THE EFFECT OF CUE EXPOSURE ON RESPONSES TO FOOD AS MEASURED BY SALIVATION AND SELF - REPORTS OF HUNGER, APPEAL AND CRAVING

by

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Abstract

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Anticipatory conditioned responses develop in the presence of stimuli that reliably signal the intake of food and prepare an organism for consumption of the food based on prior experience. The effect of manipulating the relationship between food signals and intake on physiological and self - reports of psychological responses to food is not fully understood. In this study, anticipatory salivation and self - reports of hunger, appeal and craving were concurrently measured following two minute, olfactory and visual presentations (cue-exposure trials) of food and nonfood items. Bite - sized amounts of the food presented on an exposure trial were consumed and served as reinforcers on the reinforced trials. Forty college students, who described themselves as nondieters, who ate potato chips and fruit regularly, were matched on the basis of sex and randomly assigned to one of four experimental groups. In the pretreatment phase, all participants received exposure to pencil shavings; and to fruit and potato chips, prior to and following reinforcement. During the treatment phase, based on group assignment, experimental effects were assessed after each of ten consecutive exposure trials to one stimulus. The extinction group (EX) received exposure to potato chips; the pencil shavings group (PS), pencil shavings; the reduced-level-of-reinforcement group (RLR), potato chips followed by reinforcement; and the extinction-with-rinse group (ER), potato chips. Oral rinsing with water followed all food consumption and exposure trials during the treatment phase for the extinction-with-rinse group. In the posttreatment phase, all participants received three unreinforced exposure trials, the first and third to potato chips and the second to fruit. The results showed that: (a) the repeated, unreinforced exposure to the potato chips resulted in significantly lower levels of anticipatory salivation in response to the potato chips for the EX and ER groups in the posttreatment phase; (b) reported levels of appeal for the potato chips were reliably lower for the RLR, ER and EX groups on the second posttreatment trial; (c) treatment effects did not generalize to the fruit; (d) pretreatment values for salivation did not significantly correlate with the self - report measures.

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Introduction

In man (Stunkard, 1959) and in animals (Le Magnen, 1985), the variability that characterizes eating behavior suggests a complex process of learning associated with internal hunger and satiety cues not governed exclusively by physiological reflexes. From early development, the effects of experience on eating behavior have been observed. In animal studies, insulin released in anticipation of food intake in rats was observed within the first week of life (Bernstein & Woods, 1980), and in experiments with humans, in an operant paradigm, differential patterns of sucking emerged in infants in response to water and sucrose solutions after prior exposure to these solutions (Lipsitt, 1977). In clinical studies, there is empirical evidence indicating that psychological responses to food are learned as well, and these responses are the product of prior experience. Individuals with eating disorders, commonly report a craving for food prior to an episode of overindulgence. In treatment, the reported craving diminished when the food was repeatedly presented under the same stimulus conditions that were present on prior occasions, only it was not consumed. Changing the relationship between the food stimuli and consumption was also associated with a decrease in episodic overeating as well (Jansen, Broekmate & Heymans, 1992). With respect to research strategy in the study of eating behavior, Powley & Berthoud (1985) recommended that conditioning paradigms, in particular, extinction procedures would be especially useful in determining the learned status of the physiological responses that develop in anticipation of food intake, and Booth (1991) stressed the importance of including a behavior analytic approach to the study of the stimulus and response relationships implicated in hunger and satiety mechanisms.

The appropriateness of using self - reports as measures of hedonic responses is questionable because these responses represent internal events that are constructs and are not validated by observable events (Fernandez - Ballesteros, 1991). The construct of craving represents an affective state with presumed motivational properties and is believed to have associated behavioral and physiological correlates. However, measures of operant behavior are not always feasible and may not be functionally equivalent to motivational states (Baker, Morse & Sherman, 1987). Therefore, a greater understanding of the relationship of self - reports of affective states to physiological responses is needed to assess the value of using physiological measures as indicators of treatment effects in clinical situations. The goal of this research is: (1) to assess the effect of repeated exposure to food - related stimuli on anticipatory measures of salivation, and self - reports of hunger, appeal and craving when the food presented is not consumed and when the amount consumed is less than that typically eaten; and (2) to determine the relationship between self - reports of psychological responses and anticipatory salivation.

Models of Learning

Several models have been suggested to account for the quantitatively and qualitatively distinct nature of physiological and affective responses that develop from the same CS - US relationships. Konorski (1967) proposed that the diverse nature of conditioned responding was a product of associations formed with different aspects of the unconditioned stimulus. He categorized conditioned responses into two types: consummatory and preparatory. The consummatory responses were discrete and reflexive and were based on associations formed with the particular sensory attributes of the US. Examples of these responses include salivation in dogs, licking in rats and pecking in pigeons. Preparatory responses, on the other hand, were characterized as diffuse and reflecting a general affective state developed as a result of associations formed with the emotional attributes of the same US. The behavior manifested by these responses (e.g., approach vs. withdrawal) would depend on whether the affective value of the unconditioned stimulus was appetitive or aversive. In Konorski's view the preparatory responses have motivational properties and are capable of modulating the consummatory responses. He maintained that both the CS and the US in a CS - US relationship were capable of activating distinct representations in memory, each having sensory and emotional components.

In contrast to Konorski's model for the development of preparatory responses based on learning mechanisms, Solomon & Corbit (1974) proposed an alternative hypothesis referred to as " Opponent Process Theory. " In this construct, affective states are conceived to be the result of nonassociative processes that are determined by the attributes of a reinforcer. In their view, the reinforcer could be any stimulus that has hedonic properties. When the stimulus event occurs, two forces, referred to as *a* and *b* processes, operate in response to the hedonic effects of a reinforcer and are generated by the central nervous system in order to maintain homeostasis of the affective state. The *a* process occurs first and is thought to be discrete, producing an affective state that corresponds to the hedonic nature of the US . The *b* process is generated by the *a* process and produces an affective state, the *b* state, that opposes the hedonic nature of the *a* state. The *b* process activates sluggishly and has a long latency, but with repeated use of the reinforcer, the *b* process is strengthened. The opposing hedonic states that emerge, can themselves be conditioned to stimuli associated with the reinforcer but conditioning is not necessary for their development (Solomon, 1980; Solomon & Corbit, 1974). Solomon (1977) extended this analysis to eating behavior and postulated that hunger and satiety mechanisms work together with taste - craving and taste - aversion processes. The postingestional effects of food regulate hunger and satiety, whereas taste - pleasure and taste - craving are appetitive and aversive motivational states, respectively. Accordingly, if the sum of hunger and taste - craving exceeds that of taste - pleasure and satiety, eating will persist; if the reverse is true, eating will stop.

Wagner & Brandon (1989) developed a connectionist model of conditioned responding that retained some of the features of both Konorski's and Solomon & Corbit's theories. They moved away from the rigidity of opponent - process theory and expanded the role of the opponent processes beyond affective attributes of the US to include the sensory attributes as well. Adopting Konorski's hypothesis, that there is a separate representation of the CS and the US in memory for each of the sensory and affective attributes of the reinforcer, they proposed a refinement to Opponent Process Theory called "AESOP. " AESOP is an acronym for an "affective extension of 'SOP' " which refers to an earlier version of the theory, "SOP," which is itself an acronym for "sometimes opponent process" theory (Wagner, 1981).

According to AESOP, when the sensory or affective attributes of the US are stimulated in memory, activity changes occur in a site representing that aspect of the reinforcer. The site is referred to as a node, described as consisting of a number of "elements." If stimulation of a node is achieved by a US, then " elements" in memory will be advanced from an inactive state (I), to one of primary activity (A1), and then decay and move to a state of secondary activity (A2). From the A2 state they decay further and return to the inactive state. If stimulation of a node is achieved via stimulation from a CS with which the US is paired, then nodal elements will be promoted from the inactive state directly to the A2 state. The elements stimulated by the CS then return to the inactive state after leaving the A2 state. Conditioned responses develop from the activation of the A2 state and can either mimic or oppose the nature of the US reflected in the A1 state. The CS and US representations, when activated, can interact with each other and modulate conditioned responses; however, the stimulus parameters that are necessary for a CS or US to be activated may differ: the same conditions that are optimal for the activation of one representation may impede the development of the other.

Studies using the conditioned emotional response paradigm have demonstrated the modulatory effects of emotional states on instrumental responses (Geller, 1960; Rescorla & Solomon, 1967) and on unconditioned responses (Davis, 1984). It would follow from Wagner & Brandon's model that repeated presentation of the CS without the US would weaken the A2 state and the related conditioned response. Although AESOP accounts for the diverse nature of conditioned responses, it does not specify the specific mechanisms by which the modulation occurs. In a review of the empirical evidence supporting an associative account of eating behavior, Woods (1991) proposed that organisms over time, learn to anticipate food intake based on prior experience and develop responses to compensate for the expected consumption in the same way as drug tolerance develops (Siegel, 1983, 1988). Woods concluded that the learning processes mediating eating behavior in general also provide an adequate explanation for the development of atypical patterns of eating as well.

Consistent with Wood's analysis, Jansen (1990) applied a model of learning to account for binge eating. A food-related binge, likened to an alcoholic binge is characterized as an episode of overindulgence. It is defined in the Diagnostic and Statistical Manual of Mental Disorders, fourth edition, as "eating in a discrete period of time, an amount of food that is definitely larger than most individuals would eat in similar circumstances" (American Psychiatric Association, 1994, p. 545). Even though excessive intake is the defining characteristic and there is a common understanding of this phenomenon in history (Jansen, 1990), there are no specific parameters, and the operational definition of what actually constitutes a binge remains arbitrary (Fairburn, 1983, 1984, 1991; Fairburn & Wilson, 1993; Jansen, 1990). To be clinically significant, individuals must report a loss of control over the amount consumed during the binge episode.

According to the epidemiological data that have been collected approximately 90% of the population diagnosed with bulimia and anorexia nervosa are female (DSM - 1V, APA, 1994). Although the accuracy of the data on eating disorders has been questioned, secondary to assumed underreporting, the information that has been obtained on males and females indicates that the symptoms and behavior are similar regardless of gender (Frasciello & Willard, 1995).

In Jansen's view (1990), excessive food intake, the defining feature of a binge episode is stimulus or " cue" controlled, and the craving for the food that accompanies each episode is a conditioned response that occurs in the presence of stimuli regularly associated with the onset of the episode. She proposes that a classical conditioning model of learning based on Pavlovian principles (Pavlov, 1927/1960) can adequately explain the development of binge eating. In this construct, associative strength accrues to stimuli that are regularly present during a binge episode and over time, the presence of the stimuli becomes a reliable predictor of the binge episode. In preparation for food intake, the physiological responses that normally develop in anticipation of ingestion become conditioned in the presence of these stimuli and the experience of craving that is commonly reported prior to the onset of the binge is understood as the psychological correlate of these anticipatory physiological responses, and is also a conditioned response. The strength of these anticipatory responses is thought to correspond to the magnitude of food consumed under the same circumstances in past episodes. Consequently, according to Jansen, the subsequent behavior, the excessive intake of food, is a natural outcome of overwhelming craving and physiological responses elicited in preparation for a large intake, and is itself an elicited response.

Stimulus Control and Eating Behavior

Descriptions of binge episodes as reported in the literature, share several common features and suggest a certain "cue specificity," supporting an analysis based on associative mechanisms. In a survey of patients seeking help for binge eating, all of them said that they ate food during a binge episode that they would otherwise deny themselves, and among those surveyed hunger was not a necessary precondition for the episode to occur (Abraham & Beumont, 1982). A macronutrient analysis of food eaten during binge and nonbinge periods by women diagnosed with bulimia nervosa, who were of normal weight, revealed a food specificity associated with their eating patterns as well. Typically the binge food was found to be higher in fat and had a higher caloric value compared to nonbinge food which contained more protein, water and fewer calories (Kales, 1990). Even in nonclinical populations, restrained eaters, described as those of normal weight who would be classified as dieters, reported avoiding food high in fat as part of their regular meal (Tuschl, Laessle, Platte & Pirke, 1990).

An understanding of binge eating based primarily on stimulus control by nutrient value is misleading. Although the food consumed during binge episodes is characteristically sweeter and higher in fat content than food consumed at other times, binge food does not appear to be associated with cravings based exclusively on the macronutrient content of the food eaten. Contrary to a popular belief that binge eaters crave sweets, carbohydrate cravings among this population have not received empirical support (Walsh, 1993). Instead, the scope of stimuli governing eating behavior appears to be much broader. In addition to the content and the context specificity associated with binge eating, the time a meal is eaten as well as the amount of food ingested appear to be components of associative mechanisms. In a review of dietary patterns, Wardle (1990) found that most dieters successfully refrain from eating in the morning and at midday, and then at night, their resolve fails and they consume a large amount of food. These findings suggest that the onset of a binge episode appears to be triggered by a specific set of stimuli such as the sight or taste of palatable food items, time of day, mood states, among others.

Physiological Responses to Food

The same processes thought to mediate excessive food intake are operative in eating behavior generally. In the presence of the stimuli associated with food, physiological responses are elicited prior to food intake. These responses, referred to as the cephalic phase responses (CPRs), are controlled by the autonomic nervous system in response to stimulation of the orosensory receptors. They are among the earliest predigestive reactions that occur and are thought to be implicated in the regulation of food intake by preparing the body for the ingestion of food (Powley & Berthoud, 1985; Rodin, 1985).

Sensory stimuli, such as the sight, smell and taste of food, stimulate the orosensory receptors and trigger the CPRs which in turn elicit the secretion of salivation, gastric acid, pancreatic juices and insulin. Empirical support for the conditionability of the CPRs originated with Pavlov's work (1927/1960) with the salivary response. However, research examining the phenomenon of insulin release suggests that this response may be learned as well. In his studies, Louis - Sylvestre (1976) compared the insulin response in rats administered an oral dose of glucose versus that from rats given an equal dose intragastrically. The results showed that the pattern of insulin released in response to the oral glucose load consisted of two peaks whereas there was only one peak in response to the intragastric load. Studies have also shown that the presentation of a food or the thought of food are sufficient to trigger the cephalic insulin response. In these experiments, the magnitude of the response was greater in obese subjects relative to those of normal weight, indicating that the size of the response may be based on prior experience (Johnson & Wildman, 1983).

Given a certain state of metabolic readiness (e.g., energy balance, level of deprivation), meal size is determined by the ingestive response to the stimulation received from the sensory properties of food, hence the palatability of the food determines the meal size. Le Magnen (1985) defined palatability as the ingestive response to the sensory properties of a specific food and distinguished between this definition and the more common use of the term as a referent to the sensory properties themselves or as a measure of pleasantness. In order to account for eating behavior that is not based on prior experience, he hypothesized that genetically programmed responses may play a role in accepting food with nutritive value and rejecting that which may be poisonous. In this view, the ingestion of food is learned as the sensory properties of the food become associated with its nutritive value. Booth (1972) provided empirical support for the learned nature of palatability in rats. In these experiments, he presented the animals with two starch solutions, one of high and one of low caloric density and each associated with a different odor. After the rats had received both solutions for some time under these conditions, he tested them with two solutions of medium but equal caloric density adding one of the odorants previously used to each solution. The results showed that the rats drank more of the solution whose odorant was previously associated with the solution of lower caloric content.

In related studies, Sclafani (1980) compared the eating habits and weight gain of rats who were fed routine chow diets with those given high fat and high sugar "supermarket" diets. The findings showed that the rats who were given free access to the chow diets maintained lower levels of weight gain than their counterparts who had free access to the supermarket diet. When offered a choice, the rats preferred the supermarket diet suggesting that preference in addition to energy needs played a role in the amount consumed.

According to Jansen (1990) the relationship of the CPRs to eating behavior may be explained in terms of classical conditioning principles. In this construct, the sensory properties of food and other stimuli that are reliably associated with food intake, serve as the conditioned stimuli (CS) and the stimulus effects received from the food serve as the unconditioned stimuli (US) and the postingestive - metabolic activities are the unconditioned responses (UR). After repeated pairings of the food - related stimuli with the stimulus effects received from the food intake, the CPRs are activated when the food cues are presented, functioning as conditioned responses (CR). The strength of the CPRs as conditioned responses is directly related to the strength of the CS - US relationship and is maintained as long as the stimuli that function as conditioned stimuli remain reliable predictors of food intake. In this way the CPRs function to prepare the body for the expected intake. Assuming that the same food ingested during a binge was at one time consumed in normal quantities, it is reasoned that the magnitude of the cephalic phase responses has increased to accommodate for the larger intake.

Jansen (1990) proposed that the CPRs are the biological substrates for craving and as such are assigned motivational properties manifested by subsequent food - seeking behavior. In this view, the excessive eating following the craving response may be related to the increased insulin released into the blood in response to the presence of the food - related stimuli. The hypoglycemic response to the insulin release is considered a conditioned compensatory response. Prior research with rats has shown that hyperinsulinemia has been associated with increased feeding rates (Wiepkema, De Ruiter & Reddingius, et al., 1966) and consumption (Louis - Sylvestre, 1983). Jansen does not restrict CPR activity to responses to the sensory properties of food and believes that other stimuli reliably associated with a binge episode are capable of eliciting CPR responses as well. The magnitude of the CPR response and the experience of craving depend on the associative value the CS has accrued from the binge episodes in the past.

Addiction Analogy

Empirical support for the classical conditioning account of eating is found in addiction research. Although the experience of craving, defined in the DSM-IV (APA, 1994) as "a strong subjective drive to use the substance," is not specified as one of the criteria for the clinical diagnosis of substance dependence, it is found in most cases to accompany those that are listed. Specifically, the criteria for substance dependence characterize a pattern of compulsive use that may be accompanied by tolerance to the substance, or the presence of withdrawal symptoms in its absence. Research with alcoholics suggests that the urge for a drink is a learned response based on Pavlovian principles (Ludwig, 1986). In clinical studies, the presence of stimuli (e.g., time of day, sight of a bar frequented in the past, presence of drinking buddies) has been correlated with relapses in alcoholics who have undergone treatment. These findings suggest that the differential strength of the cues associated with alcohol consumption may explain the onset of a relapse (Marlatt, 1990).

Siegel, Krank & Hinson (1987) proposed that withdrawal symptoms may represent the biological correlates of craving and that these symptoms are conditioned responses that develop over time after repeated use of the drug. Using Pavlovian procedures, Siegel (1983) demonstrated empirically that the development of morphine tolerance could be explained in terms of classical conditioning principles and provide an analysis of both drug tolerance and drug withdrawal that is based on the principles of Pavlovian conditioning. He proposed that the stimuli that are repeatedly associated with the intake of morphine serve as conditioned stimuli and are capable of eliciting physiological responses that compensate for the unconditioned effects of the drug. These physiological responses are conditioned compensatory responses that reflect the body's efforts to maintain homeostasis and occur in anticipation of the drug effects. Siegel et al. (1987) suggested that the same processes that mediate drug tolerance may also explain drug withdrawal. In their view, withdrawal symptoms are also anticipatory responses that occur as the body awaits the next dose, proposing that feedforward as well as feedback mechanisms are presumed operative in the regulation of homeostasis.

Unlike feedback mechanisms which serve to correct physiological disturbances that have already occurred, feedforward mechanisms have a preparatory function whose purpose is to accommodate anticipated disturbances. The feedforward mechanisms are therefore learned and may be manifested as responses that either mimic or oppose drug effects. The direction of the conditioned response, whether it augments or counteracts the unconditioned effects of the drug, is not fully understood, but does not compromise the conditioning analysis. Instead, the direction of the response may reflect whether the site of the brain that was stimulated was an afferent or efferent system (Eikelboom & Stewart, 1982).

Although Pavlovian principles may be used to explain the development of craving responses, drug tolerance and withdrawal symptoms associated with addictive behavior (Siegel, 1988), the relationship among the anticipatory conditioned responses that are elicited in the presence of drug- related stimuli is unclear. In a series of experiments, the effects of exposure to alcohol - related cues (e.g., the sight and smell of the subject's favorite drink as it is typically consumed, the presence of commercial packaging) on measures of physical and psychological responses in alcoholics were assessed. The results showed that craving and salivation were not significantly related to each other; however, reliable relationships were found for each of these variables with some of the other measures. For example, craving was significantly related to enjoyment at the sight and smell of alcohol, whereas salivation was correlated with positive outcome expectancies and also to the quantity and frequency of drinking in alcoholics during the first three months following detoxification. The degree of alcohol dependence, as measured by responses on a questionnaire, correlated with craving in three out of the three studies, and with salivation in one of the three studies reviewed (Rohsenow, Monti, Abrams, Rubonis, Niaura, Sirota & Colby, 1992).

Wise (1988) proposed a two - factor model of addiction to describe the neurobiological basis for craving. In this view, physiological effects on the neurological level form the basis for drug craving and are the outcome of both the appetitive properties of the drug which serve as positive reinforcers and the aversive effects (e.g., withdrawal symptoms) which serve as negative reinforcers for continued drug use. Wise suggested that different brain mechanisms are responsible for each type of reinforcement and the outcome depends on the drug taken, which may also account for the differences observed among syndromes associated with opiate and barbiturate withdrawal. Tiffany (1990) addressed the relationship between salivation and craving in drug addiction and described an alternative model suggesting that physical responses, like salivation, are automatic processes triggered by a specific constellation of stimuli leading to drug use and, do not require an associated conscious process like craving. He did not reject a conditioning analysis for the development of these physiological responses but proposed that a sequence of responses (e.g., drug acquisition and drug intake behavior) become programmed over time and in the presence of drug -related cues, are elicited. Tiffany's concept of drug intake as an elicited response is similar to Jansen's view of overeating during a binge episode; however, Jansen assigns craving a mediational role that promotes the overeating response.

Salivation

Salivation has been studied extensively since its conditionability was first discovered by Pavlov (1927/1960). Experimental data from salivation research, have consistently shown that the magnitude of the response can be influenced by many factors including cognitive, pharmacological as well as the sensory properties of food (Wooley & Wooley , 1973; Wooley, Wooley & Woods, 1975; Wooley, Wooley & Dunham, 1976; Wooley, Wooley & Williams, 1976). Initial experiments assessing the relationship of salivation to body weight showed that between subjects, the salivary response to food, judged as desirable, was positively correlated with both body weight (Wooley, Wooley & Woods, 1975) and scores measuring level of dietary restraint (Sahakian, Robbins & James, 1981). When the long term effects of weight reduction were evaluated in individuals over time, decreased salivary responses to food were associated with prolonged periods of weight loss (Durrant & Royston, 1980).

Research comparing the salivary response in obese and normal -weight dieters and nondieters, indicated that dietary status and not weight, per se, was the better predictor of anticipatory salivation (Klajner, Herman, Polivy & Chhabra, 1981). In a review of salivation research, Herman, Polivy, Klajner & Esses (1981), suggested that the pattern of dieting was the critical factor in determining anticipatory salivation, and suggested that the salivary response in the dieters examined in Durrant & Royston's study had probably undergone some measure of extinction reflecting consistent dieting. They propose that food intake among dieters in the general population is variable and as a result, the anticipatory salivary response does not exhibit any tendency toward extinction. Empirical support for this view is provided by studies that have examined the effect of dietary patterns on anticipatory salivation. This research has shown that salivary responses to food considered to be pleasurable were lower in individuals who maintained themselves on strict diets relative to those whose diet was less rigid and who reported bouts of binge eating (Guy-Grand & Goga, 1981; LeGoff & Spigelman, 1987).

LeGoff, Leichner & Spigelman (1988) studied the clinical significance of anticipatory salivation in eating disorders, and found the magnitude of the response to olfactory stimuli from food was modified in an upward direction in individuals with anorexia nervosa, and showed a downward trend in those with bulimia nervosa after both groups received an eclectic form of therapy designed to normalize eating behavior. The study compared inpatients with eating disorders to nondieting university students who served as controls. Unfortunately, the design did not include an untreated eating - disordered control group, and only one set of pre- and posttreatment salivation measures were obtained, so ongoing changes could not be assessed.

