INSTRUCTIONAL CONTROL OF VASOMOTOR RESPONDING :

A TEST OF CONDITIONING, TWO PROCESS,

AND EXPECTANCY THEORIES.

by

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STATEMENT OF SOURCES

This thesis describes original research undertaken in the department of psychology, University of Tasmania. To my best knowledge and belief, the thesis includes no material previously published or written by another person, except where due reference is made in the text of the thesis.

A. Egl

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ABSTRACT

For many years there has been a debate between proponents of competing learning theories over the role of expectancy in conditioning and extinction. Although this debate has been the subject of an intensive experimental literature, it has not been satisfactorily resolved. Many research designs are intrinsically incapable of dissociating the influence of expectancy from other factors held to be important by competing theories. However, the informed unpairing design (Brewer, 1974), in which subjects are informed of changed contingencies at the onset of extinction, is argued to provide a powerful test of expectancy, two factor, and conditioning theories. It is also argued that the bidirectional vasomotor response provides a solution to the related problems of expectancy manipulation and artifact control that confound previous research using this design .

A programme of research based on the informed unpairing design, and using the vasomotor response, was undertaken. Responding in extinction following several expectancy manipulation procedures was compared in subjects given 25 continuously reinforced acquisition trials (CRF25); 100 continuously reinforced trials (CRF100); and 100 partially reinforced trials (PRF). It was found that responding in CRF25 and PRF groups in extinction was abolished by unpairing instructions coupled with removal of the thermal stimulator used for UCS presentation. A significant reduction in responding in CRF25 and PRF groups was also obtained following unpairing instruction alone as compared with groups given no instruction. The CRF25 group instructed at the onset of extinction that they would

be reinforced on a PRF schedule showed a non significant trend for greater resistance to extinction than those given no instruction. These results provide strong support for an expectancy based, rather than two factor or conditioning based, explanation of responding in these groups.

However, no effects of expectancy manipulation on responding in extinction were obtained in CRF100 groups, and attempts to generate responding in two groups by instruction alone proved unsuccessful. These results are consistent with the hypothesis that there may be two conditioning processes; one expectancy dependent and the other expectancy independent. Existing learning theories based on two conditioning processes are unable to account for all of the results of the present research. However, it is argued that the results of the present study are consistent with a number of studies in the skill learning literature. Models proposed to account for skill learning which distinguish between processes involved in acquisition and early performance, and those involved in much practised responding, provide a possible explanation for the obtained results. Consequences of the research for the behaviour therapies are discussed.

INTRODUCTION

1.1 GENERAL INTRODUCTION

In the early decades of this century there was a major controversy over the role of cognition in determining behaviour. This controversy appeared to be resolved in favour of the behaviourist movement which dominated psychological argument in the 1940's. For a time it appeared that the behaviourist movement represented a clearly defined and universally accepted body of data, on which a set of strictly empirical principles were based. Even until recently it was commonly believed that this was so (e.g., Maher, 1972). What is not so commonly recognised is the controversial and speculative nature of many of the non trivial behaviour principles, including those relevant to the role of cognition. In the past few years there has been evidence in the psychological literature of a growing awareness that many of these old controversies were never satisfactorily resolved. Even the most basic principles of major learning theories are again the subject of intense scrutiny (e.g., Bolles, 1972; Brewer, 1974).

The first sections of this thesis (1.1 and 1.2) outline a range of traditional and modern views on the role of cognition in the acquisition and extinction of behaviour. Section 1.3 reviews the evidence concerning these views. In sections 1.3.1 and 1.3.2 the role of contingency learning in conditioning and extinction is examined. Section 1.3.3 considers whether expectancy is sufficient to account for conditioning and extinction by examining the evidence for learning without conditioning trials; extinction without extinction trials; the issue of whether extinction is complete following expectancy manipulation by unpairing instructions; alternative explanations for expectancy manipulation effects such as changes in anxiety or arousal; and the possibility that certain acquisition procedures may lead to responding that is less susceptible to instructional manipulation than others.

In this section it is argued that responding at the onset of extinction provides an unusually clear opportunity for testing major predictions of competing theories, and that the informed unpairing procedure in which subjects are informed of the onset of extinction, provides a powerful means for testing between these predictions. Section 1.4 considers the difficulties of expectancy manipulation and artifact control associated with this procedure and section 1.5 proposes solutions to these difficulties which will be employed in the experiments outlined in subsequent sections.

1.2 A BRIEF SURVEY OF THEORETICAL POSITIONS

1.2.1 Historical views on the role of cognition in acquisition and extinction

Although a great many theories of learning have been proposed, most have customarily been categorised as 'conditioning' theories, 'expectancy' theories, and 'two factor' or 'two process' theories.

