount of food regardless of whether the food is the same or different from the preceding food cue, responding more to internal signals (i.e., increased insulin secretion and/or salivation) that are nonspecific signals to eat.
Method

Subects

The subjects were 132 female first year psychology undergraduate students, aged 17 - 47 years ($M = 21.15$, $SD = 2.2$). Subjects, who received course credit for their participation, gave written consent, agreeing to participate in a study of food preferences.

Questionnaires

All subjects were classified as either restrained or unrestrained eaters as determined by scores on the Revised Restraint Scale (Polivy, Herman, & Howard, 1988). Those with scores of 14 and below were classified as unrestrained and those who scored 15 and above were classified as restrained. Subjects were also given a post-experimental questionnaire (created for the experiment) asking about experiences of food craving and any relationship to dieting.

Experimental Design

Subjects were randomly assigned to one of three cue conditions: no cue, cookie cue, or pizza cue, and were presented with the two food types, pizza and chocolate chip cookies, in counterbalanced order. All conditions were crossed with restraint. This yielded a 3 (cue condition) by 2 (order of food presented - pizza first versus cookies first) by 2 (high versus low restraint) design.

Food cues

The pizza cue consisted of the smell of pizza cooking and subjects' thoughts about pizza while they smelled it. Subjects were asked to write down their thoughts about pizza for 10 minutes while smelling pizza cooking in an oven behind them. The
cookie cue was the smell of chocolate chip cookies baking and subjects' thoughts about chocolate chip cookies. Both the pizza and the cookies were baked in the experimental room where the subject was sitting. The cooking apparatus was behind a screen and thus out of view of the subject. The no cue condition required the subjects to write down their thoughts in general and there was no smell of food cooking.

Procedure

Subjects were individually scheduled for a 60-minute session between the hours of 11:00 am and 6:00 pm. They were instructed not to eat for 2 hours prior to their appointment. All subjects were tested individually.

The experiment was presented as an investigation into food preferences and taste perception. Subjects were told that they would be asked to give their opinion on various foods and that there would be some food-tasting but they were not informed about what foods would be sampled.

Upon arrival at the lab, the subject was seated at a table in a private room. The subject first completed a series of visual analog scales (VAS) rating "hunger," "fullness," and "desire to eat". She also rated her "liking," "desire to eat," and "craving" for 4 different foods: roast beef sandwiches, chocolate chip cookies, pizza, and ice cream. The scales were anchored by "not at all" and "extremely" on a 100 mm line. The ratings for the non-targeted foods were included in order to divert the subject's attention from the experimenter's interest in the target foods (pizza and chocolate chip cookies). After completing the VAS, the subject was exposed to one of the three cue conditions (pizza, cookie, no cue) for 10 minutes. The food cue exposure consisted of smelling and writing about either pizza or cookies (depending on the
condition to which the subject was randomly assigned). In the no cue condition the subject wrote about whatever she wanted and there was no smell of food cooking.

Following cue exposure, the subject completed a second set of visual analog scales (described above). She was then given either pizza or chocolate chip cookies to taste and rate. The pizza portion consisted of a generous plate of 3 freshly-cooked individual pizzas cut into quarters (12 - 3” pieces in total). The cookie portion consisted of a plate of 12 warm freshly-baked chocolate chip cookies (about 3” in diameter). The subject was instructed to help herself to the food and asked to rate the food on several sensory variables including pleasantness of taste and smell, intensity of spicy, sweet and salty taste, as well as her desire to eat and her craving for this food. She was told that she had 10 minutes to complete the ratings and if she finished before the time was up she could help herself to more of the food if she wished, as there was plenty. After the taste-test, the subject completed visual analog scales again.

The subject then was given a second course of food, either pizza or chocolate chip cookies - the opposite of what she had received previously. For example, a subject in the pizza cue/pizza condition would be exposed to the pizza cue and then would receive pizza to taste and rate. This subject would then receive, for the second course, a plate of chocolate chip cookies. The subject had no reason to expect that a second “course” of food would be presented, and would presumably have eaten her fill of the first food. This second food was thus unexpected from the subject’s point of view, and therefore any eating of it was completely gratuitous eating. The same instructions were given for the second taste test as for the first. The subject then
received a final set of analog scales to complete, the Restraint scale (Polivy et al., 1988), and the post-experimental questionnaire. The subject was debriefed and asked not to tell others about this experiment.

**Results**

Data analyses were performed using analyses of variance (ANOVA) and, where significant effects were found, post-hoc Newman-Keuls tests ($p < .05$) were performed to determine which differences between means were significant. All discussed differences between means are supported by significant Newman-Keuls post-hoc tests unless stated otherwise.

**First Course Intake**

Analyses were performed on the consumption of the food served first to subjects, that is, the food the subjects received immediately after the food cue. This food was either the same food as the food cue or a different food. Food intake was measured in grams.

A three-way ANOVA involving restraint, cue (pizza, cookie, no cue), and food type (pizza, cookie) was computed for the intake of cookies and pizza. Overall, there

$^2$Analyses were also conducted for calories and number of pieces eaten by the subjects. More calories for cookies than for pizza were consumed by all subjects. Apart from this difference, the pattern of results were the same as that for the analyses conducted in grams.
was a main effect of cue, $F(2,120) = 3.30, p < .04$, indicating greater intake in the cued conditions as compared to the no cue condition. There was also a main effect for food type, $F(1,120) = 19.44, p < .001$; pizza intake was significantly greater than was cookie intake. A food type by cue interaction, $F(2,120) = 4.92, p < .009$, shows elevated intake of pizza following the pizza cue relative to pizza intake following the cookie or no cue (figure 4). The same pattern of means was evident for cookie intake; greater cookie intake occurred following the cookie cue as compared to cookie intake after the pizza or no cue, though the differences did not quite reach significance ($p > .1$).

The second order interaction of restraint by cue by food type was also significant, $F(2,120) = 6.48, p < .002$. Since differences between these means were predicted by the hypothesis, planned comparisons were employed. Restrained subjects ate significantly more cookies when they were cued with the same cue (cookie) than when they were cued with a different cue (pizza), $t(120) = 2.71, p < .05$ (figure 5). Restrained subjects' cookie intake following the cookie cue was significantly greater than that of unrestrained subjects in this condition, $t(120) = 2.24, p < .05$. Pizza intake following the same cue (pizza) was also significantly greater than pizza intake following a different cue (cookie), $t(120) = 3.62, p < .05$, for restrained subjects (figure 6). Restrained subjects' pizza intake following the pizza cue was significantly greater than the unrestrained subjects' pizza intake in this condition, $t(120) = 2.33, p < .05$. In summary, restrained eaters' enhanced response to pre-exposure to food cues was replicated with the same food used previously (pizza in Fedoroff et al., 1995) and with a second, quite different food (chocolate chip cookies).
Furthermore, restrained subjects ate significantly more of the first food presented only when they had been cued with that same food (Table 2).

The unrestrained subjects did not eat greater amounts of cookies in the cue conditions as compared to the no cue condition. Pizza intake increased nonsignificantly in both food-cue conditions as compared to the no cue condition. Pizza consumption was consistently (though not significantly) greater than cookie intake in all conditions for unrestrained subjects.

**Second Course Intake**

To determine whether the food cues continued to influence intake during the second serving of food, a three-way ANOVA (restraint, cue and type of food) was computed for the intake of the food served second. There was a main effect for food type, $F(1,120) = 9.97, p < .002$, indicating that there was greater intake of pizza overall. Furthermore, there was a trend towards a main effect for the food-cues, $F(2,120) = 2.13, p < .1$, such that intake was greater following exposure to the cue conditions as compared to no prior exposure to a food-cue. This suggests that pre-eating food-cues may continue to promote greater intake during a second course.

**Overall Intake**

A repeated measures ANOVA with restraint, cue (pizza, cookies, no cue) and order of food presentation (cookies served first, pizza served first) as between subjects factors and food as the repeated factor was computed in order to compare intake of both types of food (pizza & cookies) for all conditions.
A main effect for the repeated measure, $F_{(1,120)} = 45.1$, $p < .001$, shows that pizza consumption was greater than cookie consumption overall, by weight, regardless of order and cue presentation. The significant interaction of food and cue, $F_{(2,120)} = 6.48$, $p < .003$, indicates that a combination of the same food-cue and target food resulted in greater overall intake (of that target food) than when the food-cue and target food were different. For example, cookie intake was significantly greater when preceded by exposure to a cookie cue than if preceded by a pizza cue. A similar significant pattern for pizza intake also occurred.