The relationship between reported hunger and anticipatory salivation is undetermined. When food was tasted prior to testing, Hodgson & Greene (1980) found positive relationships among the magnitude of the anticipatory salivation obtained after first tasting the food (primed salivation), subjectively reported hunger, and the level of deprivation. In a later study, Jansen, Boon, Nauta & van den Hout (1992) evaluated the conditionability of self - reported hunger and anticipatory salivation and found the responses to be uncorrelated. In this experiment, light, the view of chocolate, and the taste followed by the consumption of a small piece of the chocolate served collectively as the conditioned - stimulus compound. The intake of a larger serving of the chocolate served as the unconditioned stimulus. On the test trial in the presence of the CS, after the conditioning trials were completed, anticipatory salivation significantly increased and reported hunger decreased relative to measures obtained prior to conditioning. Self - reports of craving were also obtained pre- and postconditioioning and the results showed that craving decreased significantly after conditioning as well. Jansen et al. concluded that associative mechanisms provide an adequate explanation for the observed increase in salivation obtained after conditioning but can not account for the decrease in reported hunger. The participants in this study consumed 30 grams of chocolate after each of eight acquisition trials separated by thirty minutes. The postingestive effects received from the chocolate may have contributed to the decrease in hunger.

Sensory Properties of Food

Studies examining the role of the sensory properties of food in producing satiety provide empirical evidence for the stimulus - specific nature of responses to food. Rolls, Rolls, Rowe &

Sweeney (1981) conducted a series of experiments examining the effect of the sensory properties of food and consumption on affective responses to food. Participants in the first experiment of this study rated the pleasantness, defined as "liking for the food," of the taste of eight food items and then were given one of the items to eat for lunch and instructed to eat until satiety was reached. Two and twenty minutes after lunch, they again rated each food. The results showed that pleasantness for the taste of the food decreased more from levels obtained prior to lunch, if the food tasted was the same one that was consumed at lunch. In a second experiment, the authors looked at the effect of consumption on future intake. Similar to the first experiment, participants tasted and rated their liking for eight food items, consumed one for lunch and again rated their liking for the taste of all food items, initially tasted, two minutes after lunch. The participants were then presented with a second meal, half received the same item that was consumed for lunch and the other half received one of the food items not consumed. The results showed that the decrease in liking for the food eaten during lunch correlated with a decrease in consumption of that food in the second course. The participants who received a different food in the second course ate significantly greater quantities of the food served, relative to their counterparts who received the same food.

In subsequent research, Rolls, Rowe and Rolls (1982) evaluated the specific influence of the sensory properties of food on consumption by testing each property in isolation. In one experiment, after participants tasted chocolates of varying color and rated their pleasantness, they were tested on three subsequent days under different conditions. On one day, they received four courses of chocolate of a single color, on another, four courses of a different color, and on the third, four courses of a mixture of colors. The results showed that when the same color of chocolate was served at each course, the participants reported a significantly greater decrease in the pleasantness of the food compared with the other test days, and this decrease correlated with the amount eaten. Similar results were found in related experiments when the shape of pasta was altered and other features were held constant and when only the flavor of food was changed. In the latter experiment, the flavor of the food that was preferred by the participants prior to the test was the one used in the unchanged condition. Interestingly in an earlier study, when three flavors of yogurt were introduced and all other properties remained unchanged, consumption did not increase when the flavor was varied (Rolls, Rowe, Rolls, Kingston, et al., 1981). Rolls, Rowe & Rolls (1982) discussed the discrepancy of these findings and noted that the flavor change in the 1981 study was a change in the flavor of food items that were all basically sweet, whereas in the later study the flavors used were salt, lemon, saccharin and curry (Rolls et al., 1982).

In additional research, when pleasantness of the sight and taste of food was rated before and after consumption, decreases in both the pleasantness of the sight and the taste were found to be greater for food consumed compared with those just tasted. When participants were asked to rate the pleasantness as well as the intensity of the taste of the test items, they reported a decrease in the pleasantness of the taste of the food consumed but they did not always report a corresponding decrease in the intensity of the taste. The authors interpreted these findings to suggest that different neurological substrates may be responsible for these variables. In another experiment, drinking water did not affect the reported pleasantness of the sight and taste of food and eating food did not affect responses to water when judged on the same qualities, indicating that hunger and thirst may also be influenced by separate mechanisms (Rolls, Rolls & Rowe, 1983).

The nature of the sensory - hedonic relationship described in the previous research appears to be independent of diet or weight. Tepper (1992) measured anticipatory salivation and pleasantness in response to exposure to food in normal - weight restrained and unrestrained male and female subjects. Restraint status was a measure of dieting assessed by a self - report questionnaire and history of weight stability. Although restrained subjects showed greater salivary response rates in the presence of food, both groups reported similar declines in the pleasantness of food that was eaten relative to that not eaten. In general, research evaluating the role of the sensory properties of food suggests a stimulus specificity that is consistent with the "cue specificity" thought to be associated with binge food (Abraham & Beumont, 1982; Kales, 1990; Tuschl et al., 1990; Walsh, 1993).

Cue - Exposure Therapy

The classical conditioning account of binge eating proposed by Jansen (1990) provides the theoretical basis for using cue -exposure as a method of treatment. Cue-exposure therapy is the procedure whereby an individual is repeatedly exposed to a stimulus that has been paired with and is a reliable predictor of another stimulus, but the second stimulus is never presented in treatment. It is essentially a Pavlovian extinction procedure in which the conditioned stimulus is presented without the unconditioned stimulus with the expected outcome of reducing the strength of the conditioned response. In clinical practice, the goal of this therapy is to eliminate a behavior thought to be driven by the conditioned response. Jansen makes the following assumptions in using cue - exposure as a rationale for the treatment of binge eating: (1) CPR responses become conditioned in the presence of stimuli that are reliable predictors of a binge episode. Salivation facilitates food entry and insulin lowers blood glucose to compensate for the expected intake; (2) The lowered blood glucose level is experienced as craving or hunger; (3) The insulin release and the experience of craving mediate binge eating; (4) Binge eating and CPR activity are elicited in the presence of the appropriate CS; and (5) Breaking the bond between the stimuli associated with a binge episode (CS) and the intake of the binge food (US) would result in a weakening of the conditioned responses. In Jansen's view (1990), unreinforced exposure to the stimuli associated with a binge episode should diminish both the magnitude of the CPRs, craving and be effective in reducing the number of binge eating episodes.

Cue-exposure therapy, as it has been used in the treatment of binge eating consists of several 50-60 minute sessions during which the client is exposed to the stimuli (cues) associated with a binge episode (Jansen, 1990). At the start of each session the therapist instructs the client to taste, and in some cases, to eat a morsel of the food and then refrain from eating for the duration of the session. The essential features of this treatment include: (a) cue - exposure (i.e., exposure to the cues associated with a binge episode), and (b) response prevention (i.e., instructions to refrain from eating the food in the presence of the cues). During each session, the client remains in the presence of the stimuli and is instructed to concentrate on the sensory properties of the food and to record craving for the food at regular intervals. Optimally, these stimuli include the environmental setting in which a binge usually occurs, the time of day, the food, as well as the manner in which the food is typically presented. At times other than during the exposure sessions, the client is encouraged to eat a small portion of the binge food in an environment not normally associated with a binge episode. Repeated exposure to the stimuli that signal the onset of a binge episode, not followed by bingeing, and consumption of binge food in a nonbinge environment are directed at reducing the strength of the CS - US relationship between the cues that signal the onset of the binge and the binge episode (US). Treated with this form of therapy, women diagnosed with bulimia nervosa reported a reduction in craving within and between sessions and a reduction in the frequency of binge episodes during and after treatment. Treatment effects were greater when sessions took place in the client's true binge environment than when conditions were simulated in a laboratory setting (Jansen, Van Den Hout, DeLoof & Zandergen, 1989; Jansen, Broekmate, et al., 1992). Cue - exposure has also been shown to be effective in decreasing reported craving responses in opiate addicts as well (Powell, Gray & Bradley, 1993).

Prior to Jansen's work, Rosen & Leitenberg (1985) used cue exposure and response prevention techniques in the treatment of the bingeing and vomiting episodes associated with bulimia nervosa. In their design, during treatment sessions, clients were asked to eat as much as they can, refrain from vomiting long enough for the food to be digested, and monitor their anxiety levels for the duration of the session. Rosen & Leitenberg regard the vomiting behavior associated with bulimia nervosa as an escape response from the weight gain that is threatened by the bingeing behavior. In this view, the vomiting has anxiety - reducing properties similar to the anxiety - reducing effects believed to be responsible for the maintenance of compulsive rituals associated with obsessive - compulsive disorders (Foa, Steketee, Grayson, Turner, & Latimer, 1984). Exposure and response prevention of bingeing is another form of cue-exposure therapy also based on the anxiety model in which an individual is exposed to a binge food, encouraged to eat just enough of the food to trigger the urge to binge and then refrain from bingeing. In a typical session, the individual is asked to concentrate on the feelings associated with the urge to binge and to record his or her level of anxiety at regular intervals. Exposure and response prevention techniques have been successful in reducing the number of bingeing and vomiting episodes reported by participants undergoing treatment for eating disorders even when these sessions took place in a laboratory setting (Schmidt & Marks, 1989).

Habituation Research

In the clinical studies described for the treatment of binge eating, cue - exposure techniques were applied in the context of single uninterrupted sessions during which the client remained in the presence of the stimuli. An alternative approach is to use a discrete - trial procedure within a single session in which stimuli are repeatedly presented during the trials and absent during the intertrial intervals. This design is typically used to study habituation. In a review of habituation research, Thompson and Spencer (1966) identified characteristics shared among many responses that were habituated. Of particular relevance to the study of cue - exposure are the following: (a) Responding recurred to the habituated response after a period of time when the stimulus was withheld; and (b) The habituated response recovered (dishabituated), following the presentation of another stimulus.

Habituation paradigms have been used in several studies to examine hunger and satiety mechanisms. Wisniewski, Epstein & Caggiula (1992) observed a reduction in salivary and reported hedonic responses to olfactory and visual stimuli from food, across trials, when the food was repeatedly presented and consumed. In this experiment, when a new food was introduced after subjects reported satiety in response to the original food, salivary and hedonic responses increased. Consumption but not hunger also increased for those subjects who received a different food on the later trial relative to those who received the same food. In related experiments, similar effects were obtained when gustatory stimulation was used (Epstein, Mitchell & Caggiula, 1993; Epstein, Rodefer, Wisniewski & Caggiula, 1992). When the effect of caloric consumption on salivary and hedonic responses to a repeatedly presented taste stimulus was studied, no reliable differences were found between groups based on the number of calories consumed. In this study, when a new taste stimulus was introduced, salivary and hedonic responses also recovered without a differential effect of calories on these measures (Epstein, Caggiula, Rodefer, Wisniewski & Mitchell, 1993). These findings conform to the changes in hedonic ratings reported and the associated increase in consumption observed when only the sensory properties of food items were modified in the experiments described previously (Rolls, et al., 1981, 1982, 1983; Tepper, 1992).

The habituation studies show that the pattern of change in the salivary response varies depending upon the sensory property of the food tested. Salivation measured in response to olfactory cues repeatedly presented initially increased before declining (Wisniewski, Epstein & Caggiula, 1992) whereas in response to repeated gustatory stimulation, it did not show this increase (Epstein, Rodefer, et al., 1992). In both situations, the hedonic responses declined showing no differential pattern even though food was consumed in the former study, and tasted but not eaten in the latter. Although habituation paradigms do not presuppose prior conditioning, the studies reviewed have demonstrated the stimulus - specificity of salivary and hedonic responses to the sensory properties of food. In a discussion of their findings, Epstein, Rodefer, et al. (1992) acknowledged that the rate of habituation of physiological and affective responses to stimuli may be influenced by the subject's prior experience with the specific stimuli. To date, the functional role of craving and salivation as conditioned responses in eating behavior is unclear. Craving for the food, except as a measure of satiety (Wisniewski et al., 1992), was not assessed in the habituation studies so that the effect of the repeated presentations of the stimuli on salivation and craving could not be directly compared. Jansen, van den Hout, et al.(1989) and Jansen, Broekmate, et al. (1992) showed that prolonged unreinforced exposure to binge food resulted in decreased reports of craving for the food over time, however, anticipatory salivation was not measured in these experiments.

Rationale for Present Research

The present research is based on the assumption that there are universal laws governing physiological and psychological responses to food and these are based on associative mechanisms. Within this theoretical framework, a Pavlovian extinction procedure was used to examine cue - exposure effects of food on anticipatory responses of salivation, hunger, appeal and craving. Monitoring the treatment effects concurrently on salivation and self - reports of hedonic ratings provides the opportunity to assess the relationship of an objective measure to the subjective reports and to explore the merits of using salivation as an assessment tool in research and treatment.

Self - report measures, although of questionable value because of their limited reliability and validity, remain a viable assessment tool in research (Shaw & Garfinkel, 1990) and in clinical treatment where much of a client's progress is inferred (Fairburn & Wilson, 1993). Properties of food have been associated with differential effects on self - report measures reflecting the potential sensitivity of these variables (Hill, Magson & Blundell, 1984; Bellisle, 1989) and the need to use clearly defined constructs to minimize unchecked variability in subjects' responses. In this study, in addition to salivation and reported craving, self - reports of hunger and appeal were obtained after every experimental trial because: (a) the antecedents of eating are not unitary and the likelihood of detecting an effect increases with the number of different components measured; and (b) analytically, different components may be dissociable from one another.

The method of salivation collection used in the previously cited habituation studies was the Strongin - Hinsie Peck (SHP) method which was originally used to evaluate the role of salivation as an indicator of depression (Peck ,1959). However, in research comparing draining, spitting, suction and swab collection methods, the results showed that the group mean flow rates did not reliably differ among the four techniques and test - retest reliability was significantly correlated for all of them. With respect to the test - retest reliability scores, the suction method had the highest followed by spitting, draining and lastly the swab method. When within - subject variances were compared, the spitting method showed the least variability, followed closely by the draining method. Greater within - subject variances were obtained when the suction and swab techniques were used with the greater difference found for the swab technique (Navazesh & Christensen, 1982). The spitting method was selected for this research because the findings from the Navazesh & Christensen's study suggest this method would be more appropriate to use when repeated measures are taken. The swab technique evaluated in the Navazesh and Christensen study is similar to the Strongin - Hinsie Peck method used in the habituation research and in research evaluating the conditionability of salivation and hunger (Jansen, Boon, et al., 1992).

The two food items, potato chips and fruit that were used in this study were of comparable preferences and consumed at similar rates, based on information obtained from the participants. The olfactory and visual properties associated with the food items were considered the conditioned stimuli (CS) reliably associated with the intake of each related food item. Anticipatory responses of salivation and craving to these stimuli were viewed as conditioned responses (CR) that have developed in the presence of the conditioned stimuli. In this research, the effect of the repeated exposure of olfactory and visual stimuli from the potato chips on anticipatory responses of salivation, hunger, appeal and craving was examined when trials were not reinforced (complete extinction) and when "bite " sized reinforcers were provided after every trial (reduced level of reinforcement).

Cue - exposure effects were studied in four experimental groups: extinction (EX), pencil shavings (PS), reduced-level-of-reinforcement (RLR) and extinction-with -rinse (ER). During the treatment phase, the test stimulus was presented for ten consecutive trials and performances were compared among groups under four conditions: (a) EX: unreinforced exposure to potato chips, (b) PS: unreinforced exposure to pencil shavings, (c) RLR: reinforced exposure to potato chips followed by rinsing and, (d) ER: unreinforced exposure to potato chips followed by rinsing. The effects of the repeated unreinforced exposure to the chips were evaluated in the extinction group with the pencil shavings group serving as a control for the methodological effects introduced by the salivation collection technique and other nonassociative variables. In the reduced level of reinforcement group, treatment effects were examined when trials were reinforced with small bites of the chips in amounts that would be insufficient to produce satiety. Because between - trial rinsing was necessary in order to maintain the accuracy of the salivation collection measure, the extinction-with-rinse group served as a control for possible stimulatory effects produced by the rinsing (Malamud & Tabak, 1993).

In the pretreatment phase, measures were obtained on a nonfood item, pencil shavings, and two food items, fruit and potato chips. In pilot research, olfactory and visual stimuli from fruit and potato chips have produced reliable increases in salivation relative to that obtained in response to a nonfood item. Data collected in response to the pencil shavings served as a nonfood - assessment measure for all respondents. In the habituation research, stimulus specificity was reported when the introduction of a novel stimulus restored responses to the habituated stimulus, but pretreatment values were not obtained on the untreated stimulus in those experiments (Epstein, Rodefer et al., 1992; Epstein, Caggiula et al., 1993; Wisniewski et al., 1992). In this study, pre - and posttreatment measures were obtained on both food types to provide an additional check on the specificity of the cue - exposure effect. Consistent with habituation research, additional posttreatment values were obtained in response to the potato chips to assess the maintenance of treatment effects and determine the presence of dishabituating effects from the untreated food.

Measures obtained in response to the reinforced trials during the treatment phase provided an opportunity to study the effect of the repeated exposure to the food stimulus on the anticipatory responses when gustatory stimulation was involved but the effects of satiety were minimized. Swallowing, in addition to taste stimulation provides additional olfactory stimulation from the retronasal receptors (Booth, 1990). Although chewing rates were not monitored in this study, the small size of the chip required a limited amount of chewing in order to be safely consumed and for this reason it was expected that stimulation from mastication would not represent a serious problem. If the amount of the reinforcer was a critical variable in the CS - US relationship, as was proposed in this study, then salivation and craving responses should not have been differentially affected by the cue - exposure manipulation for the extinction, extinction-with-rinse and reduced-level-of-reinforcement groups during the treatment phase. Such a finding would indicate that the portion of potato chip consumed by the reduced-level-of-reinforcement group did not function as a reinforcer. Alternatively, response maintenance during the treatment phase for the reduced-level-of-reinforcement group would suggest that one sixth of a chip did have reinforcing properties. Research findings in psychopharmacology suggest that even low doses of drugs can serve as appetitive reinforcers. For example, animals learned to self - administer opiates and responding has been maintained in experiments when the doses used in both situations were too low for the animals to develop withdrawal symptoms in their absence (Bozarth & Wise, 1981).

The relative contribution of using repeated trials of unreinforced exposure to food, versus trials in which repeated exposure to the food is followed by consumption of small bites, on anticipatory responses to the food has not been extensively explored. A clearer understanding of the effect of each component of a cue - exposure manipulation on physiological and subjective responses to food is necessary to the development of effective treatment packages using cue - exposure in the clinical management of eating disorders. A knowledge of the relationship between salivation and self - reports of affective states to eating behavior would allow the use of salivation as an index of progress during treatment when behavioral responses cannot be directly measured.

Method

Participants

Participants were undergraduate psychology students, recruited through the Human Subject Pool at Queens College, who had responded to requests for nondieters who ate junk food and liked chips and fruit. All volunteers were screened by telephone to determine appropriateness for the study based on the criteria listed below, and if accepted received research credit for their participation.

Students who participated in the study met the following requirements: (a) reported eating "junk food" defined as " candy, chips etc.," (b) rated their liking for potato chips and the three fruit items used in the study with values equal to or greater than seven on a food preference scale of one to ten, (c) reported eating potato chips and fruit (at least one of the three items used in the study) regularly with a minimum frequency of at least once a week, (d) described themselves as nondieters, (e) were not taking any medication that would influence salivation, (f) were between the ages of 17 and 35, (g) had been of stable weight, not having gained or lost more than five pounds in the past two months, and (h) were not currently receiving or had received treatment for an eating disorder in the last year. All medications reported were reviewed for possible action on salivary secretions (Hodgson, Kizior & Kingdon, 1993).

The Eating Attitudes Test (EAT: Garner & Garfinkel, 1979) was administered to all participants in order to corroborate dietary status. The EAT is a 40 - item questionnaire that is used to evaluate behavior and concerns suggestive of anorexia nervosa (DSM -1V, 1994). Answers are based on a forced choice format with a 6 - point Likert scale. Three points are assigned to answers that are considered in the extreme direction for anorexia and two and one points respectively, for adjacent selections. Zero points are given for remaining choices. The possible range of scores, based on 39 questions included in the analysis, is 0 to 117, higher scores indicating the presence of symptoms considered clinically significant. Participants were eliminated if their score was above 30, considered the cutoff for anorexia nervosa and suggestive of long - term weight reduction which would place these participants at risk for having depressed levels of salivary response to food (LeGoff et al., 1988). Refer to Appendix A for a copy of the EAT questionnaire.

Forty - four students were initially accepted based on the telephone interview; however, four recruits were later eliminated, two because of the weight criterion, one on the basis of the EAT score and one who was unable to remain for the entire session. Body mass indices were computed by dividing the body weight in kilograms by the squared value of the height in meters for each subject. Three students, two males and one female had Body Mass Index (BMI) values greater than 28 indicating that they were more than 20% above ideal weight (Metropolitan Life Insurance Tables, 1983). These students were not eliminated as weight per se was not a determining factor. Forty students completed the study (see Appendix B for a more comprehensive description of subject characteristics).

The students were instructed not to change their dietary habits except to refrain from eating or drinking for two hours prior to arrival for the session. Individual two hour sessions were scheduled in the late afternoon and early evening hours over a three month period. Participants were matched on the basis of sex and then randomly assigned to one of four treatment groups (n = 10): extinction (EX), pencil shavings (PS), reduced level of reinforcement (RLR), and extinction with rinse (ER).

Design

A mixed design was used. Within - subject factors were cue - exposure trials that comprised the pretreatment, treatment and posttreatment phases. Between - subject factors were treatment group and sex. The pretreatment and posttreatment phases were identical for all participants regardless of group assignment. During the treatment phase each group received one of the four experimental conditions. The dependent measures were salivation and self - report ratings of hunger, appeal and craving obtained after each of the 18 cue -exposure trials. Table 1 shows overall structure of the experiment.

Table 1

Organization of Experimental Design with Between - Subject Factors of Treatment Group and Gender and Within - Subject Factors of Trial

Pretreatment phase

Group	Trial	Test stimulus	Reinforcement	Rinse
EX, PS, RLR, ER	1 (Tr) **	ps*	-	-
" " " "	2 (Tr)	ps	-	-
" " " "	3	ps	-	-
" " " "	4	fruit	+	+
" " " "	5	fruit	-	-
" " " "	6	potato chips	+	+
" " " "	7	potato chips	-	-

Treatment phase

Group	Trial	Test stimulus	Reinforcement	Rinse
EX	8 thru 17	potato chips	-	-
PS	8 thru 17	ps	-	-
RLR	8 thru 17	potato chips	+	+
ER	8 thru 17	potato chips	_	+

Posttreatment phase

Group	Trial	Test stimulus	Reinforcement	Rinse
EX, PS, RLR, ER	18	potato chips	-	-
" " " "	19	fruit	-	-
" " " "	20	potato chips	-	-

* ps = pencil shavings

** Tr = training trials

Note: On all figures displayed in this text: Trial 3 = BP, the mean value of Trials 4 & 5 = BF, the mean value of Trials 6 & 7 = BC, Trials 8 thru 17 = Trials 1 thru 10 in the treatment phase, Trial 18 = AC1, Trial 19 = AF, and Trial 20 = AC2.

All trials of the pretreatment, treatment and posttreatment phases were cue - exposure trials in the sense that the participant was exposed for two minutes to the sensory properties of the test stimulus presented. The pretreatment phase consisted of seven trials. The first two trials were used for training the participants in salivation collection and the self - report measures. Pencil shavings were used as the test stimulus on the training trials and again on the third trial in order to obtain values for the dependent measures in response to a nonfood item. Fruit was presented on the fourth and fifth trials and potato chips on the sixth and seventh trials. Following trials four and six, fruit and potato chip reinforcers were presented, respectively.