1.2.1(a) Conditioning theory

Like other theories, those traditionally labelled as 'conditioning theories' (e.g., Hull, 1952; Skinner, 1969; Spence, 1948; Guthrie, 1952) attempt to explain incompletely understood phenomena by proposing a series of hypotheses, some explicitly stated and others implicit in the theory. The basic assumption shared by conditioning theories is that learning is due to the operation of predictable automatic processes, and that therefore a consideration of cognitive events is unnecessary in explaining behaviour. Some theorists, such as Hull (1952), pointedly avoid the use of terms related to cognition. Hull's concepts of drive, habit strength, inhibition and excitation are conceptually tied to hypothetical physiological mechanisms, and are intended to provide a complete explanation of conditioning processes. Although such concepts have been argued to be descriptive intervening variables rather than hypothetical constructs (Hilgard, 1948), the system as a whole takes the theoretical position that behaviour is the result of automatic physiological activity, and may be explained solely in terms of these concepts. Hull did consider the issue of anticipation, or expectation of reward. However, it was in a characteristically mathematical way, and referred only to the change in motivation brought about by reward and nonreward of a previously consistently rewarded response.

Others, such as Amsel (1962) and Spence (1966), have developed concepts such as anticipatory frustration further within a Hullian context, but still deal with these potentially cognitive concepts in a strictly non cognitive manner: Anticipatory frustration, like other fractional anticipatory responses, is simply the result of higher order conditioning and generalisation of secondary nonreward. As such it follows behavioural laws in a manner that is entirely explainable without consideration of cognition (Amsel, 1962; Spence, 1966). According to Hull, stimuli become bonded to an associated response when reinforcement in the presence of that stimulus follows the response. Whenever the animal is motivated by that drive, it is likely to give the appropriate response in the presence of the stimulus. However, inhibition resulting from non reinforcement will lead to the eventual extinction of the response (Hull, 1952).

Some contemporaries of Hull felt that the system would need to be extended to account for more complex behaviour. Spence (1948), for example, argued that "... in dealing with the more complex types of animal and human behaviour, implicit emotional responses, covert verbal responses, and not easily observable receptor-exposure and postural adjustments will have to be postulated..." These difficulties were recognised by early experimenters. In the absence of an understanding of these more complex processes, a number of strategies were designed to reduce the influence of cognition in conditioning experiments (e.g., Grant, 1939; Hilgard, Campbell & Sears, 1938). The utility of this approach must therefore be determined in terms of its ability to deal with behaviour in relatively simple traditional experimental conditioning paradigms, from which the theory was derived, and also in terms of the generality of the laws obtained.

In contrast to Hullian theorists, Skinner (1969) has dealt directly with the role of cognition. He argues that cognition is simply one possible component of learning, and that internal cognitive events do not in themselves determine behaviour. Skinner proposes that awareness of contingencies is not a necessary precondition for learning, that such awareness is learned, and that awareness results both from an analysis of our own contingency appropriate behaviour, and from environmental reinforcement for discriminating and verbalising certain sorts of contingencies (Skinner, 1969). Thus, awareness of contingencies is one possible result of learning to respond appropriately, rather than a mediator or determinant of learning. Although Skinner does consider the possibility of instructional effects on behaviour and the possibility that cognitive expectancies may influence behaviour (e.g., Skinner, 1969), these issues have not been dealt with formally, and remain outside his behaviour system.

Both Hullian and Skinnerian approaches have in common the attempt to account for behaviour without resort to cognitive mediation. While this avoidance of internal processes leads to the appearance that these theories are somehow more empirically based than theories that do refer to cognitive mediation, it should be recognised that this very avoidance of cognition is derived from the theoretical proposition that behaviour may be explained without recourse to internal congitive events. The attractive simplicity and objective nature of the conditioning theories is due to the initial intention to account for behaviour without resort to mediating mechanisms. Whether behaviour is adequately explained by these theories is an empirical question that will be dealt with in later sections.

1.2.1.(b) Expectancy Theory

Learning theories which have emphasised cognition have typically focused on expectancy of reinforcement or awareness of environmental contingencies as the outcome of the presumed cognitive processes rather than upon the processes themselves. Tolman, traditionally the most influential of expectancy theorists, argues for a highly cognitive analysis of behaviour. Instead of conceiving of animals as pre-programmed 'black boxes', Tolman argues that "behaviour reeks of purpose and cognition" (Tolman, 1959). For Tolman, the basis of learning is the acquisition of 'expectancies' rather than the attachment of responses to stimuli. These expectancies relate events in the environment to one another, and are learned by experience . While Tolman agrees with other theorists that learning is influenced by factors such as frequency, magnitude and delay of reinforcement, he specifically denies that learning consists in the stamping of S-R habits by reinforcement (Tolman, 1949). For Tolman, the animal in a conditioning experiment is learning *about* the environment, and acts purposefully to solve environmental problems. Accordingly, S-R and S-S scheduling parameter effects are due to differences in the informational value of stimuli to the organism, rather than to differences in the acquired reinforcing value of the stimulus.