There was a trend toward a significant interaction of food, restraint, and cue, $F_{(2,120)} = 2.43$, $p < .1$, and the pattern of means suggests that differences exist for the restrained but not for the unrestrained eaters. Therefore, repeated measures analyses of variance (cue and order of food presentation) were calculated separately for the restrained and unrestrained eaters.

Restrained eaters: The pattern of significant results for intake in restrained eaters alone was identical to the analyses for all subjects together, but the differences were larger. The interaction of food and cue was significant, $F_{(2,54)} = 9.03$, $p < .0004$. Post-hoc tests ($p < .05$) indicate that cookie intake following pre-exposure to a cookie cue (regardless of whether cookies were served first or second) was significantly greater than cookie intake following prior pre-exposure to a pizza cue. Similarly, pizza intake following pre-exposure to a pizza cue was significantly greater than pizza intake following a cookie cue. Cookie intake following pre-exposure to the pizza cue was not significantly different from cookie intake in the no cue exposure.
condition. Again analogously, pizza intake following a different cue (cookie) was not significantly different from pizza intake in the no cue condition (Table 3). Therefore, mere exposure to a cue does not increase food intake significantly for restrained eaters unless the target food is the same as the food-cue.

Unrestrained eaters: A main effect of food, $F_{(1,66)} = 27.39, p < .001$, indicated a significantly greater intake of pizza than cookies. No other comparisons were significant.

**Total Combined Intake**

Pizza and the cookie intakes were combined to assess total intake (pizza and cookie intake combined) during the experimental session. The ANOVA (restraint x cue x order) indicates a marginally significant main effect for cue, $F_{(2,120)} = 3.03, p < .06$, indicating that total intake was elevated in the cued conditions as compared to the no cue condition. The three-way interaction was significant, $F_{(2,120)} = 3.59, p < .03$, and although the specific post-hoc comparisons were not significant, the restrained eaters tended to have the largest total intake when they received the food they had been cued with first as compared to when they received a different food from the cue or when they were not pre-exposed to a food cue. Restrained eaters' intake was generally greater than unrestrained eaters' in the same cue and food conditions and less than unrestrained eaters' in the different cue and food conditions (Table 4).

**Visual Analog Scale Ratings**

Repeated measures ANOVAs with the between-subjects factors, restraint, cue, and food served first, measured over time (within-subjects) (pre-cue, post-cue, and
post-taste-test of first course test food) were conducted for the subjective ratings of hunger and desire to eat.

The main effect for hunger over time was significant, \( F(2,240) = 77.32, p < .0001 \), showing that hunger was greater after the cue manipulation than before cue exposure and decreased back to (or below) baseline levels after eating (Ms = 51.17, 63.87, 37.90, respectively). The time-by-cue interaction was significant, \( F(4,240) = 5.2, p < .0005 \), indicating that hunger was greater at time 2 (post-cue) in the cued conditions than in the no cue condition. The second-order interaction of time, cue and food served first was significant, \( F(4,240) = 2.60, p < .04 \). Here, hunger was reduced after eating (post-taste-test) when subjects had first received the food with which they had been cued. There were no effects involving restraint.

Ratings of desire to eat show a similar pattern. A main effect for time, \( F(2,240) = 68.11, p < .0001 \), indicates that desire to eat was greatest at post-cue as compared to pre-cue and post-consumption (Ms = 49.31, 63.56, 40.06 respectively). This finding is qualified by a significant interaction of time and restraint, \( F(2,240) = 3.75, p < .03 \); unrestrained eaters reported a greater desire to eat than restrained eaters did after exposure to either food-cue. In addition a significant time-by-cue interaction, indicates that desire to eat was greatest in the cued conditions at post-cue as compared to the no cue condition, \( F(4,240) = 8.55, p < .0001 \).

**Target Food Ratings**

Multivariate analyses of variance (MANOVAs) with the factors restraint and cue condition were calculated for the visual analog scale ratings of desire to eat,
liking and craving for cookies and pizza at time 2 (post-cue). The MANOVA for ratings of desire to eat, liking and craving for cookies was significant for cue $F(6,248) = 5.60 \ p < .0001$, which was qualified by a significant interaction of restraint and cue, $F(6,248) = 2.47 \ p < .03$. The univariate analyses indicated significant effects for cue for desire to eat, liking and craving for cookies ($F(2,126) = 12.48 \ p < .0001; F(2,126) = 3.87 \ p < .03; F(2,126) = 15.84 \ p < .0001$, respectively). Post-hoc tests indicated elevated ratings following the cookie cue relative to the pizza cue and no cue condition. The individual univariate analyses for the restraint by cue interaction did not quite reach significance. Liking for cookies was the only rating that approached significance, $F(2,126) = 2.45 \ p < .1$. The pattern of means for liking, desire to eat and craving for cookies consistently showed that restrained eaters' ratings were the same as unrestrained eaters' in the no cue condition, higher than unrestrained eaters' in the cookie cue condition, and lower than unrestrained eaters' following the pizza cue.

The MANOVA for ratings for pizza was significant for cue condition, $F(6,248) = 5.85 \ p < .0001$. The univariate analyses indicated significant effects for cue for desire to eat and craving for pizza ($F(2,126) = 5.89 \ p < .0004; F(2,126) = 11.51 \ p < .0001$, respectively). Ratings for pizza were significantly higher following the pizza cue relative to the cookie cue and no cue.

**Taste Ratings**

Subjective ratings from the taste test were divided into two categories: sensory, which includes the ratings of pleasantness of taste, smell and texture; and the appetite category, which includes the ratings of desire to eat and craving.
Multivariate analyses of variance (MANOVAs) were conducted with restraint and cue as factors for ratings of cookies and pizza.

**Sensory Ratings:** The MANOVA for ratings for cookies indicated a marginally significant interaction of restraint and cue, $F(6,112) = 2.16 \ p < .06$. The univariate analyses were significant for texture, $F(2,58) = 3.88 \ p < .03$ and smell, $F(2,58) = 3.46 \ p < .04$ and there was a trend towards significance for taste, $F(2,58) = 2.08 \ p < .2$. The post-hoc tests were only significant for ratings of the smell such that restrained eaters rated the pleasantness of the smell of cookies higher following the cookie cue relative to restrained eaters in the no cue condition (Figure 7). The means for taste, texture, and smell follow a consistent pattern showing restrained eaters' ratings in the no cue condition to be lower than those of unrestrained eaters, higher than unrestrained eaters' ratings in the cookie cue condition, and then again, lower than unrestrained eaters' ratings in the pizza cue condition. The MANOVA for the sensory ratings for pizza indicated only a trend towards significance for the interaction of restraint and cue, $F(6, 120) = 1.7 \ p < .2$. The univariate analyses were not significant.

**Appetite Ratings:** The MANOVA for ratings for cookies was significant for cue, $F(4,114) = 3.14 \ p < .02$. The univariate analyses showed significant effects for cue for desire to eat and craving for pizza ($F(2,58) = 6.31 \ p < .004; F(2,58) = 5.63 \ p < .006$, respectively). Desire to eat and craving for cookies were significantly greater following the cookie cue relative to the pizza cue and no cue. The MANOVA for ratings for pizza was not significant.
Discussion

The data once again demonstrate that restrained eaters eat more following exposure to food cues. The present study qualifies this finding, however. As predicted, restrained eaters eat more of a particular food only after pre-exposure to cues from that particular food. Moreover, the significant MANOVAs indicated that restrained eaters experienced a corresponding increase in appetite for cookies post-cue and judged the sensory qualities of the food (pleasantness of smell and to a less significant degree, texture) more positively only when the food they were eating was the same as the preceding cue (cookies). The pizza cue generated a greater self-reported appetite for eating pizza in both restrained and unrestrained eaters. Unrestrained subjects showed little differential response to the cue conditions in terms of food intake.

The significant MANOVAs for the interaction of restraint and cue for cookies indicate that there is a strong impact of prior food-cue exposure on restrained eaters' subjective perceptions, although the effect appears to be subtle given that the univariate analyses were not always statistically significant. The self-report ratings for the two target foods showed more consistent differences between restrained and unrestrained eaters for the cookies than for the pizza.