The treatment phase consisted of ten trials during which the same stimulus was presented. Trials for the extinction and extinction-with-rinse groups consisted of unreinforced exposure to potato chips and for the reduced-level-of-reinforcement group, exposure to potato chips followed by reinforcement with the potato chips. The pencil shavings group was presented with pencil shavings not followed by reinforcement. The extinction-with-rinse and reduced-level-of-reinforcement groups rinsed with water after each exposure to potato chips; rinsing followed reinforcement for the reduced-level-of-reinforcement group.

In the posttreatment phase, all participants received three unreinforced trials. Potato chips were presented on the first and third trials and fruit on the second trial.

Test items

Spring water was used for all rinsing and fliud consumption. Test stimuli presented on the cue - exposure trials consisted of a nonfood item or one of two food items. The food and nonfood items that served as stimuli were pretested for salivary response to their olfactory and visual properties on nonexperimental subjects prior to this study. The amounts of the items used on the trials and for reinforcement were standardized. Pencil shavings (0.54 g) served as the nonfood item as they have been used in olfactory stimulation studies (Desor & Beauchamp, 1974), and in prior research to obtain baseline responses to nonfood items (Legoff & Spigelman, 1987; Legoff, Leichner & Spigelman, 1988).

The food items were: (a) a fruit plate composed of one orange slice (Sunkist brand, approx. 21.1 g, 9.8 kcal), one cantaloupe melon slice (approx. 12.8 g, 4.56 kcal) and one green seedless grape (approx. 5.2 g, 3.48 kcal), and (b) two Pringle- brand potato chips (approx. 4 g, 22.8 kcal). On trials reinforced with fruit, one "bite" was consumed, approximately equivalent to 7 g, 3.25 kcal of orange, 3.7 g, 1.14 kcal of melon, and a single grape of similar weight as the one presented on the trial. On trials reinforced with chips, one "bite" was equivalent to one sixth of a chip (approx. 0.3 g, 1.9 kcal). On the Pringle label, the energy value assigned to the potato chips is listed in calories. This is misleading and it is important to note that in commercial markets the unit "calories" is often used interchangeably with, and without conversion to, kilocalories (Suitor & Hunter, 1980). Reinforcement (i.e., one bite of the item presented) was delivered following the initial presentations of each food item in order to insure palatability. In pilot research, occasionally a participant who reported a liking for a substance prior to testing would express dislike for the food once it was tasted. In this study, the dependent measures obtained on the second presentation of each food item, following reinforcement in the pretreatment phase, confirmed the participants' responsiveness to the food used in the experiment and corroborated preassessment ratings.

Cue - exposure trial sequence

All conditions described below consisted of two minute, cue - exposure trials. A hand - held manual timer (Lux Products Corp., Model # CP2428) was used to time the trial and intertrial intervals.

At the start of the trial, the participants were instructed to follow the protocol required for salivary collection regarding head position, movement and swallowing (Navazesh & Christensen, 1982). The stimulus presented on the exposure trial was either a food item or a nonfood item depending on the trial number and group type. Stimuli were presented in translucent containers (Rubbermaid brand, three inches in diameter). Participants were instructed to hold the containers approximately three inches from their faces and for the duration of the trial. When the test stimulus was presented, they were told to concentrate on the sensory properties of the item in terms of the three self-report measures. The experimenter used the following dialogue: "Look at, smell, using deep breaths, and imagine tasting and eating (the name of the item) and think of the food in terms of how physically hungry you feel, how appealing it is at this time, and how much you would like to eat it." These instructions were repeated when the experimenter returned to her seat which was out of the participant's view.

On nonfood trials, pencil shavings were presented and the participants were asked to hold the item approximately 12 inches from their faces in order to avoid inhaling some of the particles. They were aware that this was a nonfood item and were instructed at the start of the trial to "remain focused" on the stimuli and rate it using the same criteria as for the food items. These instructions were also repeated when the experimenter returned to her seat. When two minutes had elapsed, salivary and self-report measures were obtained. Spring water was provided for rinsing following all food consumption and all trials of the treatment phase for the extinction-with-rinse group.

Salivation collection. The spitting method was used to collect whole mouth salivary gland secretions. Prior to the start of each collection, participants were instructed to swallow and then refrain from swallowing for the duration of the exposure trials. During each trial, they were told to tilt their heads slightly forward and refrain from moving their tongues, mouths or jaws. When two minutes had elapsed, the participants were asked to expectorate gently three times into the paper cup provided for this purpose. Additional spitting was encouraged if the participant felt he or she had some remaining fluid. Saliva was collected in three ounce paper cups (Dixie brand, James River corp., Norwalk, CT.) which were individually numbered and weighed prior to each session. Volume was determined by weight, using a balance scale (Ainsworth, Model 10N, Serial # 49336). Measurements were taken to the nearest .0001 g.

Hunger, food appeal and measures of craving. Hunger was operationally defined by asking participants to "Rate your hunger by estimating how empty your stomach is in the presence of the item presented on the trial. If your stomach feels very empty then you would rate yourself as being extremely hungry." Food appeal was defined using the following dialogue: "Rate the food in terms of its physical attractiveness based on how it *should* look. For example, a steak that is medium red and juicy would be considered appealing versus one that is dry and overcooked. Do not include the container that holds the item when you evaluate its appeal." Craving, was defined by asking the participants to "Rate the item in terms of your desire to eat it regardless of its nutritional value." The participants were instructed to score each item according to a scale ranging from 0 to 100, zero equaling "no" and one hundred equaling " intense." Prior research has shown that a 100 point visual analog scale has proven to be a more sensitive tool than one with fewer points (Hodgson & Greene, 1980). Measures were obtained after each trial on a sheet of paper with a separate ruler drawn for each category. Refer to Appendix C for an example of the self - report measures used in the study.

Rinsing. Following reinforced cue-exposure trials and all treatment trials for members of the extinction-with-rinse group, participants were given a cup containing 15 milliliters of spring water and instructed to "rinse out." Participants who had consumed food were instructed to "use the water and rinse in order to get the taste out." They were informed that more water was available if necessary. Members of the extinction-with-rinse group were provided with 15 ml of spring water after each trial in the treatment phase with the following instructions: "Use this water to rinse your mouth even though you have not eaten anything; and attempt to rinse in the same way that you did when you ate this food at the start of the session." It was reasoned that if salivation was affected by the rinsing following the food consumption in the reduced-level-of-reinforcement group, comparable effects would occur in the extinction-with-rinse group. Because food particles were often present in the rinsed water, the water was not measured after rinsing. None of the subjects requested additional water.

Intertrial intervals. When the participants had completed the self-report measures and rinsing, if applicable, they were instructed to alert the experimenter. When signaled, the experimenter cleared the table and reset the timer for two minutes. During this time, referred to as "rest periods," subjects were asked to remain seated, not to converse with the experimenter, and swallow normally so that salivation could return to baseline levels. Instructions for the rest periods were identical throughout the session.

Procedure

At the start of the session, participants signed consent forms, completed the EAT questionnaire and had their heights and weights measured. They were then seated at a table with their backs to a wooden shutter screen which separated them from the experimenter's workspace. The design of the screen provided a partial view of the test area from the workspace. The participants were given 100 ml of spring water to drink while the protocol was explained. In pilot research, participants had expressed feelings of awkwardness and anxiety at the prospect of having their salivary flow measured and, in some cases, this was associated with an inability to produce measurable salivation in response to any of the test items. The water was given to hydrate the oral cavity. At least 20 minutes passed between the consumption of the water and the first pretreatment trial exposure to the pencil shavings.

The participants were instructed to remain seated until the session was completed, that they may or may not be given something to eat after an exposure trial and that the session consisted of "several" trials. Specific information regarding the stimuli, consumption and the number of trials was intentionally withheld. On the table was a cup for the salivary collection, tissues, a pencil and several sheets of paper for the self - report measures. The experimenter brought the test items from behind the screen at the start of each trial and then returned to the workspace in order to be out of view for the duration of the trial. From the workplace, the experimenter repeated the instructions given at the start of each trial in order to enable the participant to remain focused on the test stimulus. All participants received the same amount of instruction. During the trial and intertrial intervals, the experimenter intermittently observed the participant unobtrusively from behind the screen.

In the pretreatment phase, participants received two training trials in the salivary - collection methods and in the completion of the self - report measures. Pencil shavings were used as the test stimulus for training. When the participant acknowledged that he or she understood the procedures and after completion of the training trials, measures were obtained on the third trial also in response to pencil shavings. Fruit served as the test stimulus on the fourth and fifth trials. Following the fourth trial and after the dependent measures were obtained, participants were instructed to eat one bite of fruit. On the sixth and seventh trials, potato chips served as the test stimuli, and they were instructed to eat one bite of a chip following the measures obtained after the sixth trial. After eating, the participants rinsed their mouths according to the protocol.

During the treatment phase, each group was exposed to one test item repeatedly. The pencil shavings group was presented with pencil shavings, whereas potato chips served as the stimuli for the reduced-level-of-reinforcement, extinction and extinction-with-rinse groups. Members of the reduced-level-of-reinforcement group were instructed to eat one bite of chips following each trial. No reinforcement followed the exposure trials for the other groups. Participants rinsed following all food consumption and after all trials in this phase for the extinction-with-rinse group using the same protocol as in the pretreatment phase.

The posttreatment phase consisted of three cue-exposure trials. Potato chips served as the stimuli on the first and third trials and fruit on the second trial. These trials were similar in all respects to those in the pretreatment phase except that no food was consumed following the trials. After measures were obtained from the third trial in this phase, the session was terminated.

Statistical analyses

Tests for homogeneity of variances were computed using Cochrans C and Bartlett - Box F tests, as well as the Mauchley sphericity test and the Chi- square approximation for the repeated measures. The assumptions of the ANOVA were met with the exception of the sphericity requirement for some of the repeated measures; correction factors were applied as indicated in these situations. Analyses of variance were performed to assess treatment group and gender differences on baseline measures of age, basal mass indices, scores obtained on the EAT questionnaire, reported food preferences and frequency of consumption of the food items used in the study, and on measures obtained in response to pencil shavings. Analyses of variance with between - subject factors of treatment group and gender, and trial as a within - subject factor were performed to examine pretreatment differences obtained on the four dependent measures in response to each food item and differences within the posttreatment phase in response to the potato chips. Analyses of variance with between - subject factors of treatment group and gender, and phase as the within - subject factor were performed to examine pre - to posttreatment differences obtained on the dependent measures in response to each food item. Analyses of variance for repeated measures with between - subject factors of treatment group and gender, and trial as the within - subject factor, were performed to examine differences obtained on the dependent measures in response to the food items presented during the 10 - trial treatment phase. Greenhouse - Geisser Epsilon estimates were applied to results reported as significant by averaged $\underline{F}$ - tests in order to control for biases related to repeated measures (Levine, 1991; Vasey & Thayer, 1987). Only those results that remain reliable after applying the Greenhouse-Geisser correction factor are reported as significant. Univariate $\underline{F}$ - tests were performed in order to examine trends on the dependent measures during the treatment phase. An alpha level of .05 was used for all statistical effects.

Correlational analyses were performed using the Pearson product moment - correlation coefficient to assess the relationship between the physiological and psychological measures. All statistical analyses were performed using SPSS/PC, version 4 (Norusis, 1990).

For each dependent measure, the same format is used to graphically illustrate pretreatment, treatment and posttreatment values. Separate figures displaying male and female responses are used instead of the combined values in situations where there were reliable gender differences on one or more of the measures.

Results

Subject characteristics

All participants ranged in age from 17 to 33 years. Analyses of variance were performed on the subject characteristics of age, EAT score and BMI with treatment group and gender as factors. No significant differences were found for age among treatment groups, $F(3, 36) < 1$. Mean ages were 21.8, $SD = 4.1$, for males and 21.8, $SD = 4.8$ years for females. The mean scores obtained on the EAT questionnaire were 8.5, $SD = 6.1$ for males and 11.95, $SD = 6.6$ for females. The ANOVA revealed that EAT scores did not differ significantly among treatment groups or with respect to gender [$F(3, 32) < 1$; $F(1, 32) < 1$]. Mean BMI values were 25.08, $SD = 3.3$ for males and 21.33, $SD = 3.3$ for females. Men had significantly higher BMI values than women, $F(1, 32) = 11.61$; there were no reliable differences in BMI values among treatment groups, $F(3, 32) < 1$.

The experimental groups did not differ significantly in terms of their stated preferences or the frequency with which they reported eating the food items prior to the experiment. Preferences, assessed on a scale from one to ten, were: [fruit: $M = 8.4$, $M = 8.2$; potato chips: $M = 7.9$, $M = 7.5$, for males and females, respectively]. Frequency, estimated in the number of times per week that the food was typically eaten was: [fruit: $M = 2.3$, $M = 2.5$; potato chips: $M = 2$, $M = 1.9$, for males and females, respectively].

Analyses of pretreatment performances

Pretreatment data were analyzed with a Treatment Group x Gender analysis of variance for pencil shavings; for fruit and potato chips a trial factor was included. For each food item, the responses obtained on the first and second trials were compared among treatment groups and between genders for all dependent measures. With respect to salivation, analyses of variance with treatment group, gender and trial factors showed that in response to the fruit and the potato chips, men salivated more than women on both trials. The mean salivary response to fruit averaged over Trials 4 and 5 was 1.44 g for males and 1.02 g for females. The mean value obtained in response to the potato chips averaged over Trials 6 and 7 was 1.68 g and 1.18 g for males and females, respectively. The differences between genders were significant, [F(1, 32) = 5.94; F(1, 32) = 5.11, respectively]. No main effects involving treatment groups or trials were reliable.

Reported hunger in the presence of fruit increased on the second exposure trial. The Treatment Group x Gender x Trial analysis of variance showed that this small difference between the hunger rating reported on Trial 4 (M = 48) and Trial 5 (M = 51) was reliable, F(1, 32) = 5.87. No significant differences were found for between - subject effects. With respect to reported hunger in the presence of potato chips on Trial 6 and Trial 7, the results indicated no reliable effects for the trial factor or Treatment Group x Trial, Gender x Trial and Treatment Group x Gender x Trial interactions, [F (1,32) <1; F (3, 32) < 1; F (1, 32) = 2.26; F (3, 32) < 1, for males and females, respectively].

The difference in appeal reported in the presence of the fruit on Trials 4 and 5 was not significant, F (1, 32) < 1. However, there was a main effect of gender, F(1, 32) = 5.23, reflecting the fact that the men found the fruit more appealing than the women (M = 63 and M = 46, respectively). Main effects of treatment group and the Treatment Group x Gender interaction did not reach significance, [F (3, 32) < 1; F (3, 32) < 1, respectively]. Treatment Group x Trial and Treatment Group x Gender x Trial effects were not reliable [F (3, 32) < 1; F (3, 32) < 1, respectively]. With respect to appeal reported for the potato chips on Trials 6 and 7, analyses of variance showed that trial, Treatment Group x Trial, Gender x Trial x Treatment Group x Gender x Trial differences were not reliable, [F (1, 32) = 3.46; F (3, 32) < 1; F (1, 32) < 1; F (3, 32) < 1, respectively].

When performances were compared on the reported level of craving obtained in response to fruit on Trials 4 and 5, no reliable differences were found for the trial effect, Treatment Group x Gender, Gender x Trial and Treatment Group x Gender x Trial interactions [F (1, 32) < 1; F (3, 32) = 1.13; F (1, 32) = 1.17; F (3, 32) < 1, respectively]. With respect to potato chips, Treatment Group x Gender x Trial analyses of variance did show a significant trial effect, F(1, 32)

= 5.79, reflecting a decrease in reported craving from the first (M = 72) to the second (M = 66) trial. Treatment Group x Trial, Gender x Trial and Treatment Group x Gender x Trial effects were not reliable, [F (3,32) = 1.97 ; F (1, 32) = 1.85; F (3, 32) < 1, respectively].

A summary of the analyses of the trial effects between the first and second presentations of each food item showed that reliable effects were absent in all but two situations where changes occurred on the second trial: (1) the mean level of reported hunger in the presence of fruit increased by three points, and (2) the mean level of reported craving for the potato chips decreased by six points. Because these differences were small and reported craving levels still indicated the palatability of the potato chips on the second trial, these results suggested that access to one bite of the food, following Trials 4 and 6 had little, local effects on responding.

In the subsequent analyses, the results obtained on the first and second trials for each food item, Trial 4 and 5 for the fruit and Trials 6 and 7 for the potato chips, were pooled and represent a composite of pretreatment measures. Henceforth in this text, in the pretreatment phase for each dependent measure, the value, BF (Before treatment, Fruit), represents the mean value for the response obtained on the first and second exposure trials to fruit and value, BC (Before treatment, Chips), represents the mean value for the response obtained on the first two exposure trials to potato chips. An analyses of the pooled responses in the pretreatment phase showed that for each of the dependent measures, values obtained in response to the potato chips were generally greater than those obtained in response to the fruit. Analyses of variance with treatment group, gender and pooled response as factors were performed to compare values BF and BC on the four dependent measures.

With respect to salivation, the analyses showed a main effect of gender, $F(1, 32) = 6.01$, reflecting the fact that the male participants salivated more in response to each food item, (fruit: M = 1.44 g; potato chips: M = 1.67 g) than the females, (fruit: M = 1.02 g; potato chips; M = 1.18 g). No reliable effects were found for treatment group or the Treatment Group x Gender interaction, [$F(3, 32) = 1.05$; $F(3, 32) = 1.29$, respectively]. Analyses of within - subject effects showed a main effect of pooled response, $F(1, 32) = 9.67$, reflecting the greater level of salivation obtained in response to the potato chips (M = 1.22 g) compared to the fruit.(M = 1.42 g). No reliable effects were found for the Treatment Group x Trial, Gender x Trial and Treatment Group x Gender x Trial interactions [$F(3, 32) = 1$; $F(1, 32) < 1$; $F(3, 32) < 1$, respectively].

With respect to reported hunger, no reliable differences were found between values BF and BC for treatment group, gender or the Treatment Group x Gender interaction, [$F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) = 1.10$, respectively]. However, analyses of within - subject effects showed that the value of hunger reported in the presence of the potato chips was significantly greater, $F(1, 32) = 19.47$ than the value reported in the presence of the fruit. The Gender x Pooled Response was reliable, $F(1, 32) = 4.31$, indicating that while reported hunger increased in the presence of the potato chips for both male and female participants, this increase was greater for the female participants. Mean values of hunger reported in the presence of the potato chips were 57.5 and 58.2 whereas those obtained in the presence of fruit were 53.2 and 45.4, for males and females, respectively. An analyses of values BF and BC with respect to reported appeal indicated that participants found the potato chips (M = 66.9) more appealing than the fruit (M = 54.7) and this difference was reliable, $F(1, 32) = 19.99$. Treatment Group x Pooled Response, Gender x Pooled Response and Treatment Group x Gender x Pooled Response were not significant, [$F(3, 32) < 1$; $F(1, 32) = 3.98$; $F(3, 32) = 1.25$, respectively]. No significant effects were found for treatment group, gender and Treatment Group x Gender interactions, [$F(3, 32) = 1.12$; $F(1, 32)$ 2.85; $F(3, 32) <1$, respectively].

Similar results were obtained for reported craving when performances were compared between values BF and BC. Analyses of variance showed that the overall level of craving reported for the potato chips (M = 68.7) was greater than that reported for the fruit (M = 55) and this difference was significant, $F(1, 32) = 30.08$. Treatment Group x Pooled Response, Gender x Pooled Response and Treatment Group x Gender x Pooled Response interactions were not significant, [$F(3, 32) < 1$; $F(1, 32) = 2.81$; $F(3, 32) = 1.60$, respectively]. No reliable differences were found for main effects of treatment group and gender, or the Treatment Group x Gender interaction, [$F(3, 32) < 1$; $F(1, 32) = 1.96$; $F(3, 32) < 1$, respectively]. These results showed that the salivation, hunger, appeal and craving responses obtained in the pretreatment phase were generally greater for the potato chips than for the fruit.

A comparison of performances on Trial 3 showed that there were no significant differences among treatment groups in response to the pencil shavings with respect to any of the dependent measures. Although the salivary response obtained for males (M = 0.75 g) was greater than that obtained for females (M = 0.63 g), this difference was not reliable. All participants demonstrated an increase in salivation when the food items were presented. The difference between the mean salivary response to fruit obtained over Trials 4 and 5 and that obtained in response to pencil shavings on Trial 3 was 0.69 g and 0.39 g, for males and females, respectively. The mean change in salivation in response to potato chips averaged over Trials 6 and 7 from that obtained on Trial 3 was 0.93 g and 0.55 g for males and females, respectively. Pencil shavings were not expected to be palatable, and this was validated by the zero levels obtained for reported appeal and craving. Hunger was defined in such a way as to encourage the participants to base their responses on interoceptive cues related to deprivation rather than the item presented on the trials. The hunger ratings (M = 69) reported in the presence of the pencil shavings suggested that the participants did not use "hunger for " the test item in making their decision. Trial 3 data is illustrated graphically as Trial BP (Before treatment, Pencil shavings) in the pretreatment phase.

Correlations obtained on the dependent measures showed that salivation did not significantly correlate with any of the self - report measures obtained in the pretreatment phase for fruit or potato chips. Refer to Appendix D for correlational data.

Experimental effects

Three types of comparisons among the experimental groups were conducted on each dependent measure: (a) pre- to posttreatment changes in performance, (b) differences within the posttreatment phase, and (c) performances during the treatment phase. Because a comparison between the extinction and pencil shavings groups provided an opportunity to assess extinction versus no extinction effects, separate analyses limited to data obtained from these groups were conducted in order to detect any effects that may have been masked by the four - group analyses. Information provided by the two - group analyses is reported following the results from the four - group analyses. The same structure was used to analyze the data in both the full and restricted analyses. All pre- to posttreatment analyses were performed with treatment group and gender as between - subject factors, and phase as the within - subject factor. Similarly, changes within the posttreatment phase and treatment phase analyses were performed with treatment group and gender as between - subject factors, and trial as the within - subject factor.

Salivation

Figures 1 and 2 show the mean values of the salivary response in grams x 10, for males and females, respectively, of the EX, PS, RLR and ER groups in the pretreatment phase, in response to pencil shavings on Trial BP, averaged over Trials 4 and 5 in response to fruit (BF), and averaged over Trials 6 and 7 in response to potato chips (BC). In the posttreatment phase, Trial AC1 (After treatment, Chips, first trial) represents the mean values obtained in response to the first posttreatment exposure to potato chips, Trial AF (After treatment, Fruit), the posttreatment exposure to fruit, and Trial AC2 (After treatment, Chips, second trial), the second posttreatment exposure to potato chips.

Pretreatment -posttreatment changes. As illustrated in Figures 1 and 2, the effect of the cue - exposure manipulations during the treatment phase had a differential impact on the experimental groups. A review of the raw data showed that the repeated unreinforced exposure to the potato chips during the treatment phase resulted in a decrease in salivation on the first posttreatment trial for nine of the ten, and for all the participants of the extinction and extinction-with-rinse groups, respectively. In contrast, the salivary response was maintained on the first posttreatment trial for the pencil shavings group, who received repeated unreinforced exposure to a nonfood item, and for the reduced-level-of-reinforcement group, who received repeated reinforced exposure to the potato chips during the treatment phase. Treatment effects were assessed by comparing performances in the pretreatment phase with those in the posttreatment phase using Treatment Group x Gender x Phase analyses of variance for each food item. The

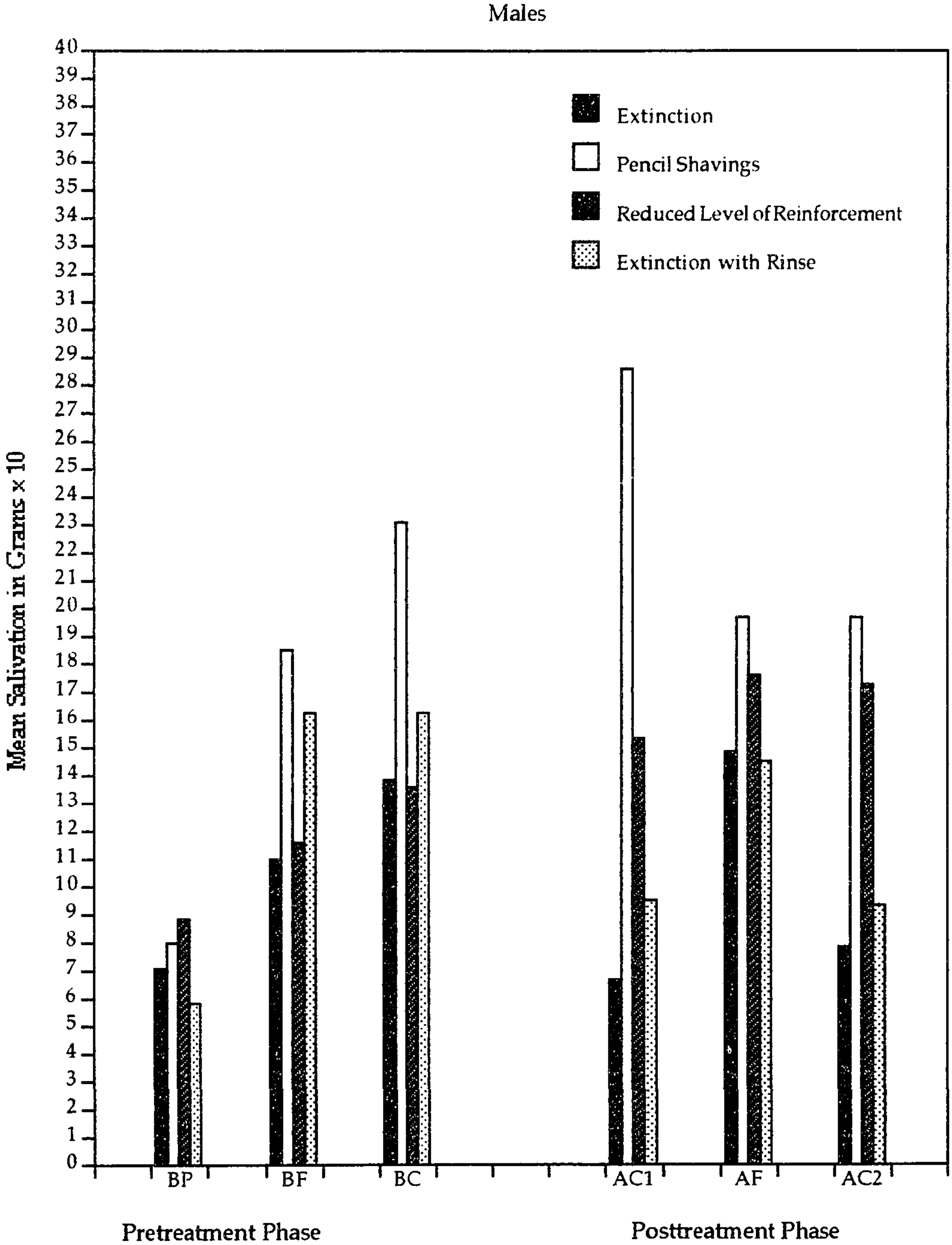


Figure 1. Mean value of the salivary response in grams x 10 obtained for male subjects from the EX, PS, RLR, and ER groups. In the pretreatment phase, Trial BP represents the response to pencil shavings; BF, the response to fruit averaged over the first two trials and BC, the response to potato chips averaged over the first two trials. In the posttreatment phase, Trial AC1 represents the mean value obtained in response to the first posttreatment exposure to potato chips; Trial AF, the posttreatment exposure to fruit; and Trial AC2, the second posttreatment exposure to potato chips. Values in the posttreatment phase represent responses to fruit and potato chips for each group, not followed by reinforcement or rinsing.

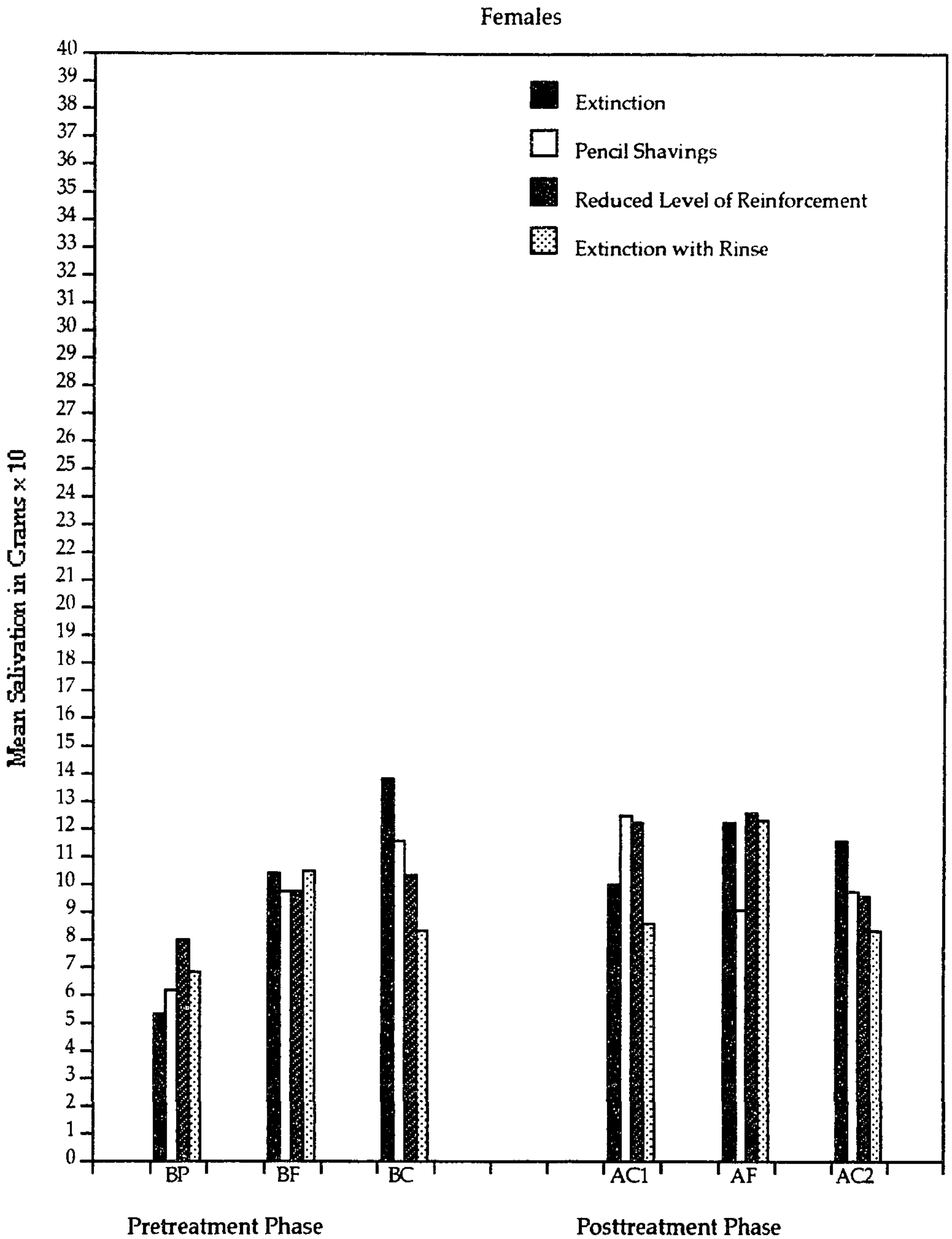


Figure 2. Mean value of the salivary response in grams x 10 obtained for female subjects from the EX, PS, RLR and ER groups. In the pretreatment phase, Trial BP represents the response to pencil shavings; BF, the response to fruit averaged over the first two trials; and BC, the response to potato chips averaged over the first two trials. In the posttreatment phase, Trial AC1 represents the mean value obtained in response to the first posttreatment exposure to potato chips; Trial AF, the posttreatment exposure to fruit; and Trial AC2, the second posttreatmentexposure to potato chips. Values in the posttreatment phase represent responses to fruit and potato chips for each group not followed by reinforcement or rinsing.

results showed that the pre- to posttreatment changes in salivary response to the potato chips were significant. The ANOVA yielded a significant Treatment Group x Phase interaction, F (3, 32) = 7.19, reflecting a reliable decrease from the pretreatment value (BC) to the first posttreatment measure on Trial AC1 for the extinction and extinction-with-rinse groups only. Separate analyses of phase effects for each group revealed that this posttreatment decrease on Trial AC1 was significant for the extinction and extinction-with-rinse groups, [$F(1,32) = 11.14$; F $(1,32) = 7.98$, respectively], but the increases in salivation obtained in the posttreatment phase were not reliable for the pencil shavings and reduced level of reinforcement groups, [$F(1,32) = 3.63$; F $(1,32) = 1.27$, respectively]. The main effect of phase and the Gender x Phase and Treatment Group x Gender x Phase interactions did not reach significance, [$F(1,32) = 2.45$; $F(1,32) < 1$; $F(3, 32) = 1.47$, respectively]. The male participants generally salivated more in response to the potato chips than the females; however, the pre- to posttreatment difference between genders, analyzed on the basis of the pooled responses, was not reliable, $F(1, 32) = 3.73$. Between - subject effects of treatment group and the Treatment Group x Gender interaction were also not significant, [$F(3, 32) = 2.38$; $F(3, 32) = 1.90$, respectively].

A different pattern of results emerged among the experimental groups when the pretreatment values for the chips (BC) were compared to those obtained on the second posttreatment exposure to the chips on Trial AC2, following the reintroduction of the fruit on Trial AF. The pre- to posttreatment decrease in salivary response observed on Trial AC1 was maintained on Trial AC2 for nine of the ten and for all the participants of the extinction and extinction-with-rinse groups, respectively. The Treatment Group x Gender x Phase analyses of variance showed that the Treatment Group x Phase interaction was significant, $F(3, 32) = 5.09$. However, the analyses of phase effects for each group revealed that a significant decrease in salivation occurred on the second posttreatment trial, not only for the extinction and extinction-with-rinse groups, [$F(1, 32) = 11.22$; F $(1, 32) = 14.82$, respectively], but for the pencil shavings group as well, $F(1, 32) = 4.47$. An examination of the raw data showed that the salivary response decreased on Trial AC2 for seven of the ten participants of the pencil shavings group.

Consistent with previous findings for the pre- to posttreatment change on Trial AC1, no reliable difference was found for the reduced-level-of-reinforcement group, on the second posttreatment exposure to the potato chips on Trial AC2, $F(1,32) = 1.35$. Gender x Phase and Treatment Group x Gender x Phase interactions were not significant, [$F(1, 32) = 1.00$; $F(3, 32) = 2.50$, respectively]. Between - subject effects of treatment group, gender and the Treatment Group x Gender interaction were not reliable, [$F(3, 32) < 1$; $F(1, 32) = 3.65$; $F(3, 32) = 1.32$, respectively].

As shown in Figures 1 and 2, the effect of the experimental manipulations on the salivary response to fruit did not differentiate among treatment groups when performances on the pretreatment exposure (BF) were compared to the posttreatment measure (AF). Treatment Group x Gender x Phase analyses of variance showed a significant main effect of gender indicating that the larger response to the fruit shown by the males in the pretreatment phase was maintained, $F(1, 32) = 5.96$. Effects of treatment group and the Treatment Group x Gender interaction were not significant, $Fs\,(3, 32) < 1$. The mean salivary response to fruit increased in the posttreatment phase by 0.19 grams from the pretreatment value. Analyses of within - subject effects showed that the phase effect was significant, $F(1, 32) = 6.02$, reflecting the overall increase. Treatment group x Phase, Gender x Phase and Treatment Group x Gender x Phase interactions were not reliable, [$F(3, 32) = 1.85$; $F(1,32) < 1$; $F(3, 32) < 1$ respectively]. The absence of differential effects among the treatment groups suggests that the cue - exposure trials in the treatment phase did not affect responding to the fruit.

Posttreatment comparisons. Treatment Group x Gender x Trial analyses of variance were conducted to examine the potential dishabituating effects of the fruit on the salivary responses to the potato chips in the posttreatment phase. A comparison of performances on Trials AC1 with AC2 showed that the trial effect, Treatment Group x Trial and Treatment Group x Gender x Trial interactions were reliable, [$F(1,32) = 5.16$; $F(3, 32) = 8.15$; $F(3, 32) = 4.08$, respectively]. The observed decrease in responding to the chips on Trial AC2 for the pencil shavings group was significant for the male subjects, $F(1, 32) = 33.11$, but not for the females, $F(1, 32) = 2.96$. The large salivary response obtained on the first posttreatment trial for the male participants of the pencil shavings group ($\underline{M}$ = 2.86, $\underline{SD}$ = 1.4) included an outlier; however, reliable effects were maintained when separate analyses were performed excluding the outlier. No reliable trial effects emerged for either male or female subjects, respectively, in the extinction group, [$\underline{F}$(1, 32) < 1; $\underline{F}$ (1, 32) = 1.02], the extinction-with-rinse group, [$\underline{F}$(1, 32) < 1; $\underline{F}$(1, 32) < 1] or the reduced-level-of-reinforcement group, [$\underline{F}$(1, 32) = 1.43; $\underline{F}$(1, 32) = 2.99]. The absence of significant changes within the posttreatment phase for the extinction and extinction-with-rinse groups suggests that the fruit was not an effective dishabituator for those groups who had received the repeated exposure to the potato chips during the treatment phase.

Treatment phase. Figures 3 and 4 show the pattern of change occurring in the salivary response from the first trial of the treatment phase through the tenth trial for the male and female subjects, respectively, of the four experimental groups. Mean values represent responses to repeated presentations to potato chips not followed by reinforcement for the extinction group, to pencil shavings not followed by reinforcement for the pencil shavings group, to potato chips on reinforced trials followed by rinsing for the reduced-level-of-reinforcement group, and to potato chips on trials followed by rinsing but not reinforcement for the extinction-with-rinse group.

As illustrated in Figures 3 and 4, the effect of the cue - exposure manipulations did not vary in a simple fashion among the treatment groups. Analyses of treatment group, trial and gender factors showed that the trial effect, Gender x Trial, and Treatment Group x Gender x Trial interactions were significant [$\underline{F}$(9, 288) = 3.04; $\underline{F}$(9, 288) = 2.32; $\underline{F}$(27, 288) = 1.63, respectively]. Subsequent analyses of the Treatment Group x Gender x Trial interaction revealed that the salivary response decreased significantly during the treatment phase for the male participants of the extinction-with-rinse group, $\underline{F}$(9, 288)= 3.76, but not for the females, $\underline{F}$(9, 288) = 1.36. Although not apparent graphically, trend analyses performed on the reliable trial effect indicated that the decrease in responding over the course of the treatment trials for the male subjects of the extinction-with-rinse group was linear, $\underline{F}$(1, 32) = 6.81; no other trends were significant. Trial effects were not reliable for males and females, respectively, of the EX group, [$\underline{F}$(9, 288) = 1.82;

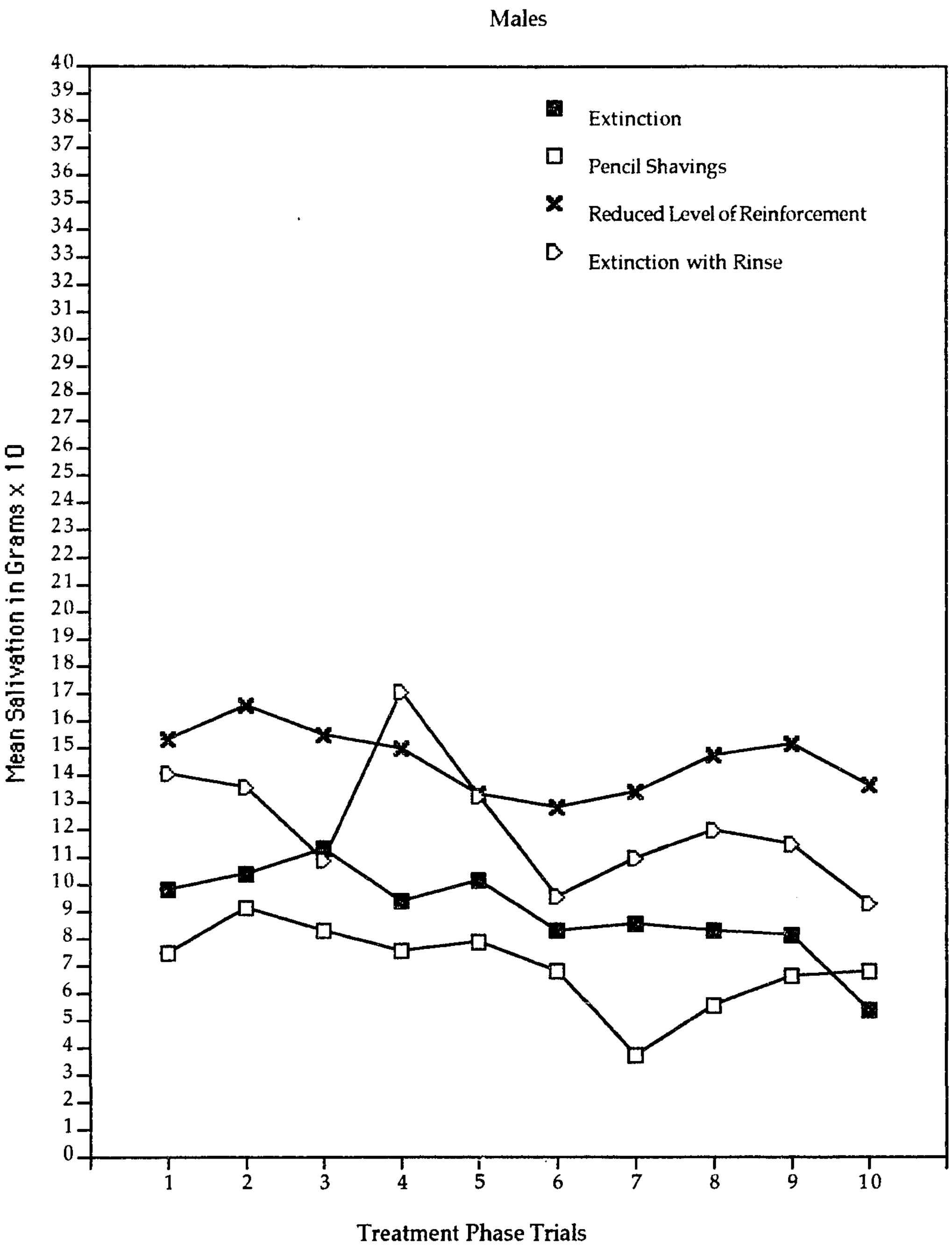


Figure 3. Mean value of the salivary response in grams x 10 obtained for male subjects in the presence of the test items for the ten trials of the treatment phase for the experimental groups. Values represent responses to repeated presentations of potato chips not followed by reinforcement for the EX group, to pencil shavings not followed by reinforcement for the PS group, to potato chips on reinforced trials followed by rinsing for the RLR group, and to potato chips on trials followed by rinsing but not reinforcement for the ER group.

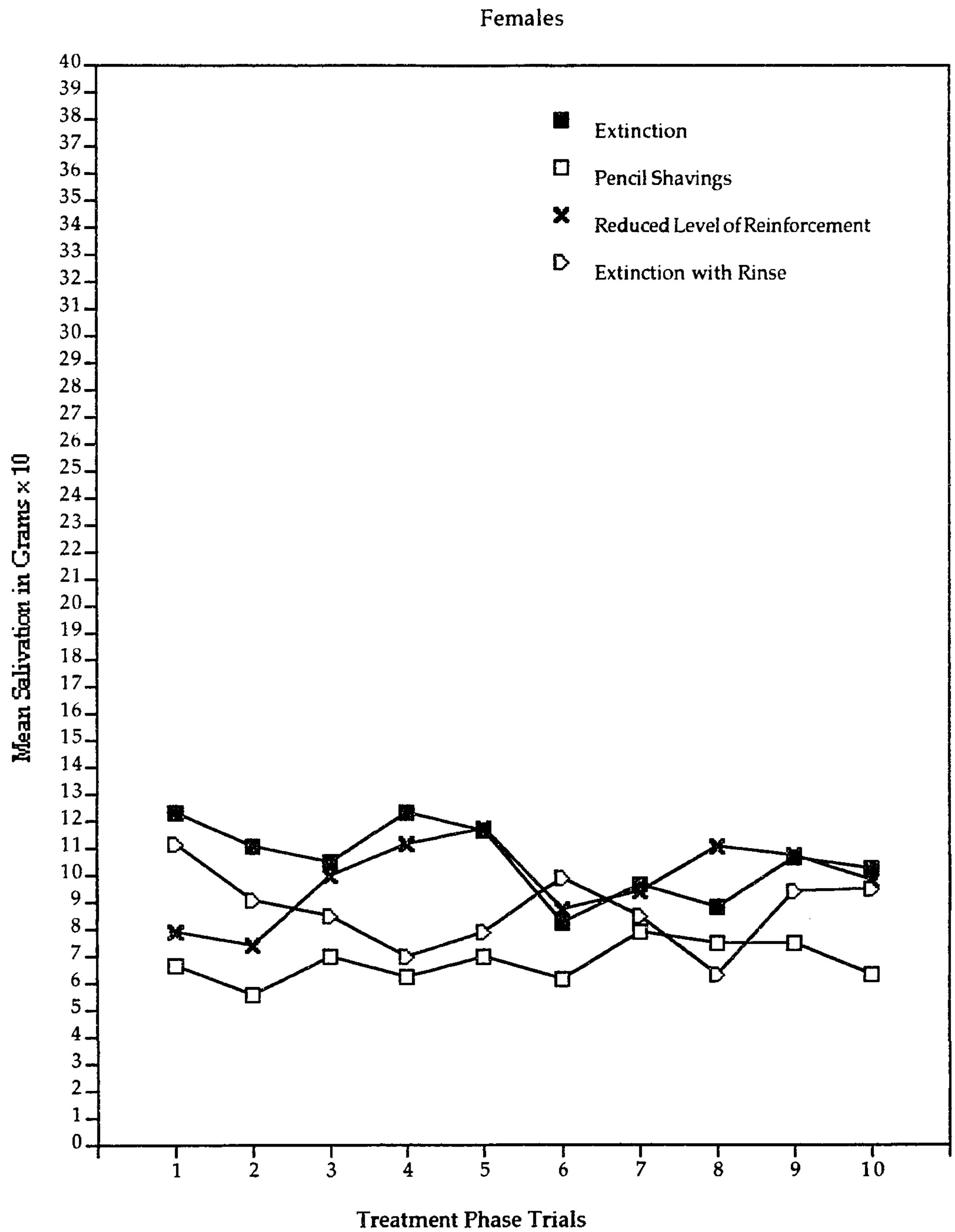


Figure 4. Mean value of the salivary response in grams x 10 obtained for female subjects in the presence of the test items for the ten trials of the treatment phase for the experimental groups. Values represent responses to repeated presentations of potato chips not followed by reinforcement for the EX group, to pencil shavings not followed by reinforcement for the PS group, to potato chips on reinforced trials followed by rinsing for the RLR group, and to potato chips on trials followed by rinsing but not reinforcement for the RLR group.