The finding that dieters respond more specifically to a food cue than do nondieters parallels observations from studies conducted with animals. Cue specificity has been demonstrated in conditioning experiments as well as for the

The underlying mechanism is hypothesized to be that the stimulus creates a motivational state or aftereffect that directs the animal toward additional stimulation or reinforcement of the same sort. Weingarten (1985) proposes that cues conditioned to a particular food produce an appetitive motivational state that may be manifested as a food craving and furthermore, may be specific to the food expected. External food cues may then act both as a signal to eat and also convey a message of what to eat (Weingarten, 1985) to receptive individuals such as animals and humans with a history of food deprivation.

In conclusion, the present study demonstrates that pre-exposure to food cues increases food consumption by restrained eaters, but only if the cue and the food are the same. Furthermore, there was some indication of specificity in the appetite and sensory ratings.
Chapter 4

Study 3

The previous study's finding that restrained eaters were very specific in their response to prior exposure to food cues generated the question as to how this response was created. A suggested explanation for this specificity of response observed in restrained eaters was that the food stimuli may have created a particular set of expectations of what food they are to receive.

Earlier studies suggest that physiologic responses to food stimuli are mediated by what the individual is led to believe. The anticipation of eating has been found to be an important factor governing salivary response to food. Both obese and normal weight subjects salivated more when they were expecting to eat a palatable food and salivation was attenuated when they were told that they could not eat the food (Wooley, Wooley, & Dunham, 1976). A subsequent study comparing dieters to nondieters (Wooley, Wooley, & Williams, 1978) found dieters exposed to palatable food salivated less than nondieters. This finding is in contrast to a later finding (Klajner, Herman, Polivy, & Chhabra, 1981) where a 15-minute exposure to palatable food which subjects expected that they could eat, induced restrained eaters to salivate more relative to unrestrained eaters. An explanation for the different results for the two studies may lie in the nature of the instructions given to subjects. In the earlier study subjects were told that they would eat the food later while in the Klajner et al. study subjects were told they could eat the food later. Herman and colleagues (Herman, Polivy, Klajner, & Esses, 1981) distinguish between the types of instructions given to subjects during food experiments (such as the prospect of forced consumption) and its effect on subsequent salivation. The prospect of forced consumption may suppress salivary flow in the conscientious dieters whereas the knowledge of having some control over the choice to eat (or not to eat) palatable food may stimulate salivary response.
Food consumption studies suggest that restrained eaters rely more on cognitive than on metabolic cues to govern their food consumption. Manipulating subjects' belief that they had eaten a high calorie preload was sufficient to induce overeating in restrained eaters regardless of the actual caloric content of the preload (Polivy, 1976; Spencer & Fremouw, 1979; Woody, Constanzo, Leifer, & Conger, 1981). Furthermore, when anticipating eating high-calorie food (i.e., a milkshake or a high-calorie dinner), restrained eaters ate more in a subsequent taste-test relative to when anticipating low-calorie food or no food (Ruderman, Belzer, & Halperin, 1985; Tomarken & Kirschenbaum, 1984).

The purpose of the present study was to experimentally evaluate the impact of expectancies on restrained and unrestrained eaters' responses to food cues. It is proposed that the food cue creates expectancies and anticipations which generate a specific desire for a food in restrained eaters.

The hypothesis for this study is that specificity of response to a food cue is controlled by what subjects are led to expect about the foods that they will subsequently be tasting. Given that restrained eaters tend to be less sensitive to internal signals of hunger and satiety and are guided more by nonmetabolic cues such as cognitions to guide their eating, it is predicted that they will be more influenced by a manipulation of expectancies. Restrained eaters, following exposure to a food cue, will show greater intake and desire to eat the cued food only when they are expecting to taste that food. If restrained eaters are not expecting to taste the particular food that they are cued with, their responses will not show the same specificity (they will eat equal amounts of either the food that they were cued with or another food) though they will report a general desire to eat. Unrestrained eaters, who are presumably more responsive to their internal physiological signals and rely less on external events to guide their eating behavior, will not be as influenced by this cognitive manipulation. They will eat equal amounts of either
food - the cued or noncued food and will not be significantly influenced by the expectancies. Both groups will eat more in the cued conditions as compared to the noncued condition.

Method

Subjects
The subjects were 130 female first year psychology undergraduate students, aged 17 - 45 years (M = 20.24, SD = 3.2). Subjects, who received a course credit for their participation, gave written informed consent agreeing to participate in a study of food preferences.

Questionnaires
All subjects were classified as either restrained or unrestrained as determined by scores on the Revised Restraint Scale (Polivy, Herman, & Howard, 1988). Those with scores of 14 and below were classified as unrestrained eaters and those who scored 15 and above were classified as restrained eaters. Subjects were also given a post-experimental questionnaire (created for the experiment) asking about experiences of food craving and any relationship to dieting.

Experimental Design
Subjects were randomly assigned to one of three cue/expectation conditions: no cue/no expectations, cookie cue/same expectations, or cookie cue/different expectations, and were presented with one of two foods, pizza or chocolate chip cookies, in a counterbalanced order. All conditions were crossed with restraint. This yielded a 3 (cue/expectation condition) by 2 (food type, cookie or pizza) by 2 (high versus low restraint) design.

Food cues
The cookie cue was the smell of chocolate chip cookies baking and subjects’ thoughts about cookies while they smelled it. Subjects were asked to write down their thoughts about
cookies for 10 minutes while smelling the cookies baking in an oven behind them. The expectation manipulation consisted of the subjects being told that they would be tasting this food later in the experiment (same expectation) or that this was not the food they would be tasting and they would be tasting a different food (different expectation). The cookies were baked in the experimental room where the subject was sitting. The cooking apparatus was behind a screen and thus out of view of the subject. The no cue condition required the subjects to write down their thoughts in general and there was no smell of food cooking.

**Procedure**

Subjects were individually scheduled for a 60 minute session between the hours of 11:00 am and 6:00 pm. They were instructed not to eat for 2 hours prior to their appointment. All subjects were tested individually.

The experiment was presented as an investigation into food preferences and taste perception. Subjects were told that they would be asked to give their opinions on various foods and that there would be some food tasting but they were not informed about what foods would be sampled.

Upon arrival at the lab, the subject was individually seated at a table in a private room. The subject first completed a series of visual analog scales (VAS) rating “hunger”, “fullness” and “desire to eat”. She also rated her “liking”, “desire to eat” and “craving” for 4 different foods: home made vegetable soup, chocolate chip cookies, pizza, and fresh fruit salad. The scales were anchored by “not at all” and “extremely” on a 100 mm line. The ratings for the non-targeted foods were included in order to divert the subject’s attention away from the experimenter’s interest in the target foods (pizza and chocolate chip cookies). After completing the VAS, the subject was exposed to one of the three cue/expectation conditions (no cue/no expectation, cookie cue/same expectation, cookie cue/different expectation) for 10 minutes.
Following the cue condition the subject completed a second set of visual analog scales (described above). She was then given either pizza or chocolate chip cookies. The pizza portion consisted of a generous plate of 3 freshly-cooked individual pizzas cut into quarters (12 - 3" pieces in total; 2.38 calories/gram). The cookie portion consisted of a plate of 12 warm freshly-baked chocolate chip cookies (about 2.5" in diameter; 4.42 calories/gram). The subject was instructed to help herself to the food and asked to rate the food on several sensory variables including pleasantness of taste and smell, intensity of spicy, sweet and salty taste, as well as her desire to eat and her craving for this food. She was told that she had 10 minutes to complete the ratings and if she finished before the time was up she could help herself to more of the food if she wished, as there was plenty. After the taste-test the subject completed a final set of analog scales, the Restraint Scale (Polivy et al., 1988), and the post-experimental questionnaire. The subject was debriefed and asked not to tell others about this experiment.