$\underline{F}(9, 288) = 1.32$], the PS group, [$\underline{F}(9, 288) = 1.54$; $\underline{F}(9, 288) < 1$] or the RLR group, [$\underline{F}(9, 288) < 1$; $\underline{F}(9, 288) = 1.42$]. The Treatment Group x Trial effect was not reliable, [$\underline{F}(27, 288) < 1$]. Between - subject effects of treatment group, gender and the Treatment Group x Gender interaction were not significant, [$\underline{F}(3, 32) = 1.70$; $\underline{F}(1, 32) = 1.03$; $\underline{F}(3, 32) < 1$, respectively].

Post hoc comparisons. Analyses of variance comparing performances between the extinction and pencil shavings groups were consistent with the results using the data from all the experimental groups.

Summary of findings: salivary responses. The pretreatment analyses of differences between food items showed that anticipatory salivation was reliably greater in response to the potato chips than to the fruit and the magnitude of the response to both food items was significantly greater for the male participants. The analyses of pre- to posttreatment changes revealed that salivary responses to the potato chips decreased significantly on the first posttreatment trial for the extinction and extinction-with-rinse groups after receiving the repeated unreinforced exposure to the chips during the treatment phase, and this effect was maintained on the second posttreatment exposure to the chips. The reintroduction of the fruit in the posttreatment phase was associated with a reliable decrease in the salivary response for the pencil shavings group relative to the pretreatment value as well. There was no evidence that the extinction trials had a similar effect on responses in the reduced-level-of-reinforcement group. The pre- to posttreatment analyses of response differences to the fruit showed that salivary responses significantly increased in the posttreatment phase but differential effects among the experimental groups were absent. Analyses within the posttreatment phase indicated that responses to the chips were not significantly disrupted by the introduction of the fruit in the extinction and extinction-with-rinse and reduced-level-of-reinforcement groups whereas responses significantly decreased for the male participants of the pencil shavings group. Trend analyses of the treatment phase data revealed that the salivary responses decreased linearly for the male participants of the extinction-with-rinse group; however, remaining effects of the cue - exposure manipulations did not reach significance.

Hunger

Following the same structure used for displaying pre- and posttreatment salivary responses, Figures 5 and 6 show the mean level of hunger reported in the presence of the test items obtained from the experimental groups during the pre- and posttreatment phases for males and females, respectively.

Pretreatment - posttreatment changes. As illustrated in Figures 5 and 6, the effect of the cue - exposure manipulations during the treatment phase on the posttreatment hunger response was variable. Pre- to posttreatment changes were assessed comparing pretreatment values (BC) with posttreatment responses on Trial AC1. The ANOVA indicated that there were no significant differences for the between - subject effects of treatment group, gender and the Treatment Group x Gender interaction, [$F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) < 1$, respectively]. The within - subject effect of phase, Treatment Group x Phase, Gender x Phase and Treatment Group x Gender x Phase interactions were not reliable, [$F(1, 32) = 3.92$; $F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) = 1.96$, respectively]. The reintroduction of the fruit on Trial AF in the posttreatment phase did not differentially affect the posttreatment responses to the chips. When pretreatment values for the potato chips (BC) were compared with those obtained on the second posttreatment exposure to the chips on Trial AC2, reported hunger increased for all treatment groups. Treatment Group x Gender x Phase analyses of variance revealed a significant phase effect, $F(1, 32) = 5.82$, reflecting a general increase in the level of reported hunger from the pretreatment value ($M = 57.9$) to the second posttreatment trial ($M = 67.1$). A review of the raw data showed that reported hunger increased from the pretreatment value (BC) to Trial AC2 for 26 of the 40 participants. Treatment Group x Phase, Gender x Phase and Treatment Group x Gender x Phase interactions were not reliable, [$F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) = 1.22$, respectively]. Main effects of treatment group and gender and the Treatment Group x Gender interaction were not significant, [$F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) = 1$, respectively]. As shown in Figures 5 and 6, the mean level of hunger reported in the presence of the fruit increased for all experimental groups in the posttreatment phase relative to the pretreatment values (BF), with female subjects generally showing the larger gains.

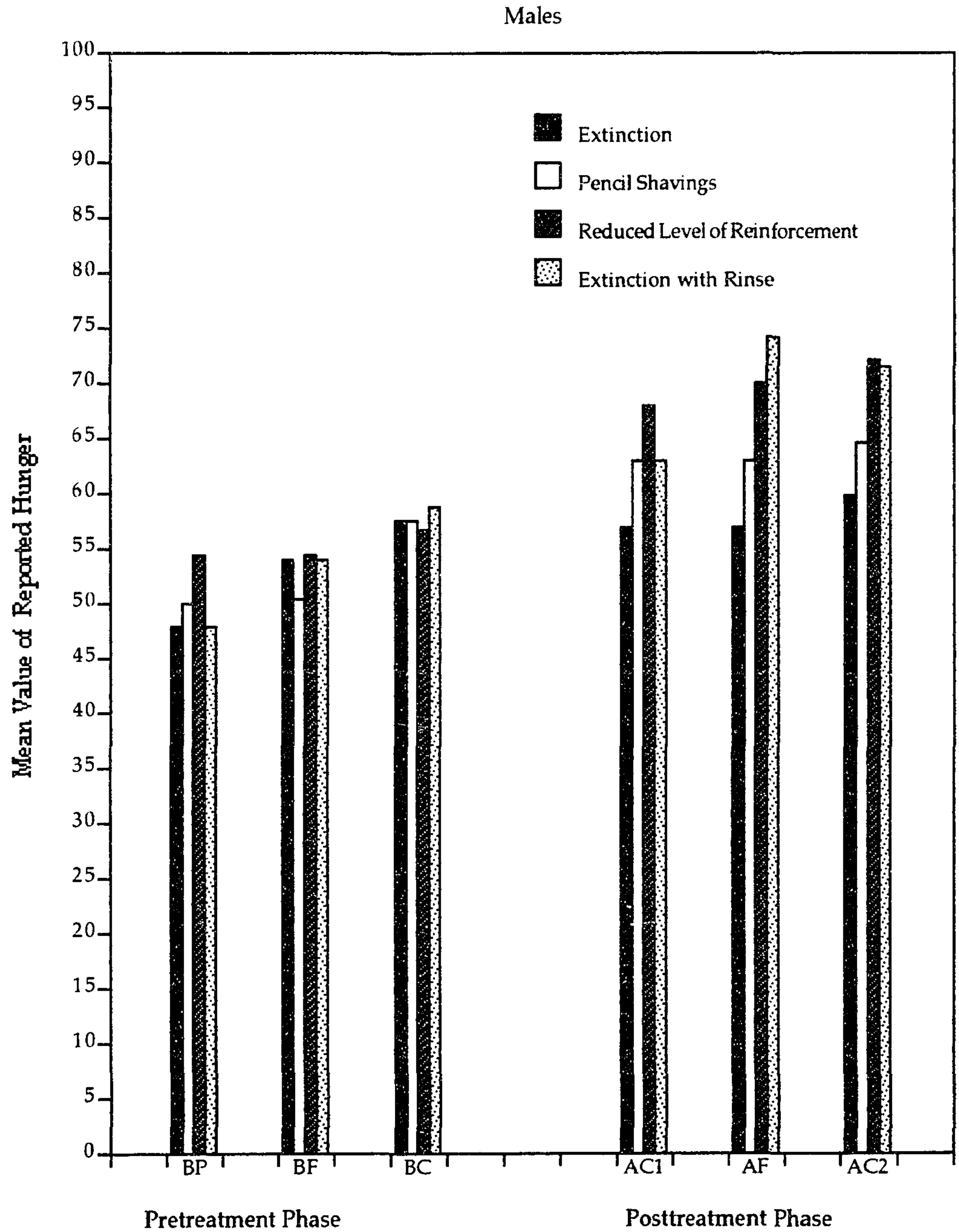


Figure 5. Mean value of reported hunger obtained for male subjects from the EX, PS, RLR and ER groups. In the pretreatment phase, Trial BP represents the response to pencil shavings; BF, the response to fruit averaged over the first two trials; BC, the response to potato chips averaged over the first two trials. In the posttreatment phase, Trial AC1 represents the mean value obtained in response to the first posttreatment exposure to potato chips; Trial AF, the posttreatment exposure to fruit; and Trial AC2, the second posttreatment exposure to potato chips. Values in the posttreatment phase represent represent responses to fruit and potato chips for each group not followed by reinforcement or rinsing.

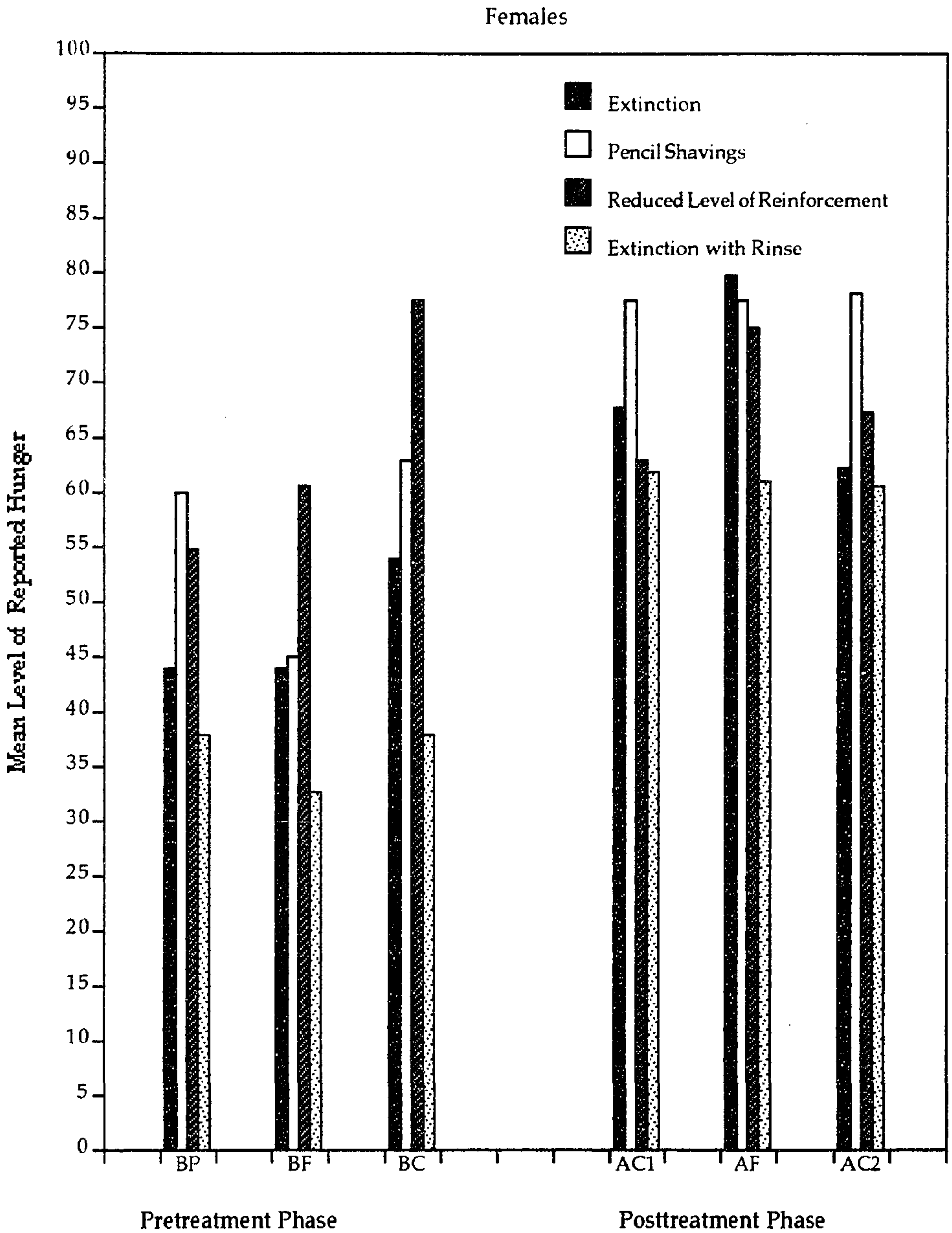


Figure 6. Mean level of reported hunger obtained for the female subjects from the EX, PS, RLR and ER groups. In the pretreatment phase, Trial BP represents the response to pencil shavings; BF, the response to fruit, averaged over the first two trials; and BC the response to potato chips averaged over the first two trials. In the posttreatment phase, Trial AC1 represents the mean level obtained in response to the first posttreatment exposure to potato chips; Trial AF, the posttreatment exposure to fruit; and Trial AC2, the second posttreatment exposure to potato chips. Values in the posttreatment phase represent responses to fruit and potato chips for each for each group not followed by reinforcement or rinsing.

An examination of the raw data revealed that 32 of the 40 participants reported an increase in hunger on Trial AF. The effect of the experimental manipulations during the treatment phase on the hunger response to fruit was examined by comparing performances on the pretreatment exposure (BF) to values obtained on the posttreatment trial (AF). An ANOVA with treatment group, gender and phase factors revealed that the phase effect was significant, $F(1, 32) = 41.23$. Mean increases obtained in reported hunger for fruit in the posttreatment phase were 13 and 30.2 points above the pretreatment values, for males and females, respectively. The analyses showed that the Gender x Phase interaction was reliable, $F(1,32) = 5.50$, reflecting the greater increase reported by the female subjects. Treatment Group x Phase and Treatment Group x Gender x Phase interactions did not reach significance, [$F(3, 32) < 1$; $F(3, 32) = 1.38$, respectively]. Main effects of treatment group and gender and the Treatment Group x Gender interaction were not reliable, [$F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) = 1$, respectively].

Posttreatment comparisons. Although hunger reported in the presence of the potato chips increased after the introduction of the fruit for all groups relative to the pretreatment value, significant differences did not emerge when responses to the chips were compared within the posttreatment phase (Trials AC1 and AC2). Analyses of variance with treatment group, gender and trial as factors showed that the trial effects, Treatment Group x Trial, Gender x Trial, and Treatment Group x Gender x Trial interactions were not reliable, [$F(1,32) = 2.44$; $F(3, 32) = 1.06$; $F(1, 32) = 3.55$; $F(3, 32) = 1.02$, respectively]. No significant effects were obtained for the main effects of treatment group and gender and the Treatment Group x Gender interaction, [$F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) = 1$, respectively]. These findings suggest that the increase in hunger obtained on the second posttreatment exposure to the potato chips was not attributable to the reintroduction of the fruit on Trial AF.

Treatment phase. Following the same structure used for illustrating differences in the salivary responses during the treatment phase, Figures 7 and 8 show the pattern of change occurring in the hunger response over the course of the treatment trials for male and female participants, respectively, of the extinction, pencil shavings, reduced-level-of-reinforcement and

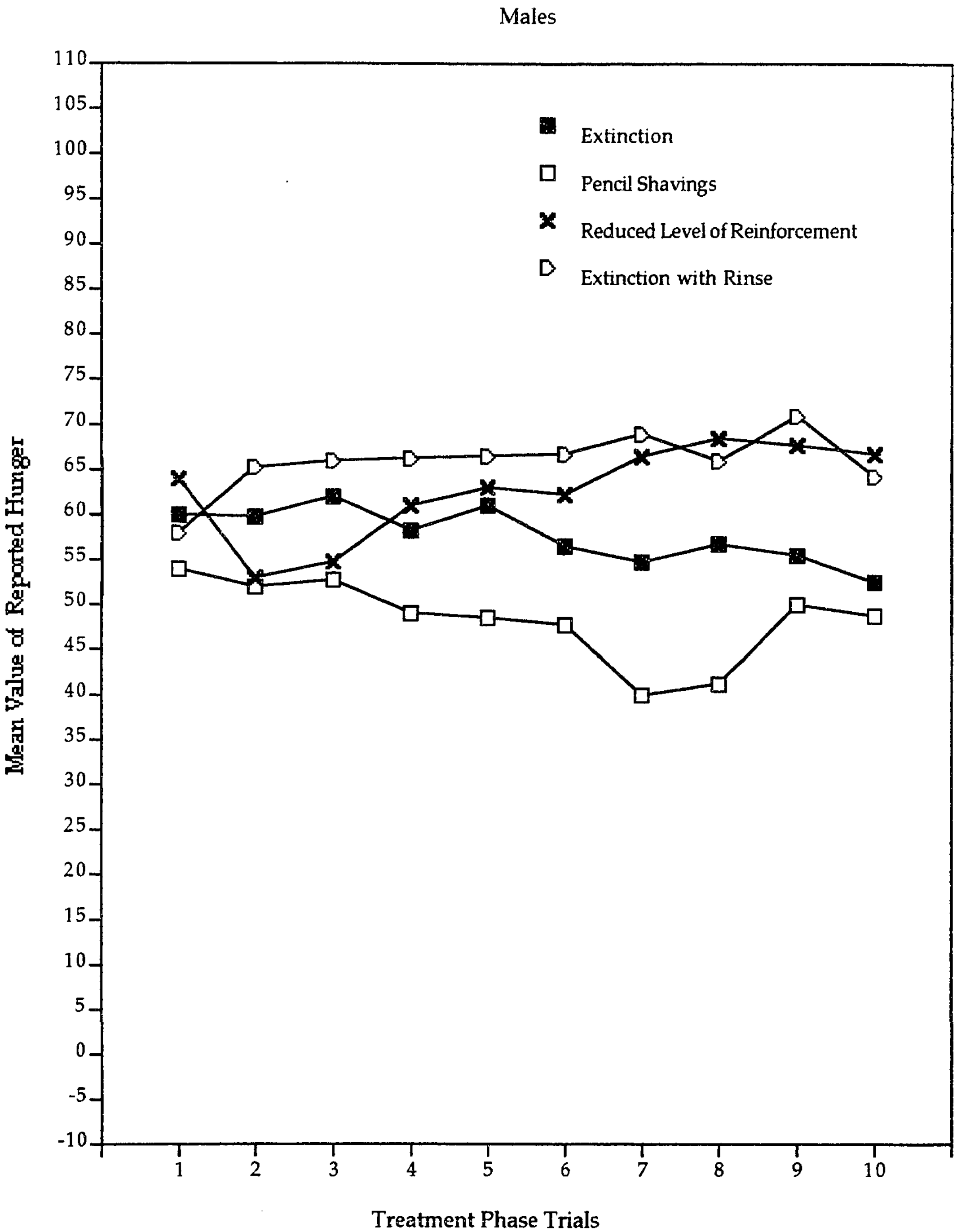


Figure 7. Mean value of hunger reported in the presence of the test items for the ten trials of the treatment phase for the male subjects of the experimental groups. Values represent responses to repeated presentations of potato chips not followed by reinforcement for the EX group, to pencil shavings not followed by reinforcement for the PS group, to potato chips on reinforced trials followed by rinsing for the RLR group, and to potato chips on trials followed by rinsing but not reinforcement for the ER group.

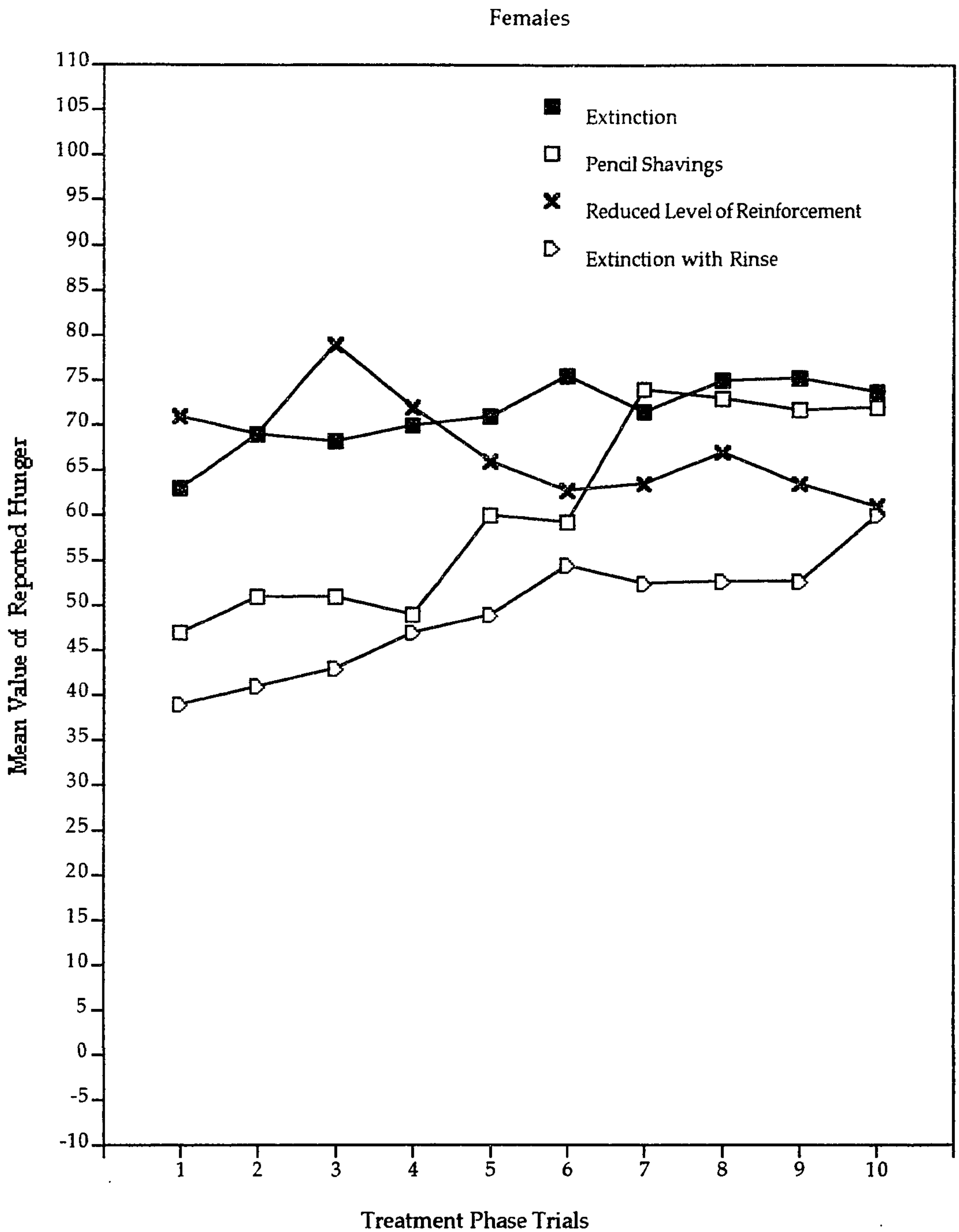


Figure 8. Mean value of hunger reported in the presence of the test items for the ten trials of the treatment phase for the female subjects of the experimental groups. Values represent responses to repeated presentations of potato chips not followed by reinforcement for the EX group, to pencil shavings not followed by reinforcement for the PS group, to potato chips on reinforced trials followed by rinsing for the RLR group, and to potato chips on trials followed by rinsing but not reinforcement for the ER group.

extinction-with-rinse groups. As displayed in Figures 7 and 8, the effect of the cue - exposure manipulations on the hunger response during the treatment phase was variable. With the exception of the female participants of the pencil shavings group who showed the largest increase in reported hunger, it would appear that treatment effects were negligible. Analyses of variance with treatment group, gender and trial factors revealed that the trial effects and interactions involving treatment group and trial, and gender and trial were not reliable, [$F(9, 288) = 1.96$; $F(27, 288) < 1$; $F(9, 288 = 1.23)$]. However, the ANOVA indicated that the Treatment Group x Gender x Trial interaction was significant, $F(27, 288) = 2.35$. Subsequent analyses of the Treatment Group x Gender x Trial interaction indicated that reported hunger increased significantly during the treatment phase for the female participants of the pencil shavings group, $F(9, 288) = 5.19$, but not for the males, $F(9, 288) < 1$. Trend analyses conducted on the significant trial effect reflected a linear increase in reported hunger over the course of the treatment trials for the females of the pencil shavings group, $F(1, 32) = 7.78$; no other reliable trends emerged. Trial effects did not reach significance for males and females, respectively, of the extinction group, [$F(9, 288) < 1$; $F(9, 288) < 1$], the extinction-with-rinse group, [$F(9, 288) < 1$; $F(9, 288) = 1.88$] or the reduced-level-of-reinforcement group, [$F(9, 288) = 1.31$; $F(9, 288) = 1.25$]. Main effects of treatment group and gender and the Treatment Group x Gender interaction were not reliable, [$F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) = 1$, respectively.

Post hoc comparisons. Analyses of variance performed on the data restricted to the extinction and pencil shavings groups were consistent with findings from the four - group analyses with two exceptions:

1. No reliable effects were found when hunger responses in the presence of the chips in the pretreatment phase were compared with responses reported on the second posttreatment exposure on Trial AC2. Phase effects, Treatment Group x Phase, Gender x Phase and Treatment Group x Gender x Phase interactions were not reliable, [$F(1,16) = 2.43$; $F(1,16) < 1$; $F(1,16) < 1$; $F(1,16) < 1$, respectively]. Consistent with the previous analyses, main effects of treatment group, gender and the Treatment Group x Gender interaction were not significant.

2. Examination of the effect of the cue - exposure manipulations during the treatment phase showed a significant gender x trial interaction, $F(9, 144) = 3.59$, reflecting a reliable increase in reported hunger for the females of both groups. Subsequent analyses of the Gender x Trial interaction indicated that the hunger response increased significantly for the female subjects, $F(9, 144) = 3.69$, but not for the males, $F(9, 144) > 1$. Trend analyses performed on the reliable trial effect indicated that the pattern of the hunger response reported by the females increased linearly during the treatment phase, $F(1,16) = 5.45$; no other reliable trends emerged. Trial effects, Treatment Group x Trial, Treatment Group x Gender x Trial interactions were not reliable, [$F(9,144) = 1.96$; $F(9,144) < 1$; $F(9,144) < 1$, respectively]. Consistent with the previous analyses, main effects of treatment group, gender and the Treatment Group x Gender interaction were not significant.

Summary of findings: hunger responses. Although pretreatment differences in reported hunger for the potato chips and fruit were small, these differences were reliable reflecting a greater hunger for the potato chips reported by both males and females; females significantly greater than males. Pre- to posttreatment changes in the hunger response in the presence of the potato chips from the pretreatment values (BC) to the posttreatment measure obtained on Trial AC1 were not reliable. When the pretreatment values were compared to measures obtained on Trial AC2, the phase effect was significant reflecting an overall increase in hunger reported in the presence of the chips on the second posttreatment trial. However, the absence of differential effects among the experimental groups suggests that treatment effects were not responsible for this effect. When the analyses of pre- to posttreatment performances in the presence of the chips were restricted to the extinction and pencil shavings groups, no reliable differences emerged. With respect to fruit, pre- to posttreatment differences in reported hunger were reliable, reflecting a general increase on the posttreatment trial for males and females, with female differences reliably greater; differential effects between treatment groups did not emerge. The Gender x Phase interaction was also reliable reflecting the greater increases reported by the female participants with respect to this measure. The introduction of the fruit in the posttreatment phase did not have a significant effect on reported hunger in the presence of the potato chips when posttreatment performances were compared.

Reported hunger in the presence of the potato chips increased linearly for the females of the pencil shavings group when performances during the treatment phase were compared among the four experimental groups. When the data were restricted to the extinction and pencil shavings groups, the analyses revealed a linear trend in the hunger response for the females of both groups, reflecting the increase during the course of the treatment phase.

Appeal

Consistent with the previous structure used to illustrate pre- and posttreatment responses, Figure 9 presents the mean level of appeal reported in the presence of the test items for the extinction, pencil shavings, reduced-level-of-reinforcement and extinction-with-rinse groups during the pre- and posttreatment phases. The values in Figure 9 represent the combined values for male and female subjects because gender effects were not detected in the analyses that are displayed.

Pretreatment - posttreatment changes. As shown in Figure 9, the effect of the cue - exposure manipulations appeared to have a differential impact on the level of appeal reported for the potato chips in the posttreatment phase. Relative to the pretreatment values (BC), mean levels of appeal decreased on Trial AC1 for the extinction and extinction-with-rinse groups who received repeated unreinforced exposure to the potato chips during the treatment phase and for the reduced-level-of-reinforcement group who received repeated exposure to the chips followed by reinforcement during this period. A review of the raw data revealed that 23 of the 40 participants reported a decrease in appeal on Trial AC1 relative to the pretreatment value. Analyses of variance with treatment group, gender and phase factors indicated that while the phase effect was significant, $F(1, 32) = 15.12$, the Treatment Group x Phase, Gender x Phase, and Treatment Group x Gender x Phase interactions were not, [$F(3, 32) = 2.46$; $F(1, 32) < 1$; $F(3, 32) < 1$, respectively]. Main effects of treatment group and gender and the Treatment Group x Gender interaction were not reliable, [$F(3, 32) < 1$; $F(1, 32) = 1.04$; $F(3, 32) < 1$, respectively].

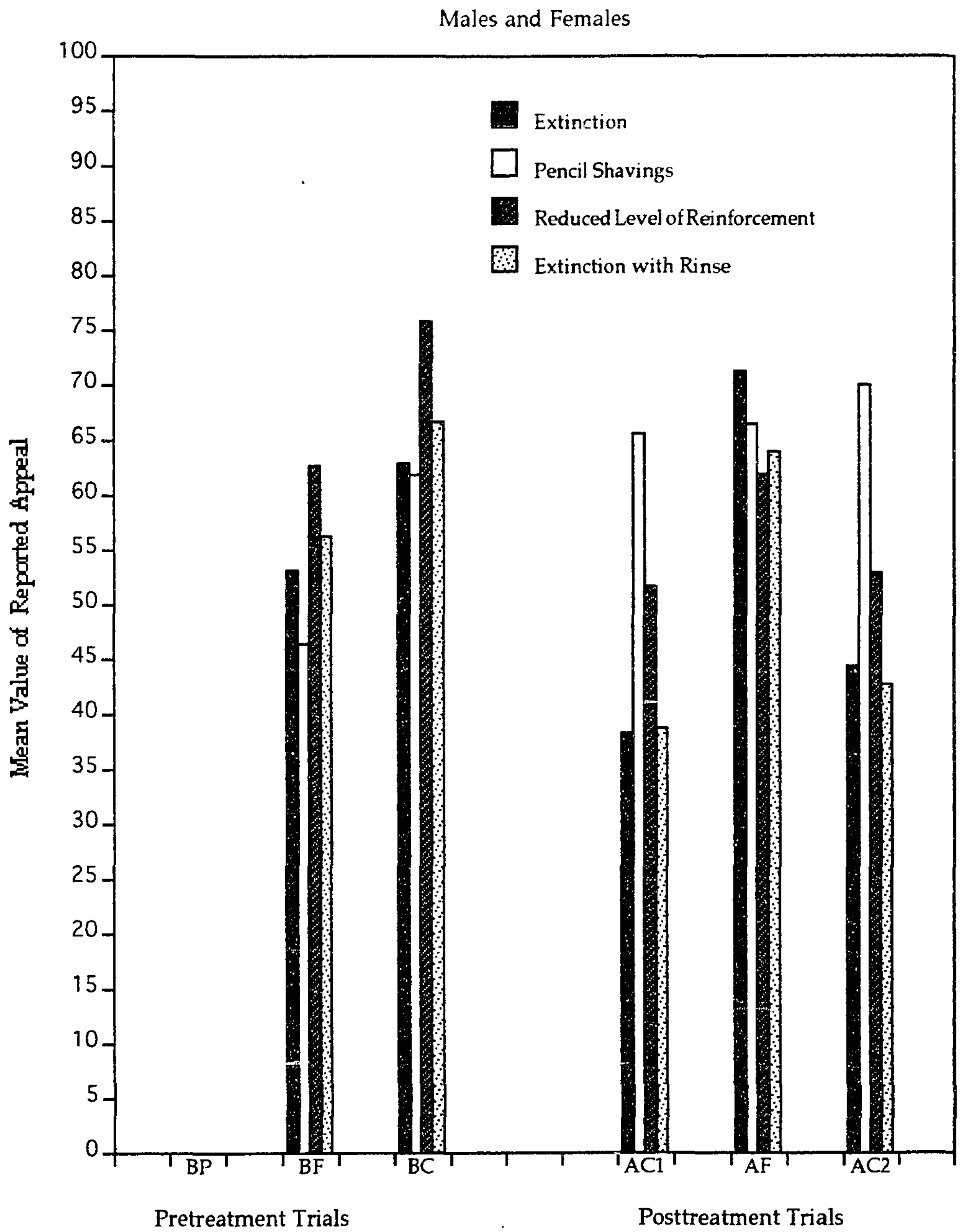


Figure 9. Mean value of reported appeal obtained for male and female subjects from the EX, PS, RLR and ER groups. In the pretreatment phase, Trial BP represents the response to pencil shavings; BF, the response to fruit averaged over the first two trials; and BC, the response to potato chips averaged over the first two trials. In the posttreatment phase, Trial AC1 represents the mean value obtained in response to the first posttreatment exposure to potato chips; Trial AF, the posttreatment exposure to fruit; and Trial AC2, the second posttreatment exposure to potato chips. Values in the posttreatment phase represent represent responses to fruit and potato chips for each group not followed by reinforcement or rinsing.

A similar pattern of results emerged when pretreatment values of appeal for the chips were compared to those obtained on Trial AC2, following the introduction of the fruit on Trial AF. Except for slight increases from those obtained on Trial AC1, levels of appeal reported on Trial AC2 remained lower than pretreatment values for the extinction, extinction-with-rinse and reduced-level-of-reinforcement groups whose mean levels decreased by 18.6, 24.5 and 23 points, respectively. The mean level of appeal increased for the pencil shavings group by 8.1 points. An examination of the raw data showed that appeal reported on the second posttreatment exposure to the potato chips was lower than the pretreatment value for seven, six, and six of the ten participants of the extinction, extinction-with-rinse and reduced-level-of-reinforcement groups, respectively. Treatment Group x Gender x Phase analyses of variance revealed that the phase effect and the Treatment Group x Phase interaction were significant, [$F(1, 32) = 11.83$; $F(3, 32) = 3.29$, respectively]. A test of the phase effects within the experimental groups revealed that the response level obtained on Trial AC2 was reliably lower than its pretreatment value (BC) for the extinction, reduced-level-of-reinforcement and extinction-with-rinse groups, [$F(1, 32) = 4.95$; $F(1, 32) = 7.54$, $F(1, 32) = 8.28$, respectively]. The response change for the pencil shavings group with respect to these measures was not significant, $F(1, 32) < 1$. Gender x Phase and Treatment Group x Gender x Phase interactions were not reliable, [$F(1, 32) < 1$; $F(3, 32) = 1.13$, respectively]. Main effects of treatment group and gender and the Treatment Group x Gender interaction were not significant, [$F(3, 32) < 1$; $F(1, 32) = 1.12$; $F(3, 32) < 1$, respectively].

As illustrated in Figure 9, the mean value of reported appeal for fruit increased for the extinction, extinction-with-rinse and pencil shavings groups and remained essentially unchanged for the reduced-level-of-reinforcement group on the posttreatment trial (AF) relative to the pretreatment value (BF). A review of the raw data showed that 30 of the 40 participants reported a decrease in appeal for the fruit from the pre- to the posttreatment phase. Treatment Group x Gender x Phase analyses of variance indicated that the phase effect was significant, $F(1, 32) = 7.19$, reflecting an overall increase in appeal reported on the posttreatment trial. However, differential effects did not emerge. Interactions between treatment group and trial, gender and trial, and treatment group, gender and trial were not reliable, [$F(3, 32) = 1.34$; $F(1, 32) = 1.77$; $F(3, 32) < 1$, respectively]. Main effects of treatment group and gender and the Treatment Group x Gender interaction were not significant, [$F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) < 1$, respectively].

Posttreatment comparisons. A comparison of performances within the posttreatment phase were conducted to examine the potential dishabituating effects of the fruit on the reported appeal for the chips after the treatment phase. As shown in Figure 9, the mean level of reported appeal for the chips increased from Trial AC1 to Trial AC2 for all the experimental groups with the RLR group showing the least change. Treatment Group x Gender x Trial analyses of variance indicated that there was no differential responding by the experimental groups after the presentation of the fruit on Trial AF. However, the results did show that the trial effect was significant, $F(1, 32) = 8.48$, reflecting a general increase in reported appeal for the chips on Trial AC2. A review of the raw data showed that reported appeal for the chips increased for 16, decreased for 8, and remained unchanged for 16 of the 40 participants. Analyses of the interaction between treatment group and trial did not reach significance indicating that magnitude of the increase did not differentiate among the experimental groups, $F(3, 32) < 1$. Gender x Trial and Treatment Group x Gender x Trial interactions were not reliable, [$F(1, 32) < 1$; $F(3, 32)$ 1.58, respectively].

Treatment phase. Figure 10 shows the pattern of change occurring in the reported level of appeal for the test items repeatedly presented during the treatment phase for the four experimental groups, for males and females combined. Consistent with results obtained when pre- and posttreatment performances were compared, no reliable differences emerged between genders. As expected, the mean value of appeal reported for the pencil shavings remained near zero for the pencil shavings group throughout the treatment phase. The ANOVA with treatment group, gender and trial factors yielded a significant main effect of treatment group, $F(3, 32) = 11.23$; gender effects and the Treatment Group x Gender interaction were not reliable, [$F(1, 32) = 1.88$; $F(3, 32) = 1.09$, respectively]. The analyses of within - subject effects showed that the trial effect was significant, $F(9, 288) = 7.58$; trend analyses performed on the trial effect reflected a

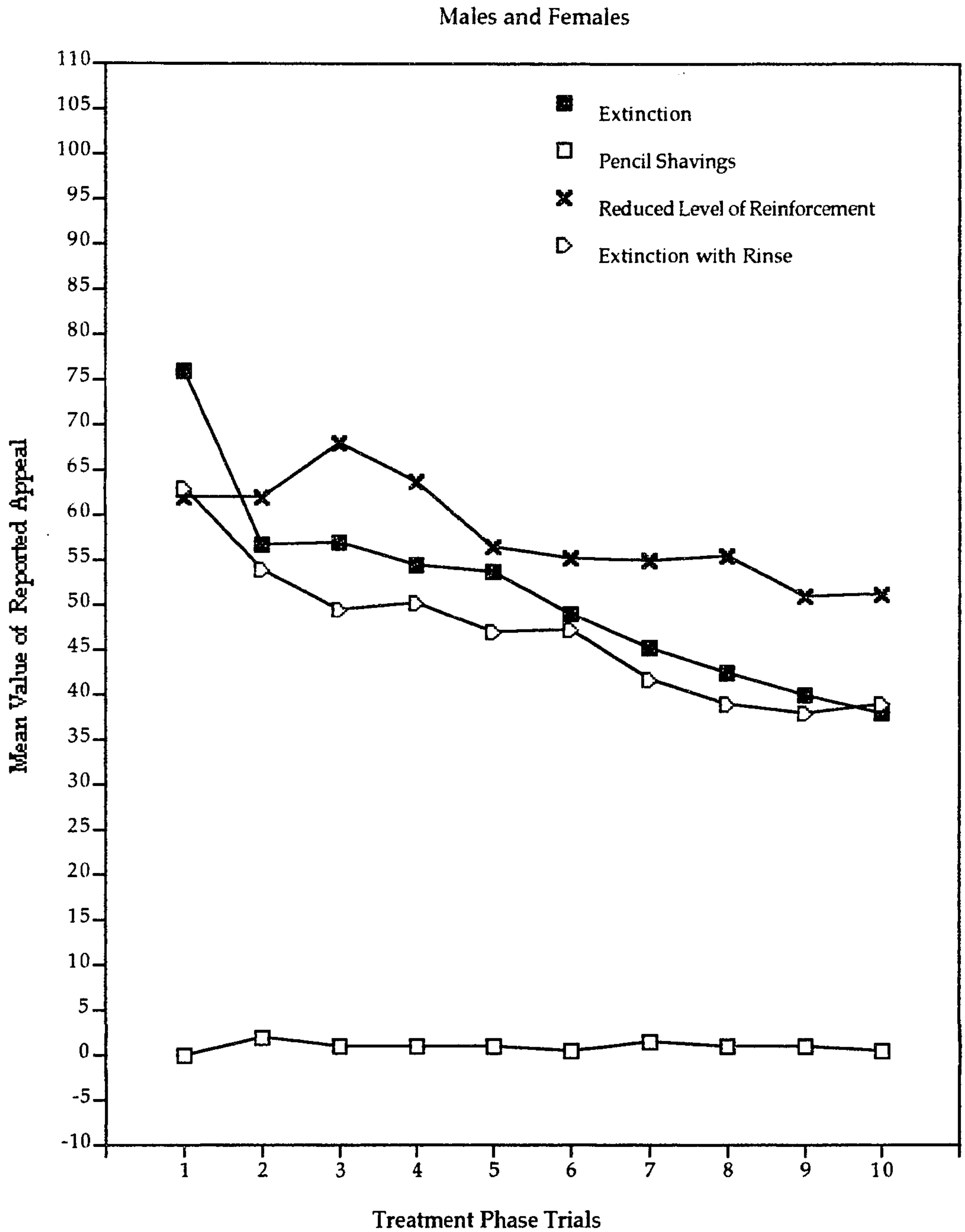


Figure 10. Mean value of appeal reported in the presence of the test items for the ten trials of the treatment phase for the male and female subjects of the experimental groups. Values represent responses to repeated presentations of potato chips not followed by reinforcement for the EX group, to pencil shavings not followed by reinforcement for the PS group, to potato chips on reinforced trials followed by rinsing for the RLR group, and to potato chips on trials followed by rinsing but not reinforcement for the ER group.

reliable, linear decrease in reported appeal over the course of the treatment trials, $F(1, 32) = 10.52$. As illustrated, the mean level of appeal for the chips decreased during the treatment phase for the extinction and extinction-with-rinse groups; however, these differences were not supported by the ANOVA. Treatment Group x Trial, Gender x Trial and Treatment Group x Gender x Trial effects were not significant, [$F(27, 288) = 1.10$; $F(9, 288) < 1$; $F(27, 288) < 1$, respectively].

Post hoc comparisons. A similar pattern of results, with some additional effects, emerged when the analyses were restricted to the extinction and pencil shavings groups. A comparison of performances between pretreatment responses to the chips (BC) and posttreatment measures obtained on Trial AC1 showed that the Treatment Group x Phase interaction was significant, $F(1, 16) = 6.21$. Subsequent analyses revealed that the decrease in appeal for the chips reported by the extinction group on the first posttreatment trial was reliable, $F(1, 16) = 9.38$, whereas changes in responding for the pencil shavings group did not reach significance, $F(1,16) < 1$. Unlike the four - group analyses, the phase effect was not reliable, $F(1,16) = 3.39$. Consistent with the previous analyses, Gender x Phase and Treatment Group x Gender x Phase interactions did not reach significance, [$F(1, 16)$ 3.39; $F(1, 16) < 1$; $F(1, 16) < 1$, respectively]; main effects of treatment group and gender and the Treatment Group x Gender interaction were not reliable, [$F(1, 16)$ 1.15; $F(1, 16) < 1$; $F(1, 16) < 1$, respectively]. The remaining analyses performed on the data restricted to the extinction and pencil shavings groups were consistent with the results obtained from the four - group analyses.

Summary of findings: appeal responses. Based on the self - reports, analyses of pretreatment differences between food items suggested that the participants found the potato chips more appealing than the fruit. A comparison of pre- to posttreatment performances showed that appeal reported for the chips decreased significantly on the second posttreatment trial relative to the pretreatment measure for the extinction, extinction-with-rinse and reduced-level-of-reinforcement groups. Pre- to posttreatment comparisons restricted to the extinction and pencil shavings groups showed that reported decreases in appeal were reliable on the first posttreatment trial as well. Pre- to posttreatment analyses of responses to fruit revealed that reported appeal increased significantly in the posttreatment phase; however, differential effects among the experimental groups were not reliable. Analyses of posttreatment performances in response to the potato chips, between Trials AC1 and AC2, indicated that the increases in appeal observed on the second posttreatment trial were reliable; however, differential effects among the experimental groups were not. Analyses of performances during the treatment phase revealed a main effect of treatment group reflecting the low level of appeal for the pencil shavings reported by the pencil shavings group. Trend analyses of treatment phase data showed a reliable decrease in reported appeal for the chips over the course of the treatment trials; differential effects were not reliable.

Craving

Following the same format used previously to illustrate pre- and posttreatment data, Figures 11 and 12 represent the mean pre- and posttreatment values of craving reported for the test items obtained from the extinction, pencil shavings, reduced-level-of-reinforcement and extinction-with-rinse groups, for males and females, respectively.

Pretreatment - posttreatment changes. As presented in Figures 11 and 12, the mean level of craving reported for the potato chips on Trial AC1 decreased from the pretreatment value (BC) for all participants of the extinction, reduced-level-of-reinforcement and for the male participants of the extinction-with-rinse group. An examination of the raw data showed that 22 of the 40 participants reported a decrease in craving for the chips on the first posttreatment trial relative to the pretreatment value. Analyses of variance with treatment group, gender and phase factors revealed a significant phase effect, $F(1,32) = 5.63$; however, interactions involving phase effects with treatment groups, gender, and treatment group and gender were not reliable, [$F(3, 32) = 1.47$; $F(1, 32) < 1$; $F(3, 32) = 1.07$, respectively]. These results indicate that treatment effects did not differentially affect craving for the chips on the first posttreatment trial. Main effects of treatment group and gender and the Treatment Group x Gender interaction were not significant, [$F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) < 1$, respectively.