Results

Data analyses were performed using analyses of variance and where significant effects were found, post-hoc Newman-Keuls tests (p < .05) were performed to determine which specific means differed. All discussed differences between means are supported by significant Newman-Keuls post-hoc tests unless stated otherwise.
Food Intake

A three-way analysis of variance with restraint, cue/expectation, and food type as factors was computed for cookie and pizza intake (measured by weight in grams\(^3\)). There was a main effect of cue/expectation on intake \(F_{(2,118)} = 4.25, p < .02\), indicating significantly more intake following both cue/expectation conditions relative to the no cue/expectation condition. A main effect for food type \(F_{(1,118)} = 31.83, p < .0001\), shows that more pizza was eaten than chocolate chip cookies. There was a trend towards a significant interaction of restraint, cue/expectation, and food type, \(F_{(2,118)} = 2.60, p < .08\). Separate two-way analyses of variance were conducted for restrained and unrestrained eaters (see table 5). There was a significant interaction of food type and cue/expectation for restrained eaters \(F_{(2,56)} = 3.56 p < .04\).

Restrained eaters ate significantly more cookies when they were pre-exposed to the cookie cue and were expecting to taste cookies (cue/same expectation) than restrained eaters who received the cookie cue but were expecting to taste a different food (cue/different expectation) and more than restrained eaters in the control condition (no cue/no expectation). Equivalent amounts of cookies were eaten in the control condition and the cue/different expectation condition (they expected to eat a different food from the cue). Pizza intake was not significantly different among the conditions.

Cookie intake by unrestrained eaters was not significantly influenced by the cue/expectation manipulations. There was a main effect for food type \(F_{(1,62)} = 24.07 p < .0001\), such that pizza intake was greater than cookie consumption. The interaction of cue/expectation and food type was not significant.

\(^3\)Analyses were also conducted for calories and number of pieces eaten by the subjects. Slightly more calories for cookies than for pizza were consumed by all subjects. The pattern of results was the same as that for the analyses conducted in grams.
Visual Analog Scale Ratings

Repeated measures analyses of variance with the between subjects factors restraint, cue, and food type, measured over time (within subjects) (pre-cue, post-cue, and post-taste-test) were conducted for the subjective ratings of hunger.

The main effect for cue/expectation was significant $F(2, 124) = 3.47, p < .04$, and hunger as measured over time was significant, $F(4, 248) = 99.44, p < .0001$. These effects were qualified by a significant interaction of time and cue/expectation, $F(2, 248) = 2.46, p < .05$.

Hunger was significantly greater post-cue in both the cue/expectation conditions as compared to the no cue/expectation condition. Hunger increased significantly from pre-cue to post-cue in both the cue/expectation conditions but this did not occur in the no cue/expectation condition. Hunger was significantly lower after the taste test than the pre-cue and post-cue levels. There were no differences in hunger between conditions after the taste test.

Target Food Ratings

Preliminary analyses of subjective ratings of the test foods (cookies and pizza) prior to cue exposure indicated that unrestrained subjects consistently endorsed higher ratings of desire to eat, liking, and craving for both cookies and pizza than did the restrained subjects. Therefore, two-way analyses of covariance (ANCOVA) with the factors of restraint and cue/expectation and the covariates of desire to eat, liking and craving at time one (pre-cue) were computed for post-cue ratings in order to account for the higher initial ratings. No effects were found for restraint for post-cue ratings of desire to eat, liking, and craving for cookies or pizza.

A main effect of cue/expectation was significant for craving for cookies, $F(2, 124) = 3.60, p < .03$; craving for cookies was significantly higher in the cue/same expectation condition as compared to the no cue/expectation condition. A main effect of cue/expectation was marginally significant for desire to eat cookies, $F(2, 124) = 2.94, p < .06$, indicating that desire
to eat was greater in both the cue/expectation conditions as compared to the no cue/expectation condition. There were no significant effects of cue/expectation for any of the ratings for pizza.

**Taste Ratings**

Subjective ratings from the taste test were divided into two categories: sensory, which includes the ratings of pleasantness of taste, smell and texture, and the appetite category which includes the ratings of desire to eat, craving, and feelings of satisfaction. Statistical analyses, with restraint, cue/expectation, and food type (either cookies or pizza served first) as factors were conducted using multivariate analyses of variance (MANOVAs).

**Sensory Ratings:** The MANOVA was significant for food type $F(3, 115) = 11.38 \ p < .0001$. The univariate analyses indicated that the cookies were rated more positively than pizza on all the sensory variables (taste $F(1, 117) = 7.30 \ p < .008$; texture $F(1, 117) = 16.81 \ p < .0001$; smell $F(1, 117) = 27.07 \ p < .0001$).

**Appetite Ratings:** The MANOVA was significant for food type $F(2, 116) = 4.08 \ p < .02$. The univariate analyses showed that desire to eat and craving were higher for cookies as compared to pizza ($F(1, 117) = 6.95 \ p < .01; F(1, 117) = 7.25 \ p < .009$, respectively).

**Discussion**

The present study was designed to investigate the influence of food cues and expectancy effects on individuals' food consumption as a function of restraint. Expectancies played a significant role in determining food intake, as indicated by the finding that restrained eaters ate significantly more when they were expecting to taste the same food as the preceding cue relative to restrained eaters who were expecting to taste a different food, even though the food that they eventually ate, chocolate chip cookies, was the same in both conditions. The restrained eaters
who were exposed to the cookie cue but were expecting to taste a different food ate no more
cookies than did restrained eaters in the control condition (no cue/no expectation). Conversely,
unrestrained eaters' food intake was not significantly affected by exposure to the food cue or
expectation conditions. Both the restrained and unrestrained eaters' subjective sensations of
hunger, desire to eat, and craving for the cued food were elevated after exposure to the
cue/expectation conditions. This suggests that unrestrained eaters are not immune to the effect
of the thought and smell of palatable foods but it does not necessarily govern their eating
behavior.

These findings provide support for Weingarten's model of incentive-induced hunger.
Food cues not only provide a signal to eat but send a message of what to eat. The specificity effect
demonstrated by restrained eaters appears to be mediated by the expectation of what food they
were going to receive. A similar concept is utilized to understand the expectancy effect
on urges to drink or use drugs and enhanced substance consumption. The conditioned
appetitive motivational model posits that drug or alcohol use is maintained by appetitive
motivational processes (Stewart, deWit, & Eikelbloom, 1984). Through classical conditioning,
previously neutral drug-related stimuli come to elicit a positive motivational state similar to
that elicited by the drug itself. The stimuli previously paired with the positive motivational
effects of the drug are thought to stimulate a desire for more drug, and consequently more drug
seeking.

Though the disinhibiting power of cognitive beliefs that one has already
overeaten has been demonstrated (Knight & Boland, 1989; Polivy, 1976; Spencer &
Fremouw, 1979; Woody et al., 1981), it is not necessary for the dieter to believe that
her diet has been or will be broken in order for overeating to occur. Positive
emotional states can induce overeating in dieters (Cools, Schotte, & McNally, 1992).
Herman and Polivy (1993) distinguish between inhibitory and excitatory food cognitions, suggesting that the former revolve around caloric consequences of food intake whereas the latter focus on the sensory or gustatory pleasure of consumption. In the present study, the combination of stronger prior conditioning and the expectation of eating a highly palatable food may have generated a positive motivational appetite to eat in restrained eaters, which in turn prompted excessive consumption.

In conclusion, this study lends empirical support to the importance of cognitions such as expectancies in governing food intake. It appears that pre-eating exposure to food cues evokes an appetitive urge to eat but it is what a restrained eater expects that governs what she subsequently eats.
Chapter 5

General Discussion

This thesis set out to examine cue-induced eating among restrained and unrestrained eaters. In each of the studies, restrained eaters ate more following pre-eating exposure to food cues relative to no prior cue exposure. Study one examined the effect of exposing restrained and unrestrained eaters to food cues presented singly or in combination. Olfactory and thought cues were both effective in generating greater food consumption in restrained eaters and the combination of both cues generated the greatest food intake in this group. The second study addressed the question of whether food cues produced a specific or general appetite to eat. Restrained eaters showed a specific response to pre-eating exposure to food cues by eating more of a particular food only if the preceding cue and the food were the same. The third study demonstrated that this specificity effect can be moderated by what the restrained eaters expected to eat. Restrained eaters ate significantly more when they were expecting to taste the same food as the preceding cue than did restrained eaters who were expecting to taste a different food. Unrestrained eaters' food intake in all the studies was relatively unaffected by a period of exposure to food cues. The remainder of this thesis will examine possible explanations for the pattern of results and comment on notable findings of the studies.
Explanations for the Effects of Food Cues on Eating

As previously discussed, explanations for disinhibited eating have focused on set point theory, the 5-HT hypothesis and cognitive theories. Disinhibited eating in response to exposure to food cues, however, is not adequately explained by any of the above theories. For instance, it is untestable whether or not dieters are below their biological set body weights. The set point theory predicts that an individual below her biological set point weight will be in a state of chronic hunger and energy deficit which will trigger compensatory behaviors such as binge eating to restore body weight to a normal level. However, some of the most accomplished dieters, and those most below their biological set points, anorexics, do not binge eat. The set point theory can not account for individuals who do not binge eat even though they are obviously below their set point weights.

The 5-HT hypothesis proposes that the avoidance of carbohydrates by dieters will lower serotonergic activity in the brain and trigger carbohydrate binges to restore serotonin levels (Goldbloom, 1987; Kaye et al., 1984; Kaye & Gwirtsman, 1985; Wurtman, & Wurtman, 1984). However, the existing data do not consistently indicate a specific impact of serotonin dysregulation on carbohydrate regulation. Furthermore, research shows that bulimics' binges (documented by food diaries) are not excessively rich in carbohydrates (Jansen, van den Hout, & Griez, 1989).

Neither the set point nor the serotonin theory account for the observation that disinhibited dieters overeat or counterregulate and nondisinhibited dieters do not (Jansen, 1990). According to these biological theories, all dieters are in a state of
energy deficit and should therefore overeat in order to restore physiological equilibrium.

Cognitive theories have previously focused on the notion that dieters overeat because they believed that they had already or were about to break their diets. Dysfunctional cognitive strategies such as dichotomous thinking lead the dieter to consider dieting futile, so she abandons her dietary restraint (at least in the short term). However, this approach cannot explain why dieters overeat when they have not broken their diets.

Alternatively, a cognitive theory originally developed to explain drug urges and drug use behavior (Tiffany, 1990, 1992) may be useful to account for dieters' increased eating following exposure to food cues. Tiffany proposes that drug use in the addict is largely controlled by automatic processes and involves no urges or cravings. However, urges are invoked under certain circumstances. For example, when an addict tries to stop drug use, an urge or craving develops which is associated with relapse. It is only when the automatic behavior (to use drugs) is being resisted that the action becomes nonautomatic and urges are likely to develop. Moreover, such urges are particularly likely to occur in the presence of cues associated with taking the substance, in this case food cues (Woods, 1991). A dieter who is consciously attempting to reduce her food intake, when faced with the very type of food she is trying to resist eating – pizza and chocolate chip cookies are both rated as forbidden foods by dieters (Knight & Boland, 1989) – develops an urge or an appetite to eat which undermines her diet and promotes even greater eating. A nondieter, on the other hand, when presented with an appetizing food, does not experience the urges or appetite to
the same extent because she is not attempting to deny herself those foods. The nondieter's automatic response would be to eat in accord with hunger and satiety signals and not to experience intense urges which could push eating beyond the normal limits of satiety.

This theory offers an alternative framework to investigate cognitive processing and key characteristics of behaviors such as drug use and perhaps eating. The evidence from the present studies showing restrained eaters to have greater urges to eat only after pre-exposure to food cues suggests that this explanation may have some merit. However, it is necessary to design experiments to provide critical tests of the theory before any conclusions can be drawn about restrained eating.

A Learning Theory for Disinhibited Eating

The theory of incentive-induced hunger (Weingarten, 1985) proposes that a history of learned associations between external stimuli and eating provides the basis for subsequent cue-induced eating. Conditioned food cues produce a motivational state which can control meal initiation and meal size. Moreover, food-related cues have a particularly powerful effect on later food consumption when previous associations between food stimuli and eating were formed during periods of food deprivation (Grant & Milgram, 1973; Schallert et al., 1982; Weingarten, 1985).

Restrained eaters may have experienced a pattern of learning and reinforcement similar to those animals that underwent conditioning to food-associated stimuli. Restrained eaters may overeat because of classically conditioned responses to food associated cues which have been formed during critical periods of
food deprivation (dieting). After repeated associations of a set of cues with large food intake, presentation of merely the conditioned stimuli will elicit the urge to eat and enhanced eating. Unrestrained eaters, who do not restrict their food intake, are less likely to form such strong associations and therefore are not as influenced by external food stimuli.

This heightened responsivity may operate through a physiological mechanism such as enhanced cephalic responding conditioned to the anticipation of eating (Powley, 1977; Weingarten & Powley, 1981). Previous research has demonstrated restrained eaters' cephalic reflexes are particularly sensitive to the presence of food stimuli (Klajner et al., 1981; Legoff & Spigelman, 1987; Sahakian et al., 1981; Simon et al., 1986).

There are some limitations to this explanation which must be taken into consideration. It is not possible to directly assess the conditioning history of humans. Therefore, it is an assumption that the experiences of restrained eaters resemble those of animals undergoing conditioning. Jansen (1991) also faced this problem when she speculated that overeating in dieters is due to a conditioned compensatory response. This is not a unique problem. Even within learning models it is not always possible to tell what mechanism is at work to produce the observed behavior. For example, drug or alcohol abusers' increased substance use after exposure to substance-related cues is predicted by several learning models. However, the predictions are based on different theoretical underpinnings. The withdrawal model theorizes that cues increase consumption by inducing conditioned physiological symptoms of drug withdrawal (Ludwig & Wikler, 1974) whereas the appetitive motivational model
claims that cues create positive outcome expectancies which in turn, increase substance use (Marlatt, 1985; McAuliffe & Gordon, 1974).

An alternative method to assess conditioning is to determine whether behaviors can be extinguished. Support for a conditioning model comes from studies investigating the effect of dieting on sensations of hunger and craving. Lappalainen (1993) has reasoned that if hunger and craving are learned reactions, then the extinction of these feelings should be possible. Fasting and dieting obese subjects (consuming 200 and 1200-1600 calories per day, respectively) were compared over a period of three weeks. Ratings of hunger, craving and reactivity to food stimuli declined over time only for the fasting subjects (Lappalainen et al., 1990). The authors suggested that conditioned hunger and craving were extinguished by fasting. During fasting, the unconditioned stimuli are no longer present and the conditioned stimuli (food cues) are repeatedly presented alone, eventually resulting in reductions of hunger and craving. The dieting group, however, was still being partially reinforced so their responses to food cues did not diminish. No measures of food intake were taken, so it is not possible to comment on the possibility of excess food consumption being controlled by extinction of conditioned responses.

In summary, the data from the three studies in this thesis concur with the model of incentive-induced hunger (Weingarten, 1985). Exposure to food cues prior to eating evoked an appetitive response as indicated by increased food intake as well as ratings of liking, desire to eat, and craving. The effect was particularly pronounced in restrained eaters, disrupting their customary restraint and inducing significantly more eating and self-reports of an inclination to eat. The combination of food intake
data and self-report information provide converging evidence for an appetitive conditioned model of eating. The actual mechanism operating in restrained eaters can not be conclusively stated since the actual conditioning histories of the subjects are unknown.

Specificity

The specific response of restrained eaters to exposure to food cues in the second study is an interesting and unique finding. Cue specificity has been previously demonstrated in animals (Deutsch, Adams, & Metzner, 1964; Eiserer, 1978; Konorski, 1967). It is hypothesized that the stimulus produces a motivational state or aftereffect that directs the animal towards further reinforcement of the same sort. Cues may not only send a signal to eat but also send a message of what to eat (Weingarten, 1985).

An earlier report also found evidence of cue specificity in humans (Cornell et al., 1989). However, there are some important differences between these studies that must be considered before formulating any conclusions. First, subjects in the earlier study were males and restraint was not measured, so the dieting status of the subjects is unknown. Second, the type and duration of cue exposure differed. That study employed a brief preliminary taste rather than a 10-minute pre-exposure. It has been proposed that these two types of cues may have different effects (Konorski, 1967). A brief cue is thought to elicit a short-term motivational effect which elicits an immediate consummatory response, whereas a more lengthy food cue elicits preparatory responses that include general motor and sensory arousal (Konorski,
1967). In the previous study (Cornell et al., 1989), the short exposure to food may have elicited a brief consummatory response which then enhanced food consumption for all subjects, regardless of restraint. A longer cue may create a longer-lasting appetitive motivational state within the organism, which may include enhanced physiological responses (cephalic reflexes) and cognitive effects (the development of expectations, anticipations, or cravings). Finally, Cornell et al.'s subjects were exposed to both of the target foods simultaneously. Since subjects had equal access to both foods, they may have merely chosen to continue, uninterrupted, to eat the food that they had already tasted. It is also not possible to reconstruct the subjects' eating pattern; for example, did they eat the primed food first and then later switch to the nonprimed food for variety or did they try both foods initially and then focus on eating the primed food or did they switch back and forth between foods? Tracking subjects' actual eating behavior during the session would offer more information on exactly how the subjects responded to the initial cue.