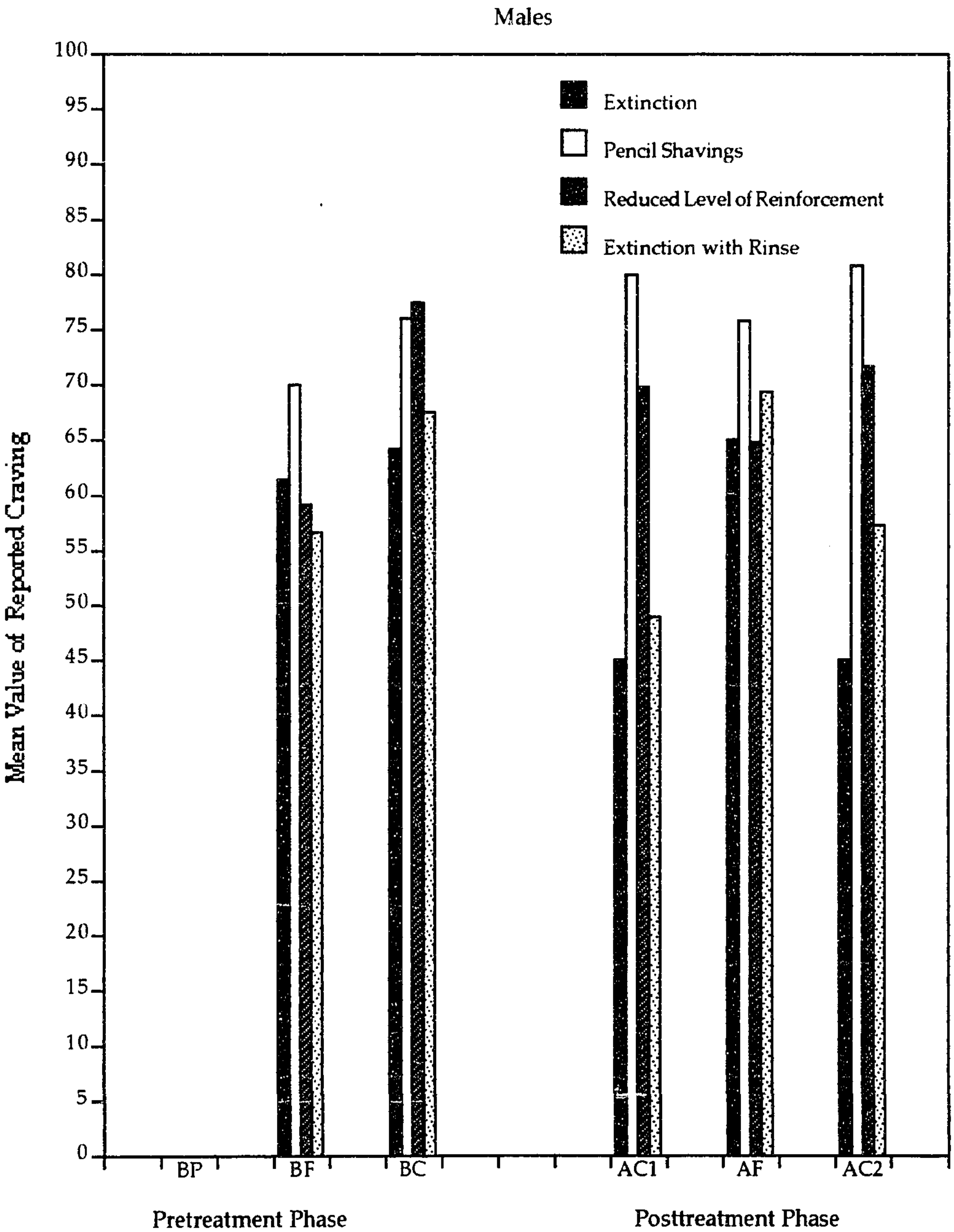


Figure 11. Mean value of reported craving obtained for the male subjects from the EX, PS, RLR and ER groups. In the pretreatment phase, Trial BP represents the response to pencil shavings; BF, the response to fruit averaged over the first two trials; and BC, the response to potato chips averaged over the first two trials. In the posttreatment phase, Trial AC1 represents the mean value obtained in response to the first posttreatment exposure to potato chips; Trial AF, the posttreatment exposure to fruit; and Trial AC2, the second posttreatment exposure to potato chips. Values in the posttreatment phase represent responses to fruit and potato chips for each group, not followed by reinforcement or rinsing.

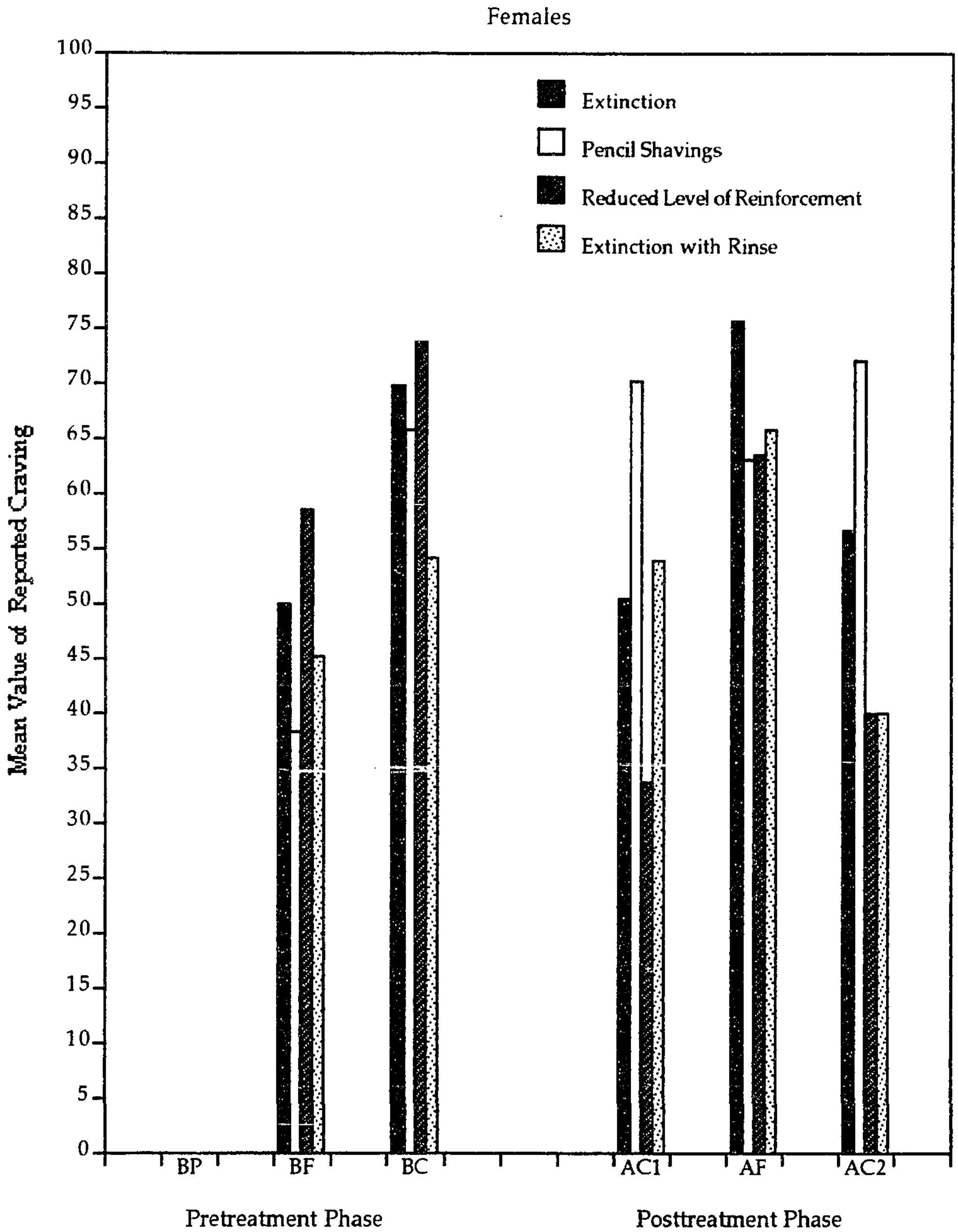


Figure 12. Mean value of reported craving obtained for the female subjects from the EX, PS, RLR and ER groups. In the pretreatment phase, Trial BP represents the response to pencil shavings; BF, the response to fruit averaged over the first two trials; and BC, the response to potato chips averaged over the first two trials. In the posttreatment phase, Trial AC1 represents the mean value obtained in response to the first posttreatment exposure to potato chips; Trial AF, the posttreatment exposure to fruit; and Trial AC2, the second posttreatment exposure to potato chips. Values in the posttreatment phase represent responses to fruit and potato chips for each group, not followed by reinforcement or rinsing.

Results were similar when the mean level of craving for the potato chips reported on the second posttreatment measure was compared to the pretreatment value (BC). A review of the raw data showed that 20 of the 40 participants reported a decrease in craving on Trial AC2 relative to the pretreatment value. Treatment Group x Gender x Phase analyses of variance showed that the phase effect was significant, $F(1, 32) = 6.32$, reflecting the overall decrease in reported craving obtained on Trial AC2. Treatment Group x Phase, Gender x Phase and Treatment Group x Gender x Phase interactions were not reliable, [$F(3, 32) = 1.75$; $F(1, 32) < 1$; $F(3, 32) < 1$, respectively], again demonstrating the absence of differential effects. Main effects of treatment group and gender and the Treatment Group x Gender interaction were not significant, [$F(3, 32) < 1$; $F(1, 32) = 1.03$; $F(3, 32) < 1$, respectively]. The effect of the cue - exposure manipulations during the treatment phase did not appear to have a differential impact on craving for the fruit in the posttreatment phase. An examination of the raw data revealed that 28 of the 40 participants reported an increase in craving for the fruit in the posttreatment phase. Treatment Group x Gender x Phase analyses of variance showed that the phase effect was significant, $F(1, 32) = 7.80$, reflecting the overall increase in craving from the pretreatment value (BF) to Trial AF in the post-treatment phase. Treatment Group x Phase, Gender x Phase and Treatment Group x Gender x Phase interactions were not reliable, [$F(3, 32) < 1$; $F(1, 32) = 1.69$; $F(3, 32) < 1$, respectively]. Main effects of treatment group and gender and the Treatment Group x Gender interaction were not significant, [$F(3, 32) < 1$; $F(1, 32) = 1.21$; $F(3, 32) < 1$, respectively].

Posttreatment comparisons. As shown in Figures 11 and 12, a variable pattern emerged among the experimental groups with respect to posttreatment changes in craving for the potato chips between Trials AC1 and AC2. Treatment Group x Gender x Trial analyses of variance revealed that trial effects and interactions between treatment group and trial, gender and trial, and treatment group, gender and trial were not reliable, [$F(1, 32) < 1$; $F(3, 32) < 1$; $F(1, 32) < 1$; $F(3, 32) = 2.87$, respectively]. Main effects of treatment group and gender and the Treatment Group x Gender interaction were not significant, [$F(3, 32) = 1.15$; $F(1, 32) < 1$; $F(3, 32) < 1$, respectively].

Treatment phase. Figure 13 shows the pattern of change occurring in the reported level of craving for the test items repeatedly presented during the treatment phase for the four experimental groups, for males and females combined. Consistent with reported appeal for the pencil shavings, the mean level of craving remained at zero over the course of the treatment trials for the pencil shavings group. Treatment Group x Gender x Trial analyses of variance showed that the main effect of treatment group was reliable, $F(3, 32) = 9.90$. Gender effects and the Treatment Group x Gender interaction were not significant, [$F(1, 32) = 1.21$; $F(3, 32) < 1$, respectively]. As illustrated, only minor changes occurred in the mean level of craving reported for the test items by the extinction, extinction-with-rinse and reduced-level-of-reinforcement groups during the treatment phase. A review of the raw data shows that one female member of the extinction-with-rinse group reported a sizable increase in craving on the tenth treatment trial and this level was maintained on the first posttreatment exposure to the potato chips. After the introduction of the fruit, this subject reported a decrease in craving for the chips but the level was still larger than the pretreatment value. The analyses indicated that the differential effects of the cue - exposure manipulations during the treatment phase were negligible. The trial effect was not reliable, after the degrees of freedom were adjusted with the epsilon correction factor, $F(9, 288) = 2.30$ and the Treatment Group x Trial, Gender x Trial, and Treatment Group x Gender x Trial interactions were not significant, [$F(27,288) < 1$; $F(9, 288) = 1.02$; $F(27, 288) < 1$, respectively].

Post hoc comparisons. Analyses restricted to responses within the extinction and pencil shavings groups were consistent with the findings reported for all the experimental groups with minor exceptions. Analyses of variance with treatment group, gender and phase factors conducted on pre- to posttreatment performances in craving for fruit revealed a significant Gender x Phase interaction, $F(1,16) = 4.53$. An examination of the phase effect revealed a reliable increase in craving reported by the female participants in both experimental groups in the posttreatment phase, $F(1, 16) = 13.87$, but not for the male participants, $F(1,16) < 1$. Main effects of treatment group, gender and the Treatment Group x Gender interaction were not reliable, [$F(1, 16) < 1$; $F(1, 16) = 1.38$; $F(1,16) = 1.27$, respectively].

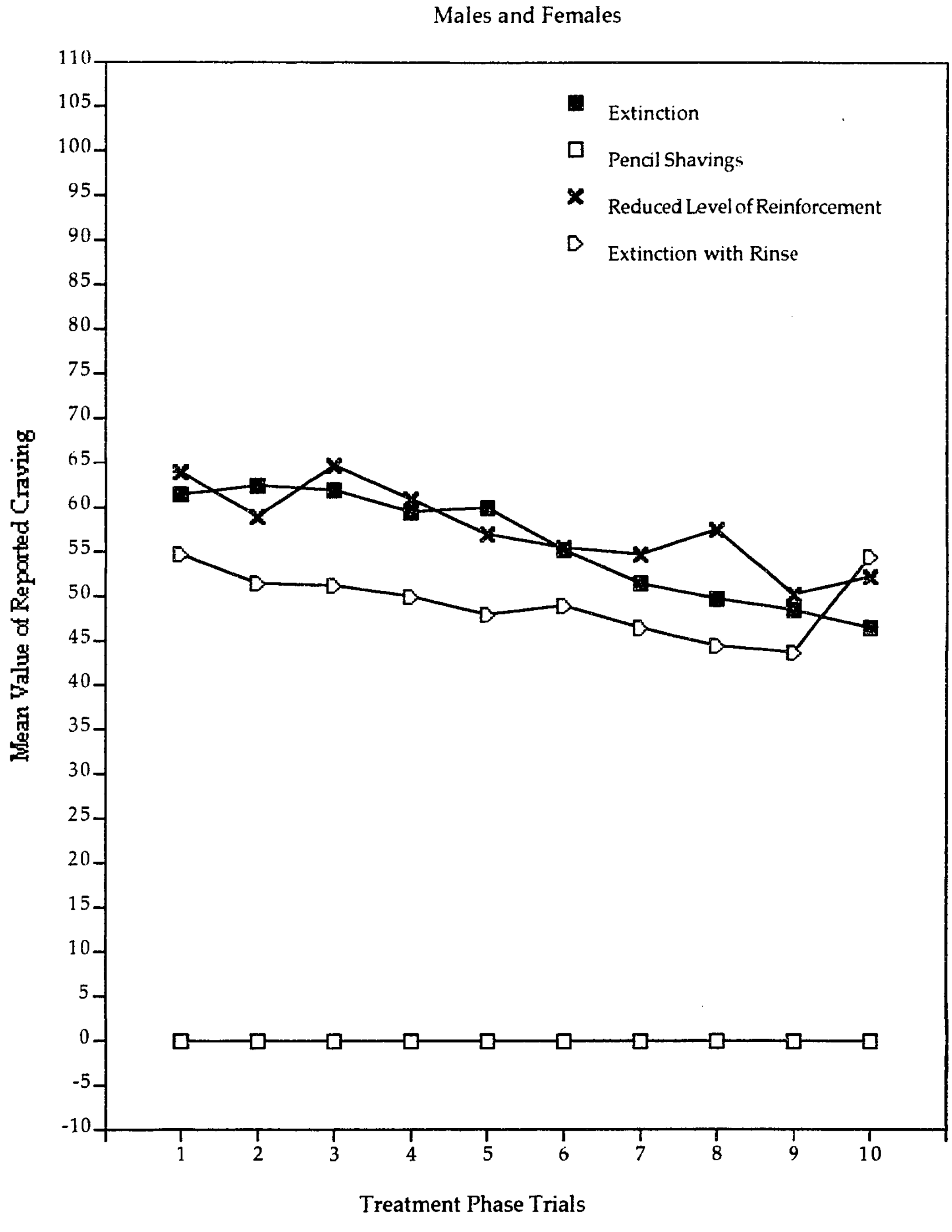


Figure 13. Mean value of craving reported in the presence of the test items for the ten trials of the treatment phase for the male and female subjects of the experimental groups. Values represent responses to repeated presentations of potato chips not followed by reinforcement for the EX group, to pencil shavings not followed by reinforcement for the PS group, to potato chips on reinforced trials followed by rinsing for the RLR group, and to potato chips on trials followed by rinsing but not reinforcement for the ER group.

Summary of findings: craving responses. Based on the self - reports, analyses of pretreatment differences between food items revealed that participants craved the potato chips more than the fruit. The effect of the cue- exposure manipulations on reported craving for the potato chips was not demonstrated. The analyses of pre- and posttreatment differences revealed a significant phase effect reflecting the overall decrease in craving for the chips reported by the four experimental groups on Trials AC1 and AC2, relative to the pretreatment values. The Treatment Group x Phase interaction was not reliable. The analyses of pre - to posttreatment performances with respect to the fruit revealed a significant phase effect indicating that the reported increase in craving for the fruit obtained on Trial AF was reliable; differential effects were not significant among the four experimental groups, suggesting that treatment effects on reported craving for the fruit were negligible. In the post hoc analyses, females reported significantly greater craving for the fruit than the males, relative to pretreatment values. The introduction of the fruit in the posttreatment phase did not affect reported craving for the potato chips when responses on Trial AC1 were compared to those obtained on Trial AC2. The level of craving reported for the chips during the treatment phase was variable. The analyses showed that the main effect of treatment group was significant, reflecting the low level of craving reported for the pencil shavings; remaining effects were not reliable.

Correlational analyses

Pearson r coefficients were computed for the dependent measures in order to assess the value of the salivary response as an indicator of the self - report measures. The analyses were based on the averaged values, BF and BC, obtained in the pretreatment phase in the presence of fruit and potato chips, respectively. The results suggested that anticipatory salivation was not a reliable predictor of self - reported hunger, appeal or craving. The salivary response was not significantly related to any of the self - report measures; however, significant correlations were obtained between measures of hunger, appeal and craving for both of the food items. Refer to Appendix D for the correlational analyses.

Discussion

Salivation

This study showed that repeated exposure to the olfactory and visual properties of the potato chips in the discrete - trial procedure resulted in a decrease in anticipatory salivation when the exposure trials were not reinforced. Although the linear trend anticipated during the treatment phase emerged only for the male participants of the extinction-with-rinse group, overall responding to the potato chips on the first posttreatment trial for the extinction and extinction-with-rinse groups was significantly lower than the pretreatment values. This finding is consistent with the fact that extinction and extinction-with-rinse groups received extinction trials during the treatment phase and provides empirical support for an analysis based on Pavlovian mechanisms.

The effect of the cue - exposure trials on the salivary responses for the extinction and extinction-with-rinse groups was not clearly demonstrated during the treatment phase. In prior research, although trend analyses were not reported on the data, repeated presentations of a taste stimulus over ten trials were associated with a significant decrease in the salivary response to the stimulus when food was eaten (Epstein, Caggiula & Rodefer, 1993) and not eaten between trials (Epstein, Rodefer, Wisniewski, Caggiula, 1992). In the present research, the analyses indicated that salivary responses decreased linearly over the course the treatment trials for the male participants of the extinction-with-rinse group suggesting that there was a gradual weakening of the salivary response for these participants. The extinction and extinction-with-rinse groups differed procedurally in that the latter group rinsed with spring water after every trial in the treatment phase. Because the expected effect from rinsing, if any, would have been to stimulate salivation, it is doubtful that the rinsing negatively influenced responding in the extinction-with-rinse group.

Salivary responding remained lower on the second posttreatment exposure to the potato chips relative to the pretreatment values for the participants of the extinction and extinction-with-rinse groups. In prior studies, a stimulus change introduced after repeated presentations of another stimulus resulted in a significant increase in the salivary response to the first stimulus when it was subsequently presented (Epstein, Rodefer et al, 1992). In the present experiment, all subjects were exposed to fruit as well as to potato chips in the pretreatment phase whereas in the study cited, a second stimulus was presented for the first time in the experiment, after habituation to the first stimulus had occurred. The fruit did not serve as a novel stimulus in this experiment, and this may have contributed to its failure to dishabituate the salivary response to the potato chips for the extinction groups.

The ability of a second stimulus to function as a dishabituator may depend on several variables, including the degree to which the response has been habituated. This phenomenon was not tested in this study; however, prior research has shown that some responses that have been habituated show further decreases when the eliciting stimulus is again presented on additional trials (Thompson & Spencer, 1966). In a review of the empirical literature concerning habituation, Thompson and Groves (1970) reported that the dishabituating stimulus becomes less effective when it is repeatedly presented and, in fact shows evidence of habituation itself. Alternatively, Epstein, Rodefer & Wisniewski (1992) demonstrated that habituation did not occur when a computer game was played during intertrial intervals between repeated presentations of a taste stimulus. Although, the failure of the salivary response on the second posttreatment trial to return to pretreatment levels does not lend itself to a single interpretation, it is consistent with findings in extinction research. In studies of spontaneous recovery, the restoration of an extinguished response is rarely complete (Kimble, 1961). Compatible with these results, differences in the salivary response to the chips within the posttreatment phase were not reliable for the extinction and the extinction-with-rinse groups, providing further evidence that the fruit did not effectively dishabituate the salivary response to the chips for these groups.

Pre- to posttreatment changes in the salivary response were unremarkable for the reduced-level-of-reinforcement and pencil shavings groups with respect to the responding on the first posttreatment trial, suggesting that this response was not extinguished after the treatment phase. The bite-sized reinforcers may have supported salivary responding for the reduced-level-of-reinforcement group if they served as reinforcers. Furthermore, the reduced-level-of-reinforcement group was maintained on a schedule of continuous reinforcement during the treatment phase which may have facilitated responding as well (Catania, 1979). It is also conceivable that heightened CPR activity may have contributed to the response maintenance. Only the reduced-level-of-reinforcement group swallowed after each trial and the act of swallowing nutrients has been associated with an increase in digestive processes apart from those that occur when nutrients are placed directly in the stomach. In addition to stimulation received from the olfactory and visual properties of food, the cephalic phase reflexes are activated in response to gustatory stimulation received from both swallowing and gastric entry. The CPRs in turn, cause gastric changes that provide interoceptive stimuli and may affect anticipatory salivary responding as well (Deutsch, 1991). The possibility remains that salivation may have decreased had a greater number of trials been used.

For the pencil shavings group, salivary responses to the potato chips obtained on the first posttreatment trial were not reliably different from the pretreatment values. These findings indicate that the experimental procedures and the methodology associated with salivary collection and self - reporting were not responsible for the posttreatment decrease demonstrated by the extinction and extinction-with-rinse groups. Furthermore, response maintenance in the pencil shavings group is consistent with responding found in Pavlovian procedures when a subject is retested on an established response after a period of time when no testing has been done. Empirical support for this phenomenon can be found in historical accounts of Pavlovian responses that have survived the passage of time and include conditioned eyelid responses in dogs lasting 16 months (Marquis & Hilgard, 1936) and salivation in man lasting 16 weeks (Razran, 1939); and of operant responses, for example, pecking responses in pigeons lasting four years (Skinner, 1950).

Salivary responses to the potato chips for the pencil shavings group decreased on Trial AC2 after the presentation of the fruit in the posttreatment phase relative to the pretreatment value (BC). This difference was statistically indistinguishable from those observed for the extinction and extinction-with-rinse groups. Examination of differences between Trials AC1 and AC2 for the pencil shavings group, showed that the male subjects were responsible for the decrease obtained on the second posttreatment trial. Although only the pencil shavings group received a nonfood item during the treatment phase, it is not clear why the posttreatment response to the chips was lower following the reintroduction of the fruit. The fruit did not function as a dishabituator to the chips for this group because the salivary response to the chips obtained in the pretreatment phase was maintained on the first posttreatment trial.

Response strength was maintained in the presence of the fruit on the posttreatment measure for all the experimental groups suggesting that treatment effects did not generalize to the untreated food. Fruit is categorically different from potato chips with respect to odor, flavor, texture and nutrient value and the absence of generalization effects provides empirical support for the stimulus - specific nature of the salivary response. These inferences, of course, rest on the assumption that the potato chips and fruit are functionally equivalent with respect to the potential effects of repeated exposure.

Hunger

In general, the reported level of hunger increased in the posttreatment phase. Relative to pretreatment values, reliable increases were obtained in the posttreatment phase on the exposure to fruit and on the second exposure to potato chips. Differential effects did not emerge among the experimental groups, but there were gender differences: females reported greater increases in the presence of the fruit than the males. During the treatment phase, reported hunger for the pencil shavings group increased linearly for the female participants as well. Although significant effects were not obtained on the first posttreatment exposure to the chips, it is doubtful that the presentation of the fruit was solely responsible for the increase in hunger obtained on the subsequent trials. Analyses of results obtained on the first posttreatment exposure to the chips indicated a general increase in hunger on the first posttreatment trial, approaching significance ($p = .056$).