In summary, the present study offers a better test of specificity by offering only one food at a time, either the cued or noncued food, (subjects did not know that they would eventually receive both foods) and comparing subjects' intake to control levels of consumption. The finding that an individual's dieting status not only determines her receptivity to a cue's signal to eat but also influences what she eats, extends existing knowledge about dieters' eating behavior.

The third study provides evidence that the specific response of restrained eaters to food cues is cognitively mediated. Only when restrained eaters were expecting to eat the cued food did they increase their intake. Restrained eaters who
were exposed to the same food cue but did not expect to eat that food ate no more than restrained eaters in the no cue/expectation condition.

Nowhere is the role of expectancies more apparent than in the alcohol and drug field. Balanced placebo designs have shown a significant expectancy effect on urge to drink and drinking. The belief that alcohol was ingested, regardless of actual alcohol intake, resulted in stronger urges to drink and drinking among alcohol abusers (Berg, Laberg, Skutte, & Ohman, 1981; Engle & Williams, 1974; Laberg, 1986; Ludwig, et al., 1977; Marlatt, Demming, & Reid, 1973; Stockwell, Hodgson, Rankin, & Taylor, 1982) and salient alcohol cues (sight and smell of alcohol), independent of whether alcohol was ingested, resulted in stronger urges to drink and more work for alcohol (Ludwig et al., 1974). Conversely, expectancy manipulations had no significant effect on social drinkers or less dependent alcohol abusers (Berg, et al., 1981; Berg, 1986).

Individuals trying to quit smoking self-administered similar amounts of a nicotine gum and a placebo gum if they believed both contained the active drug (Hughes, Pickens, Spring, & Keenan, 1985). Informing subjects that they had received nicotine gum increased abstinence rates independent of the nicotine content of the gum (Hughes, Gulliver, Amori, Mireault, & Fenwick, 1989). These studies highlight the importance of psychological mediating mechanisms in drug and alcohol intake.

Similar processes may be operative for both expectation-induced drug use and eating. Both drug/alcohol abuse and excessive eating may be maintained by appetitive motivational processes (Stewart, deWit, & Eikelboom, 1984). A combination of prior conditioning coupled with a positive expectancy (i.e., the expectation of the positive effects of the drug or the expectation of eating a highly palatable food) may generate a
positive motivational appetite to consume that particular substance which in turn, prompts excessive consumption.

Craving

In previous studies, the discussion of the role of craving as a mediator of cue-induced eating has arisen (Cornell et al., 1989; Jansen & van den Hout, 1990; Weingarten, 1985). Craving is a hypothetical construct which has evaded a clear scientific definition (see Kozlowski & Wilkinson, 1987). However, the term craving is ubiquitous in the everyday world. Most individuals when asked, can easily list numerous experiences with cravings for various substances including cigarettes, alcohol, and food. Surveys (Schuman, Gitlin, & Fairbanks, 1987; Weingarten & Elston 1991) found between 43% and 97% of ordinary individuals report food cravings and about 50% of overweight women report carbohydrate cravings and identify this experience as an impediment to weight loss (Bjorvell, Ronnberg, & Rossner, 1985). Furthermore, in one study over 70% of bulimics attributed their binge eating to food cravings (Mitchell, Hatsukami, Eckert, & Pyle, 1985).

It has been proposed that food cravings develop as a result of a physiological need such as food deprivation (Keys et al., 1950; Warren & Cooper, 1988), or mineral (Wilkins & Richter, 1940), or macronutrient deficiencies (e.g., Wurtman, & Wurtman, 1984). Conversely, others have proposed that food craving is characterized by eating in the absence of physiological need (Cornell et al., 1989; Weingarten, 1985). In his studies of cue-induced eating in sated animals, Weingarten suggested the possibility that the resulting subjective sensation could be characterized as a craving. Cornell
and colleagues further elaborated on this idea with human subjects. They found that
sated subjects after receiving a small taste of a food ate a significant amount of that
food and reported a desire to eat when in the presence of the food. Eating in the
absence of physiological need, they surmise, may be indicative that a type of craving
was created which motivated eating to continue past satiety.

Others have proposed that craving may mediate disinhibited eating in
restrained eaters by way of a conditioned compensatory response (Jansen & van den
Hout, 1990). Blood glucose levels decrease in response to food cues as a way of
preparing the body for the consumption of large amounts of food (as in a binge by
bulimics or disinhibited eating by dieters).

Both these studies submit that craving mediates eating, but through different
substrates. The former study proposes craving controls eating in defiance of satiety
signals and the latter study suggests that craving is the cognitive correlate of a
preparatory physiological response to the presence of food. However, neither of these
studies specifically defined or measured craving, so these proposals remain merely
speculation.

To gauge the subjective effects of food cues, several self-report measures
were incorporated into the studies in this thesis. Kozlowski and Wilkinson (1987)
suggest a direct approach by asking about cravings as well as asking other questions
about urges and desires, offering subjects alternative ways of describing their
desires so as to avoid devaluing the meaning of craving. In the present studies,
subjects were asked to rate their hunger, desire to eat in general, as well as liking,
desire to eat, and craving for various foods.
The self-report data from the three studies offer some insight into the question of the role of craving in cue-induced eating. Restrained eaters reported a significantly greater craving for pizza following a pizza cue in the first study. The self-report and food intake data of the restrained eaters in study two suggest a specific appetite was created by exposure to food cues. Restrained eaters experienced a greater liking, desire to eat and craving for cookies post-cookie cue than did unrestrained eaters. Both restrained and unrestrained eaters expressed a greater desire to eat and craving for pizza following the pizza cue (as compared to following the cookie cue or no cue). In study three, all subjects distinguished between craving and desire to eat cookies by specifically craving cookies following the cookie cue and the expectation to taste cookies relative to no cue or expectation. Desire to eat cookies was evoked following both cue/expectation conditions. This data suggests that a specific craving was induced following pre-eating exposure to that food. Subjects were able to distinguish between a general desire to eat and a specific craving. The restrained eaters' enhanced intake only for the food to which they had been previously exposed is in keeping with their elevated ratings of craving for that food. Unrestrained eaters, on the other hand, might have experienced a general appetite to eat rather than a specific craving as evidenced by the lack of a specific effect of the cue on their subsequent food intake.

In summary, the pattern of subjective reports suggests that exposure to food cues generates an appetite to eat. Craving was elevated in response to pre-eating exposure to food cues and in studies two and three, craving was specific to the food expected. Furthermore, craving was somewhat stronger and more specific in
restrained eaters. The evidence of a specific desire for a particular food following
cues associated with that food suggests something more than a general appetite to eat.
It is possible that part of what constitutes a craving is a specific desire for a
substance, in this case food. Cues conditioned to a given food may produce an
appetitive motivational state that may be manifested as a food craving and
furthermore, may be specific to the food expected (Weingarten, 1985).

However, the varied pattern of subjective ratings among the three studies
suggests that the self-report ratings are not as reliable as food intake data. The self-
reports show more consistent differences between restrained and unrestrained eaters
for cookie ratings than for pizza ratings. No differences in self-report were found for
restraint in study three. In recognition of this limitation, the self-report
information is considered as only a tentative guide towards determining the
mechanism governing restrained eaters' food intake after exposure to food cues.

Implications

The findings that dieters are more responsive to pre-eating exposure to food
cues have several implications for eating disorder patients. There is evidence that
eating disordered individuals are more sensitive to food-, weight-, and shape-
related cues in the environment. Information processing, which refers to the way
individuals perceive, selectively attend to, and retrieve information from memory,
may differ in a variety of clinical disorders relative to nondisordered controls (e.g.,
Gotlib & McCann, 1984; Lavy, van Oppen, & van den Hout, 1994; Matthews & MacLeod,
1985; Mattia, Heimberg, & Hope, 1993; McNally, Rieman, & Kim, 1990). Vitousek and
Hollon (1990) hypothesize that individuals with eating disorders develop organized
cognitive structures around the issues of food, weight and shape. Several studies have
demonstrated that anorexics and bulimics exhibit an attentional bias towards food-,
weight- and shape-related information (e.g., Ben-Tovim & Walker, 1991; Channon,
Hemsley, & de Silva, 1988; Cooper & Fairburn, 1992; Fairburn, Cooper, Cooper,
McKenna, & Anastasiades, 1991; Perpina, Hemsley, Treasure, & de Silva, 1993;
Schotte, McNally, & Turner, 1990). It is possible that eating disordered individuals
may be in a constant state of selective processing, dwelling specifically on food- and
weight-related materials in their environment. This sensitivity may place eating
disordered patients in a perpetual state of exposure to, for example food cues, which
may trigger eating binges, thereby prolonging eating disorder symptoms.

Analyses of external cues affecting hunger, craving, and food intake have
implications for the treatment of eating disorders. For bulimics, particular food cues
may come to act as conditioned stimuli triggering sensations of craving and
consequent binge eating behavior. A behavioral treatment variant of exposure plus
response prevention therapy (ERP; Rosen & Leitenberg, 1985) has achieved some
success. This cue exposure treatment strategy, in contrast to ERP which concentrates
on the control of vomiting, focuses on the control of bingeing. Specific cues or
triggers are identified and bulimics are exposed to their preferred binge foods
without bingeing. Binge food exposure with response prevention of bingeing was found
to be effective in reducing urges to binge and vomit, tension, lack of control, and guilt
in anorexia patients with bulimia, and bulimia nervosa inpatients (Kennedy, Katz,
Neitzert, Ralevski, & Mendlowitz, 1995). Similarly, in a case study report, preferred
binge foods were presented to a bulimic patient who was encouraged to touch the food, to smell it and even to taste a small amount but bingeing was prevented. The patient's binge eating episodes decreased and craving declined for the cued foods during the exposure sessions and this was maintained during a 9-month follow-up period (Jansen, van den Hout, & Griez, 1990).

Future research should be directed toward investigating how broad or specific the range of cues should be to maximize effects. It would also be useful to evaluate the impact of cue exposure and binge prevention treatment on bulimics' subsequent eating pattern, for example, can they incorporate previously forbidden binge foods into a normal meal plan?

Conclusion

This thesis began with the notion that food-associated cues appear to induce eating in both animals and humans even when they are not food deprived. The results of this thesis have developed some specification of the parameters surrounding cue-induced eating in humans. Restrained eaters are more likely to eat significantly more following a period of pre-eating exposure to food cues. These individuals are relatively insensitive to internal states of hunger and satiety and rely more on external cues such as those presented to them in the pre-eating exposure conditions. Furthermore, this thesis has extended and qualified this finding such that restrained eaters eat more after cue exposure only if the food is the same as the preceding cue. This specificity effect appears to be mediated by what the restrained eater is led to expect about what she will subsequently eat.
A learning-based interpretation was offered to explain restrained eaters' responses to food cues. The incentive-induced theory of hunger (Weingarten, 1985) proposes that cue-induced eating is produced by a history of learned associations between external stimuli and eating that are formed during periods of food deprivation. Conditioned food cues produce an appetitive motivational state which influences subsequent food consumption. Restrained eaters may overeat because of conditioned responses to food-associated cues which have been formed during periods of dieting. The specific responses of restrained eaters to food cues are likely to be under cognitive control, given their sensitivity to the manipulation of expectancies. The notion of craving as a cognitive mediator of cue-induced eating has some merits but more research needs to be conducted before any conclusions can be drawn.

Future research is needed to examine other parameters of cue-induced eating, such as the importance of the duration of the cue, and the effects of delay between cue exposure and subsequent eating. Additional research will advance knowledge about the relationship between dieting and eating behavior and aid in the development of treatments for eating disorders.
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98, 89-92.


### Table 1
**Means and Standard Deviations for Pizza Consumption (grams) for Study 1**

<table>
<thead>
<tr>
<th></th>
<th>Free thoughts</th>
<th>Pizza thoughts</th>
<th>Free thoughts</th>
<th>Pizza thoughts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No Smell</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unrestrained</td>
<td>103.76</td>
<td>140.37</td>
<td>147.49</td>
<td>120.72</td>
</tr>
<tr>
<td>M</td>
<td>103.76</td>
<td>140.37</td>
<td>147.49</td>
<td>120.72</td>
</tr>
<tr>
<td>SD</td>
<td>30.91</td>
<td>49.35</td>
<td>48.05</td>
<td>41.86</td>
</tr>
<tr>
<td>n</td>
<td>14</td>
<td>10</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td><strong>Smell</strong></td>
<td>89.06</td>
<td>152.91</td>
<td>162.44</td>
<td>190.56</td>
</tr>
<tr>
<td>Restrained</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>89.06</td>
<td>152.91</td>
<td>162.44</td>
<td>190.56</td>
</tr>
<tr>
<td>SD</td>
<td>29.38</td>
<td>74.32</td>
<td>68.37</td>
<td>47.17</td>
</tr>
<tr>
<td>n</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>
Table 2
Means and Standard Deviations for Intake (grams) of the Food Served Immediately after Cue Exposure for Study Two

<table>
<thead>
<tr>
<th>Food Served First</th>
<th>No Cue</th>
<th>Cookie Cue</th>
<th>Pizza Cue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cookie</td>
<td>Pizza</td>
<td>Cookie</td>
</tr>
<tr>
<td>Unrestrained</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>78.96b</td>
<td>95.12b</td>
<td>71.74b</td>
</tr>
<tr>
<td>SD</td>
<td>35.99</td>
<td>44.11</td>
<td>28.91</td>
</tr>
<tr>
<td>n</td>
<td>12</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Restrained</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>58.58b</td>
<td>84.84b</td>
<td>107.96a</td>
</tr>
<tr>
<td>SD</td>
<td>17.38</td>
<td>40.32</td>
<td>52.62</td>
</tr>
<tr>
<td>n</td>
<td>10</td>
<td>9</td>
<td>11</td>
</tr>
</tbody>
</table>

Note: Means that share the same superscript are not significantly different from each other. Differences are based on planned comparisons (t-tests)
Table 3
Means and Standard Deviations for Overall Cookie and Pizza Consumption (grams) Regardless of What Food was Served First for Study Two

<table>
<thead>
<tr>
<th>Cue</th>
<th>No Cue</th>
<th>Cookie Cue</th>
<th>Pizza Cue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intake</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cookie</td>
<td>Pizza</td>
<td>Cookie</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unrestrained</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>71.77a</td>
<td>93.00a</td>
<td>77.30a</td>
</tr>
<tr>
<td>SD</td>
<td>37.61</td>
<td>44.57</td>
<td>35.38</td>
</tr>
<tr>
<td>n</td>
<td>22</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>Restrained</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>66.68b</td>
<td>86.01a</td>
<td>101.71a</td>
</tr>
<tr>
<td>SD</td>
<td>29.30</td>
<td>46.90</td>
<td>47.95</td>
</tr>
<tr>
<td>n</td>
<td>19</td>
<td>19</td>
<td>21</td>
</tr>
</tbody>
</table>

Note. Data come from the repeated measures analysis of variance calculations. All subjects received both cookies and pizza to eat. Comparisons are separate for unrestrained and restrained subjects. Means in the same row that share the same superscript are not significantly different from each other.
Table 4
Means and Standard Deviations of Total Combined Food Intake (Cookie and Pizza) for Study Two

<table>
<thead>
<tr>
<th>Cue</th>
<th>No Cue</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Served First</td>
<td>Cookie</td>
<td>Pizza</td>
<td>Cookie</td>
<td>Pizza</td>
<td>Cookie</td>
</tr>
<tr>
<td>Unrestrained</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>170.21</td>
<td>158.27</td>
<td>172.81</td>
<td>197.25</td>
<td>188.45</td>
</tr>
<tr>
<td>SD</td>
<td>65.90</td>
<td>65.45</td>
<td>61.16</td>
<td>65.80</td>
<td>72.38</td>
</tr>
<tr>
<td>n</td>
<td>12</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Restrained</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>145.34</td>
<td>160.86</td>
<td>221.96</td>
<td>179.56</td>
<td>158.12</td>
</tr>
<tr>
<td>SD</td>
<td>63.22</td>
<td>66.54</td>
<td>97.09</td>
<td>82.00</td>
<td>47.54</td>
</tr>
<tr>
<td>n</td>
<td>10</td>
<td>9</td>
<td>11</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
Table 5
Means and Standard Deviations for Chocolate Chip Cookie and Pizza Consumption for Study Three