The absence of differential effects in reported hunger among the experimental groups is understandable because hunger was defined as a measure of the sensation of "stomach emptiness." Determined on the basis of the sensory feedback received from interoceptive cues, hunger would serve as the subjective correlate of deprivation level (Le Magnen, 1985). From the analyses, it would appear that the participants may have used interoceptive cues in assessing hunger and were less influenced by the sensory property of the stimuli presented on the trials. However, the possibility also remains that the participants measured hunger as a function of time. They were asked to fast for two hours before arriving for the session and, assuming compliance with this request, deprivation levels would be similar for all groups at the start of the experiment. Reported increases in hunger would be expected at the end of the session considering at least 60 minutes of time had elapsed between the first presentation of the fruit in the pretreatment phase and the last exposure to the potato chips in the posttreatment phase. Participants in the reduced-level-of-reinforcement group consumed a total of only 1 and 2/3 potato chips during the treatment phase, an amount that would not likely have contributed to satiety for this group.

For the extinction and extinction-with-rinse groups, with respect to pretreatment values, anticipatory salivation in response to the potato chips decreased in the posttreatment phase whereas hunger responses increased. The relationship between subjective hunger and salivation is unclear. Jansen, Boon, et al. (1992) reported a poor correlation between the two measures whereas Legoff, Leichner, et al. (1988) found a positive relationship between them. Nevertheless, the results from both of those studies support a conditioning analyses of anticipatory salivation which is also consistent with the findings in this experiment. In the research cited, it appeared that hunger was defined similarly as it was in this study, as a feeling, and not "hunger" for a particular food item. In experiments examining the relationship between deprivation level and anticipatory salivation, positive correlations were found between anticipatory salivation and deprivation level when participants were of normal weight (Wooley, Wooley & Dunham, 1976). However, in the Wooley et al., study, extinction procedures were not applied prior to testing and the participants' eating patterns were believed to be normal, so positive relationships between anticipatory salivation and deprivation level would be expected.

Appeal

Appeal, as it was defined, was intended to address the sensory properties of the test stimulus and not the desire to consume it. The repeated unreinforced exposure to the potato chips in the treatment phase was associated with a decrease in reported appeal for the chips in the posttreatment phase. This decrease in reported appeal from the pretreatment value (BC) was reliable on the second posttreatment trial, AC2 for the extinction, extinction-with-rinse and reduced-level-of-reinforcement groups; and on the first and second posttreatment trial for the extinction group in the post hoc comparison. The trial effect during the treatment phase reflected a general (linear) decrease in reported appeal over the course of the exposure trials. The absence of differences among the extinction, extinction -with-rinse and reduced-level-of-reinforcement groups indicates that the inclusion of the chip reinforcers during the treatment trials may not have affected reported appeal for the chips. Many of the appeal ratings obtained in response to the potato chips from the extinction -with-rinse and reduced-level-of-reinforcement groups on the first posttreatment trial were lower than pretreatment values; however, the Treatment Group x Phase effect did not reach significance ($p = .08$). The expected decrease in appeal for the potato chips demonstrated on the second posttreatment trial for the reduced-level-of-reinforcement group again raises the possibility that salivation may have decreased for this group had a greater number of trials been used.

The presentation of the fruit in the posttreatment phase was not responsible for the pre- to posttreatment decrease in appeal for the chips obtained on the second posttreatment trial for the extinction, extinction -with-rinse and reduced-level-of-reinforcement groups. Within the posttreatment phase, the mean value of appeal reported for the chips on the second trial, AC2 was actually higher for each of the experimental groups relative to the first trial, AC1, yielding a reliable increase within the posttreatment phase for all groups, without evidence of treatment effects. The analyses suggest that the repeated exposure to the olfactory and visual stimuli from the potato chips was responsible for the decrease in reported appeal for the chips in the posttreatment phase. Appeal for the fruit increased in the posttreatment phase, relative to the pretreatment value, suggesting that the reported appeal was stimulus - specific and that the fruit was not negatively affected by the experimental manipulations. However, the contribution of treatment effects to the increase in appeal reported for the fruit is unclear.

Craving

Craving did not prove to be a reliable measure of the experimental manipulations. The expected within - session decline found in previous studies using cue-exposure (Jansen, Broekmate, et al., 1992) and cue - exposure and response prevention techniques (Schmidt & Marks, 1989) with craving and urges to binge as the dependent variables, respectively, was not supported statistically in this study. During the treatment phase, responding to the potato chips was variable. The treatment phase analyses yielded a general decrease in reported craving over the course of the exposure trials, but differences among the experimental groups did not reach significance. Similarly, differences in craving for the chips from the pre- to posttreatment and post- to posttreatment trials were not reliable. Craving for the fruit increased in the posttreatment phase for all groups (this increase was greater for the females in the post hoc analyses) relative to pretreatment values. The increase, similar to the posttreatment increase in appeal, indicates that treatment effects did not negatively affect craving for the fruit and provides evidence for the stimulus - specific nature of this response as well.

One of the reasons why treatment effects did not emerge for the craving response, may be that the context associated with the intake of the food was not controlled in this design. Some cues, for example, the time of day, may have been correlated with the time that some of the subjects would have eaten potato chips whereas it might have been totally unrelated for others. Prior research has shown that the magnitude of reported craving depends on both the contextual stimuli associated the intake of the substance and the sensory properties of the food (Jansen, 1990; Wardle, 1990). This finding is further supported by the fact that superior results have been observed when cue - exposure therapy was conducted in the client's home environment rather than the laboratory (Jansen, 1990; Jansen, Broekmate, et al., 1992; Jansen, van den Hout, et al., 1989).

A second consideration is that a discrete - trial procedure was not used within a single session when craving was assessed over time in the clinical studies cited (Jansen, 1990; Jansen, Broekmate et al., 1992; Jansen et al., 1989; Schmidt & Marks, 1989). The trial - intertrial interval may have played a role in maintaining the reported craving level. With respect to the reduced-level-of-reinforcement group, the chip reinforcers that were administered after each trial during the treatment phase may have had a "priming" effect on the exposure trial following it and contributed to its survival. Prior research with alcoholics showed that for the severely dependent drinkers, the speed of drinking alcohol, used as a behavioral correlate of craving, was significantly greater when the subjects had received a high priming dose of the alcohol as opposed to a low dose or when no alcohol was consumed prior to testing (Hodgson, Rankin & Stockwell, 1979). Additional support for a priming hypothesis for the chips is found in drug - related studies (de Wit & Stewart, 1981). In these experiments, rats were trained to self - administer doses of cocaine and then underwent extinction until responding ceased. The animals were subsequently given priming doses of cocaine or drugs with similar properties under extended extinction conditions. The analyses showed that responding for cocaine was reinstated in the extended extinction condition after the priming doses were given. The drugs used in this study were stimulants and were not known to have associated withdrawal effects. In related research, similar results were found when heroin was used, suggesting that drug - seeking behavior, an operant response may be related to the positive reinforcing properties of the drug rather than an outcome of a conditioned withdrawal effect (de Wit & Stewart, 1983).

Relative to craving, appeal was more sensitive to the treatment effects. It is conceivable, that environmental factors may have had a greater impact on craving than on appeal because of the way appeal and craving were defined in the study. In judging appeal for the test items, the participants were explicitly instructed not to consider contextual cues associated with the food and to concentrate on the visual and olfactory properties of the item presented. Although there was no way to insure that the participants' thoughts remained focused as instructed, it is interesting that reported appeal for the chips decreased in the posttreatment phase from the pretreatment value (BC): approaching significance on Trial AC1 and reliably on Trial AC2 for the extinction, extinction-with-rinse, and reduced-level-of-reinforcement groups; and on both Trials AC1 and AC2 for the extinction group in the post hoc analyses.

Although not anticipated prior to this experiment, gender differences emerged with respect to all the dependent measures: (a) The analyses showed that the salivary responses decreased linearly during the treatment phase for the male participants of the extinction-with-rinse group who received the unreinforced exposure to the potato chips; (b) Both male and female participants reported an increase in hunger in the presence of the fruit on the posttreatment trial, except that female increases were significantly larger, and females of the pencil shavings group showed reliable increases in hunger during the treatment phase; (c) When the analyses were restricted to the extinction and pencil shavings groups, pre- to posttreatment changes in reported craving for the fruit were significantly greater for females on the posttreatment trial; (d) The analyses of pretreatment differences, showed that male participants salivated more in response to both food items and found the fruit more appealing than the females; and (e) The salivary response to the potato chips reliably decreased after the introduction of the fruit in the posttreatment phase for the male participants in the pencil shavings group.

The presence of the gender effects do not compromise the validity of the hypothesis tested in this study. Pretreatment differences between males and females did not have a differential impact on the posttreatment results; and differences in hunger between the genders during the treatment phase, were one of degree and not of direction. In view of the possible role of typical consumption, it is not surprising that there were no reliable pretreatment differences between male and female responses to the pencil shavings. All of the participants described themselves as junk - food eaters who liked potato chips but also enjoyed and ate fruit. Preference and frequency of eating were assessed as part of the subject - selection process; however, the amount of these food items usually eaten at one sitting was not recorded. Response strength may have been related to typical consumption and in this way, account for the gender differences. A comparison between food items in the pretreatment phase showed that the responses obtained on the dependent measures were greater for the potato chips. As previously hypothesized, the relative difference in the response strength may reflect the amount typically ingested and / or that baseline values differ for different food items. Because potato chips were given the superior ratings on the self - report measures, it is unlikely that value judgments were affected by differences in nutritional merit.

Pearson's coefficients indicated that salivation was not a linear correlate of hunger, appeal or craving based on the pretreatment values. This finding agrees with previous research that found anticipatory salivation to food was not significantly related to subjective reports of hunger (Jansen, Boon, Nauta, et al., 1992). However, stronger relationships have emerged for measures of salivation and craving in alcoholics. Pomerleau, Fertig, Baker & Cooney (1983) found significant correlations between the frequency of swallows and reported craving for alcoholics who were asked to sniff alcohol at predetermined rates. This finding is relevant because swallowing rates and salivation levels were found to be positively correlated in prior testing with another sample of alcoholics under comparable conditions. In related alcohol research, enjoyment and craving were correlated in the presence of the sensory properties of the alcohol. Although salivation was not significantly correlated to the psychological measures, it proved to be a reliable indicator of consumption and frequency of alcohol intake during a three month post detoxification period (Rohsenow, Monti, Abrams, & Rubonis, 1992).

Concluding remarks. The effect of cue-exposure manipulations on salivation, hunger, appeal and craving responses to food was evaluated and the results showed that anticipatory salivation and reported appeal measured in response to the potato chips were affected by the extinction procedures. Of these two measures, anticipatory salivation proved to be more sensitive to the cue- exposure manipulations than appeal as judged by the treatment effects. The decrease in salivation demonstrated by the extinction and extinction-with-rinse groups in the posttreatment phase is consistent with an associative analysis based on the following assumptions: (a) Prior to the cue - exposure manipulations, the sensory properties of the potato chips served collectively as a CS and were reliable predictors of the stimulus effects received from the eating the potato chips, the US; (b) Anticipatory salivation was conditioned to the CS as a result of these established CS - US relationships in the past; (c) The decrease in salivation in response to the potato chips found on the posttreatment trials reflects the weakening of the conditioned salivary response expected to follow extinction trials when the CS is no longer a reliable predictor of the US.

The design used in this study provided an opportunity to look at stimulus - specificity effects. If cue- exposure effects were nonspecific, then responding to the fruit in the posttreatment phase would have been lower for those groups who received the repeated exposure to the potato chips during the treatment phase. Apart from an overall pre- to posttreatment increase obtained on all the dependent measures on the posttreatment trial in response to fruit, the failure to find differential effects among the treatment groups provides empirical support for the stimulus - specific nature of the salivary (Epstein, Cagguila, et al., 1993; Epstein, Mitchell, et al., 1993; Epstein, Rodefer, et al., 1992) and self - reported hedonic (Epstein, Cagguila, et al., 1993; Epstein, Mitchell, et al., 1993; Epstein, Rodefer, et al, 1992 ; Jansen, 1990; Jansen, Boon, et al, 1992; Jansen, Broekmate, et al, 1992; Jansen, van den Hout, et al, 1989; Rolls, Rolls & Rowe, 1983; Rolls, Rowe, Rolls, et al., 1980; Rolls, Rowe & Rolls, 1982;) responses to food described in prior research.

The functional relationship between salivation and craving remains unclear. Salivary and craving responses were not similarly affected by the experimental manipulations in this study, a finding that has interesting theoretical implications supporting a modulatory account of conditioned responding as described by Wagner and Brandon (1989). Consistent with Konorski's (1967) distinction between consummatory and preparatory responses, it would be expected that anticipatory salivation would have a less protracted course than one would expect for craving, presuming that craving can be inferred from the preparatory responses. While much of Siegel's

(1978, 1983, 1988; Siegel, et al. 1987) research is devoted to the understanding of the development of conditioned compensatory responses that oppose unconditioned drug effects, the feedforward capability of these responses is compatible with the findings in this study. In this view, both conditioned salivation and craving responses can be understood as serving preparatory functions: salivation, to facilitate the food entry; craving, the expression of biological responses (e.g., insulin release) that serve to compensate for the expected increase in glucose associated with food intake. On the other hand, Stewart, de Wit & Eikelboom's (1984) account of drug use based on appetitive motivational states is without recourse to the development of compensatory responses. This theory would meet two of the challenges facing an addiction analogy for binge eating: the development of tolerance to food and the presence of withdrawal states in its absence. Regardless of the nature of the motivational states that are elicited by the conditioned stimuli, the foregoing models are all consistent with a modulatory view of the development of conditioned responses and provide a role for Pavlovian mechanisms.

The importance of understanding the development of craving is its presumed status as a motivational state and its relationship to future consumption of the desired substance. The modulatory effect of affective states on operant behavior has been reported (Rescorla & Lolordo, 1965; Rescorla & Solomon, 1967); however, in a review of alcohol and drug studies, Baker, Morse & Sherman (1987) cautioned that human research that focuses on the behavioral correlate of drug craving, drug acquisition, may be misleading. Drug - seeking may be affected by outside controls (e.g., finances, opportunity) and for this reason craving may be more relevant to the understanding of addictive behavior than drug use itself. The effect of the cue - exposure manipulations on food intake was not measured in this study because the experimental sessions lasted approximately two hours and most students were unable to remain any longer. Given these time constraints reliable measures of food intake could not be obtained.

It is conceivable that appetitive emotional states would be elicited in the presence of the sensory properties of preferred food; however, the precise way in which conditioned responses develop and influence behavior remains a question. This knowledge is essential to the development of effective behavioral approaches for the treatment of eating disorders. The increasingly complex characteristics of contemporary models reflect the difficulty researchers are having in developing theories that account for the variable nature of conditioned responses. In order to better understand the role of associative mechanisms in the development of the physiological and affective responses to food and subsequent eating behavior, future research should:

1. Include contextual variables among the stimulus - control factors involved in the eating behavior under study and systematically vary each to assess their relative contribution to the behavior .

2. Use Pavlovian paradigms, in addition to extinction procedures, to apply empirical challenges to the CS - US relationships in eating behavior to evaluate the physiological and affective responses that are assumed to modulate the behavior.

3. Extend the number of cue - exposure trials per session to see if treatment effects are stronger with additional trials.

4. Investigate the relationship between the amount of food consumed, the strength of the salivary response and the self - reported affective states to see if the salivary response is a valid predictor of food consumption and to determine its usefulness as a correlate of subjective measures.

5. Study the effect of cue - exposure manipulations on additional food items to see if the effects demonstrated in this study generalize to other food.

Appendix A

Test

Please place the appropriate number in the space which best applies to the numbered statement:
5 = Always
4 = Very often
3 = Often
2 = Sometimes
1 = Rarely
0 = Never
All of the results will be strictly confidential. Most of the questions relate to food or eating, although other types of questions have been included. Please answer each question carefully. Thank you.

1. I like eating with other people. ______
2. I prepare food for others, but I do not eat what I cook. ______
3. I become anxious prior to eating. ______
4. I am terrified about being overweight. ______
5. I avoid eating when I am hungry. ______
6. I find myself preoccupied with food. ______
7. I have gone on eating binges where I feel that I may not be able to stop. ______
8. I cut my food in small pieces. ______
9. I am aware of the caloric content of the foods that I eat. ______
10. I particularly avoid food with a high carbohydrate content (e.g., bread, potatoes, rice, etc.) ______
11. I feel Bloated after meals. ______
12. I feel that others would prefer if I ate more. ______
13. I vomit after I have eaten. ______
14. I feel extremely guilty after eating. ______
15. I am preoccupied with a desire to be thinner. ______
16. I exercise strenuously to burn off calories. ______
17. I weigh myself several times a day. ______
18. I like my clothes to fit tightly. ______
19. I enjoy eating meat. ______
20. I wake up early in the morning. ______
21. I eat the same foods day after day. ______
22. I think about burning up calories when I exercise. ______
23. I have regular menstrual cycles. ______
24. Other people think that I am too thin. ______
25. I am preoccupied with the thought of having fat on my body. ______
26. I take longer than others to eat my meals. ______
27. I enjoy eating meals at restaurants. ______
28. I take laxatives. ______
29. I avoid foods with sugar in them. ______
30. I eat diet foods. ______
31. I feel that food controls my life. ______
32. I display self control around food. ______
33. I feel that others pressure me to eat. ______
34. I give too much time and thought to food. ______
35. I suffer from constipation. ______
36. I feel uncomfortable after eating sweets. ______
37. I engage in dieting behavior. ______
38. I like my stomach to be empty. ______
39. I enjoy trying rich, new foods. ______
40. I have the impulse to vomit after meals. ______

Appendix B

Pencil Shavings

Group	Sex	Age	BMI	EAT Score	FP	FF	PCP	PCF
1	M	18	22.15	7	8	1	7	1
2	M	26	22.43	6	10	3	8	3
3	F	21	21.11	9	8	1	9	1
4	F	25	18.19	9	8	1	8	1
5	F	31	23.05	13	7	3	7	1
6	M	19	36.05	13	8	1	10	7
7	F	33	23.86	18	8	1	7	1
8	M	17	22.38	3	10	1	10	1
9	M	19	24.54	6	7	1	8	1
10	F	19	17.37	23	9	7	10	1

Extinction

Group	Sex	Age	BMI	EAT Score	FP	FF	PCP	PCF
1	F	17	18.89	4	10	4	7	3
2	F	23	31.09	12	10	3	7	7
3	M	26	25.56	10	7	3	7	3
4	M	28	27.20	24	7	1	7	3
5	F	21	20.51	24	10	7	8	2
6	F	20	20.25	5	8	1	8	1
7	M	19	25.77	5	7	2	7	1
8	M	31	24.94	0	10	1	7	2
9	F	21	20.09	6	10	1	9	1
10	M	18	29.13	2	10	1	10	1

Reduced Level of Reinforcement

Group	Sex	Age	BMI	EAT Score	FP	FF	PCP	PCF
1	F	19	19.14	15	10	1	8	2
2	F	20	20.55	5	7	1	7	1
3	F	21	23.78	12	10	1	8	1
4	F	19	17.97	11	10	3	7	3
5	M	19	17.97	11	9	1	7	1
6	M	20	23.24	20	8	1	9	3
7	M	20	22.24	5	10	1	10	1
8	M	22	25.09	6	9	7	8	3
9	F	25	23.30	14	8	1	8	1
10	M	18	24.31	10	8	1	8	1

Extinction with Rinse

Group	Sex	Age	BMI	EAT Score	FP	FF	PCP	PCF
1	F	20	18.89	7	7	7	7	3
2	F	19	22.67	10	7	1	7	3
3	F	21	21.03	27	7	1	9	1
4	F	18	18.60	8	7	2	7	1
5	M	26	22.15	2	9	2	9	2
6	M	19	22.18	8	7	1	8	1
7	M	18	25.11	13	9	7	8	2
8	F	21	22.40	9	8	3	8	3
9	M	18	27.32	6	7	1	8	1
10	M	23	26.09	7	10	3	8	2

FP=Fruit Preference
PCP=Potato Chip Preference
PCF=Potato Chip Frequency
FF=Fruit Frequency

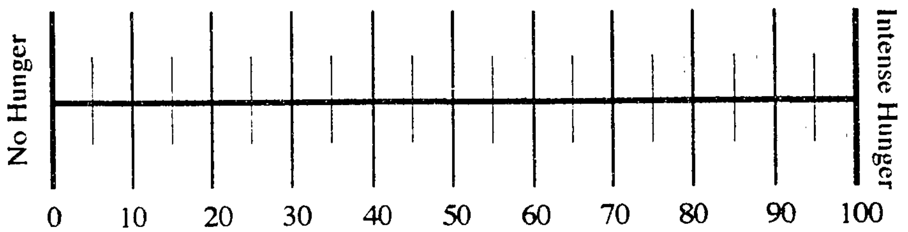
Appendix C

Name:____________________ **Date:**____________

Trial Number:____________________

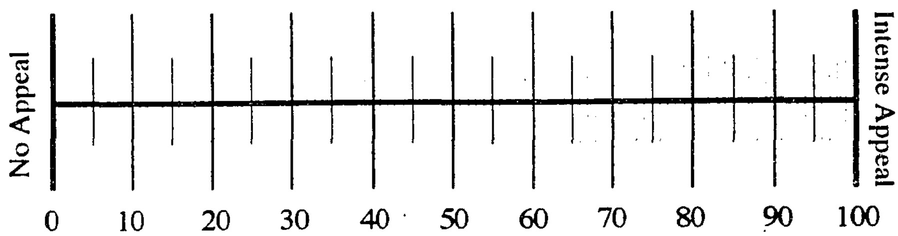
Please note on the appropriate chart the degree of hunger, appeal or craving. 0 represents none; 100 represents intense. Mark your reaction on the chart and enter the numerical score in the space provided to the right of the chart.

Hunger



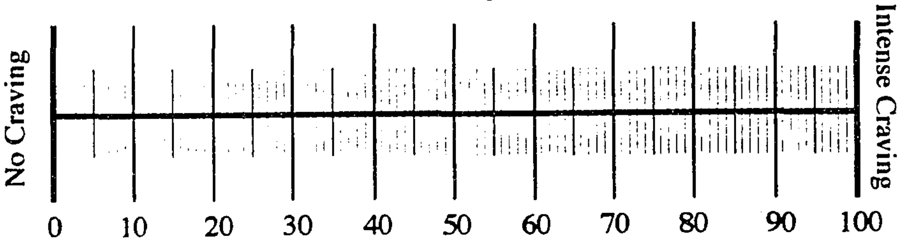
____
Numerical Score

Appeal



____
Numerical Score

Craving



____
Numerical Score

Appendix D

Intercorrelations Between Responses to each Food Item in the Pretreatment Phase

Pearson r Coefficients were obtained using values averaged over the first two exposure trials obtained on each dependent measure in response to fruit (BF), and to potato chips (BC) in the pretreatment phase.

Fruit

Correlations :	Salivation	Hunger	Appeal	Craving
Salivation	--	-.0034	.1657	.1597
Hunger		--	.6359 **	.6874 **
Appeal			--	.7315 **
Craving				--

Potato chips

Correlations :	Salivation	Hunger	Appeal	Craving
Salivation	--	-.1461	.1128	.1067
Hunger		--	.6598 **	.7228 **
Appeal			--	.8283 **
Craving				--

Number of cases = 40

** 1 - tailed significance: .001

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