<table>
<thead>
<tr>
<th></th>
<th>No Cue</th>
<th></th>
<th>Cookie Cue</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Expectations</td>
<td>None</td>
<td>Same</td>
<td>Different</td>
</tr>
<tr>
<td>Food Type</td>
<td>Cookie</td>
<td>Pizza</td>
<td>Cookie</td>
<td>Pizza</td>
<td>Cookie</td>
<td>Pizza</td>
</tr>
<tr>
<td>Unrestrained</td>
<td></td>
<td></td>
<td>M</td>
<td>67.0\textsuperscript{a} &amp; 102.0\textsuperscript{b} &amp; 73.6\textsuperscript{a} &amp; 138.8\textsuperscript{b} &amp; 72.9\textsuperscript{a} &amp; 134.7\textsuperscript{b}</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SD</td>
<td>24.0 &amp; 35.2 &amp; 31.7 &amp; 61.5 &amp; 19.1 &amp; 73.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>10 &amp; 16 &amp; 11 &amp; 11 &amp; 10 &amp; 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restrained</td>
<td></td>
<td></td>
<td>M</td>
<td>48.1\textsuperscript{b} &amp; 89.2\textsuperscript{a} &amp; 101.0\textsuperscript{a} &amp; 95.6\textsuperscript{a} &amp; 58.5\textsuperscript{b} &amp; 123.9\textsuperscript{a}</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SD</td>
<td>26.3 &amp; 47.0 &amp; 36.9 &amp; 46.5 &amp; 18.4 &amp; 64.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>11 &amp; 10 &amp; 10 &amp; 10 &amp; 11 &amp; 10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comparisons are separate for unrestrained and restrained subjects. Means in the same row that share the same superscript are not significantly different from each other.
Figure Captions

**Figure 1.** Mean consumption of pizza (g) as a function of restraint and olfactory cue condition. (Study 1)

**Figure 2.** Mean consumption of pizza (g) as a function of restraint and cognitive cue condition. (Study 1)

**Figure 3.** Mean ratings of desire to eat as a function of restraint and olfactory cue condition. (Study 1)

**Figure 4.** Mean consumption of pizza or chocolate chip cookies (g) as a function of cue conditions. (Study 2)

**Figure 5.** Mean consumption of chocolate chip cookies (g) as a function of restraint and cue conditions. (Study 2)

**Figure 6.** Mean consumption of pizza (g) as a function of restraint and cue conditions. (Study 2)

**Figure 7.** Mean ratings of pleasantness of the smell of cookies as a function of restraint and cue condition. (Study 2)
I

Unrestrained – Restrained

No Cue Cookie Cue Pizza Cue

Cue Condition

Cookie Intake (g)

160
140
120
100
80
60
40
20
0

Unrestrained

Restrained
Restraint Scale (Polivy, Herman, & Howard, 1988)

**Eating Habits Questionnaire**

The following questions refer to your normal eating pattern and weight fluctuations. Please answer accordingly.

Age ________ Sex ________

Height ________ Weight ________

1. How often are you dieting? (circle one)

   Never    Rarely    Sometimes    Usually    Always

2. What is the maximum amount of weight (in pounds) have you ever lost in one month? (circle one)

   0-4       5-9       10-14      15-19      20+

3. What is your maximum weight gain within a week? (circle one)

   0-1       1.1-2      2.1-3      3.1-5      5.1+

4. In a typical week, how much does your weight fluctuate? (circle one)

   0-1       1.1-2      2.1-3      3.1-5      5.1+

5. Would a weight fluctuation of 5 lbs. affect the way you live your life? (circle one)

   Not at all    Slightly    Moderately    Very Much

6. Do you eat sensibly in front of others and splurge alone? (circle one)

   Never    Rarely    Often    Always

7. Do you give too much time and thought to food? (circle one)

   Never    Rarely    Often    Always

8. Do you have feelings of guilt after overeating? (circle one)

   Never    Rarely    Often    Always

9. How conscious are you of what you are eating? (circle one)

   Not at all    Slightly    Moderately    Very Much

10. What is your maximum weight ever? ________________

11. How many pounds over your desired weight were you at your maximum weight? (circle one)

   0-1       1-5       6-10      11-20      21+

12. When you break your diet do you react by: (circle one)

   - Going right back on the diet
   - Compensating by eating less for a while
   - Continue to eat non-diet foods and start the diet another day
   - Get rid of non-diet food by vomiting or taking laxatives
   - not applicable
SENSATION QUESTIONNAIRE

Please describe how you feel at the present time in terms of the following sensations. A vertical slash at the left hand side will indicate that you do not feel that sensation at all and a mark at the right hand side will indicate that you feel that sensation strongly.

1. How hungry do you feel?

_________________________________________________________________
not at all hungry extremely hungry

2. How great is your desire to eat?

_________________________________________________________________
not at all great extremely great

3. How great is your desire to eat roast beef sandwiches?

_________________________________________________________________
not at all great extremely great

4. How much do you like roast beef sandwiches?

_________________________________________________________________
not at all extremely

5. How great is your craving for roast beef sandwiches?

______________________________
not at all                      extremely
great                         great

6. How great is your desire to eat chocolate chip cookies?

______________________________
not at all                      extremely
great                         great

7. How much do you like chocolate chip cookies?

______________________________
not at all                      extremely

8. How great is your craving for chocolate chip cookies?

______________________________
not at all                      extremely
great                         great

9. How great is your desire to eat pizza?

______________________________
not at all                      extremely
Example of Visual Analog Scales used in Study Two

10. How much do you like pizza?

________________________________________________________________________
not at all                                           extremely

11. How great is your craving for pizza?

________________________________________________________________________
not at all                                           extremely
  great                                           great

12. How great is your desire to eat ice cream?

________________________________________________________________________
not at all                                           extremely
  great                                           great

13. How much do you like ice cream?

________________________________________________________________________
not at all                                           extremely

14. How great is your craving for ice cream?

________________________________________________________________________
not at all                                           extremely
  great                                           great
Taste Test Questionnaire

Please describe how you feel at the present time in terms of the following questions. A vertical slash at the left hand side will indicate that you do not like or feel that sensation at all and a mark at the right hand side will indicate that you feel that sensation strongly.

1. How pleasant is the taste of this food?

   __________________________

   not at all pleasant
   extremely pleasant

2. How pleasant is the texture of this food?

   __________________________

   not at all pleasant
   extremely pleasant

3. How pleasant is the smell of this food?

   __________________________

   not at all pleasant
   extremely pleasant

4. How spicy is this food?

   __________________________

   not at all spicy
   extremely spicy
5. How salty is this food?


not at all salty

extremely salty

6. How sweet is this food?


not at all sweet

extremely sweet

7. How great is your desire to eat this food?


not at all great

extremely great

8. How satisfied does this food make you feel?


not at all satisfied

extremely satisfied

9. How much do you crave this food?


not at all

extremely
POST EXPERIMENTAL QUESTIONNAIRE

Please be as specific and complete as you can when you answer these questions. All information is confidential.

1. Have you ever experienced a craving for a certain food(s)?

2. If so, what food(s)?

3. How often do you experience a craving for a certain food?
   daily
   weekly
   monthly

4. Have you noticed any connections between a craving and an event, for example, mood or menstrual cycle? (please be specific)

5. How often do you eat the craved food(s)?

6. Do you ever deny yourself these craved foods? Why?
7. Do you ever try to substitute another food for the craved food? (give an example if answer is yes)

8. Does this substitute satisfy or at least get rid of the craving? (be as specific as you can)

9. Do you diet?

10. If yes, while dieting, do you crave certain foods?

11. If yes, what foods?

12. Do you deny yourself these foods?

13. If yes, what happens to your feelings of craving a food?

14. On what date did your most recent menstrual period begin?

15. On what date do you expect your next menstrual period to begin?
IMAGE EVALUATION
TEST TARGET (QA-3)

1.0  1.1  1.25
  1.8  1.4  1.6

1.1  1.0  1.25
  2.0  1.4  1.6

1.25 1.4 1.6

150mm
6"

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