Tolman's theory has been described as 'an explicit statement of "ordinary common sense"'(White, 1943), and has frequently been criticised as imprecise, a point eventually acknowledged by Tolman himself (1959). For most of his career, Tolman attempted to define his constructs in terms of behaviour, and did so in such a way as to leave unclear just how cognitive he intended them to be (e.g., Tolman & Kalish, 1946). However, he later described his constructs as "...merely an aid to thinking...", "...common sense notions ... seem for the most part to suffice and to allow for adequate objectivity and communication" (Tolman, 1949). However, his theory should not be thought of as a woolly and ill-defined version of conditioning theory. Tolman's admittedly vague approach is importantly and testably different to conditioning theory approaches, and has led to a number of important experimental controversies. For Tolman, contingency learning (leading to the acquisition of expectancies), in conjunction with motivation, is necessary and sufficient to account for behaviour, while for conditioning theorists contingency learning in this cognitive sense is irrelevant to behaviour. Although Tolman makes similar predictions to conditioning theorists in some circumstances (though perhaps with less precision than some others), in others Tolman's theory leads to markedly different predictions.

This is especially so if Tolman is interpreted according to the common language meaning of his terms, as he advocated in 1959. Although Tolman argued at various times that he was strictly a behaviourist, and suggested that Hullian concepts may be useful in explaining certain forms of learning (Tolman, 1949), it is the strictly cognitive version of Tolman that has been most influential, and it is in this way that most modern expectancy theorists interpret Tolman (e.g., Atkinson & Wickens, 1971; Estes, 1971; Bindra, 1972, 1974; Bolles, 1972; Brewer, 1974; Smith, 1974). Accordingly, 'expectancy theory' in this thesis will refer to the strictly cognitive interpretations of Tolman proposed by White (1943) and by Tolman himself (1959).

The basic contention of this approach is that experience with the environment leads to behaviour change through the formation of expectancies concerning environmental contingencies, rather than through the formation of S-S and S-R bonds. Further, since animals behave in accord with the expectancies they hold concerning contingencies, rather than in accord with actual contingencies, those procedures which influence expectancy will influence behaviour, while those which have no influence on expectancy will have no influence on behaviour. Thus, expectancy theory explicitly argues that it is information concerning contingencies, rather than previously experienced contiguity or reinforcement (though the latter frequently leads to the former) that is the determinant of behaviour and behaviour change.

1.2.1(c) Two factor or two process theories

A number of theorists have tried to integrate the more successful aspects of conditioning and expectancy theories into two factor or two process theories. The most influential of these was Mowrer (1950). Mowrer argues that there are two factors important in conditioning. Stimuli acquire reinforcing value through classical associationism, while responses are not conditioned in this way; they are simply a means of solving environmental problems. Although he uses apparently cognitive terms such as 'expectancy', he argues that these represent conditioned emotional or arousal states. A rat that 'expects' shock following a tone is simply one that has acquired autonomic responses to the tone following pairing of the tone and shock. Mowrer (1950) shows considerable sympathy for the view of Humphreys (1939), that "conditioned responses are a consequence of anticipated reinforcement, extinction a consequence of anticipated non reinforcement, and that the role of frequency in the repetition of reinforcement and non reinforcement is by way of its influence on the subjects' expectation of the stimuli which are to appear". However, he preferred his own restatement of this, which avoids the (to him) questionable terms 'anticipated' and 'expectation'; "if during acquisition, a response (conceived as a more or less isolated movement) occurs frequently but is rewarded only now and then, the transition from acquisition to extinction will not be discriminated as sharply as if acquisition has involved reward for each and every response. With "faith" thus established that failure will ultimately be followed by success, "discouragement" is slower to set in..." While "faith" and "discouragement" are not defined, they are intended to refer to emotions that have the direct effect of energising or inhibiting behaviour, rather than to cognition concerning contingencies (Mowrer, 1950).

The second conditioning factor of 'problem solving', which determines the response made by the animal in response to external events and consequent internal emotional states, is less clearly argued. It would appear that Mowrer intended this factor to be based on Thorndikian reward learning (Mowrer, 1956), with no additional cognitive concepts. Thus, despite his use of terms relating in everyday language to cognition, Mowrer was proposing an integration of Pavlovian contiguity learning (to account for the acquisition of emotional responses) and Thorndikian reward learning (to account for modifications in behaviour).

1.2.2 Current views on the role of cognition in acquisition and extinction

Grand behaviour systems in the Hullian tradition are now less fashionable than they were, and modern theorists have tended to restrict themselves to a consideration of more limited areas of interest, without attempting to account for the whole of the behavioural spectrum. The models and theories outlined below represent a range of recent views on the role of expectancy in learning and performance. Only those theories that deal with the role of expectancy, either by explicitly including it as an irreducible process or by attempting to account for it by postulating hypothetical mechanisms, have been reviewed. Recent models dealing with other aspects of the conditioning process (e.g., Rescorla & Wagner, 1972; Frey & Sears, 1978) are not included in this review.

1.2.2(a) Bolles

Bolles (1972) proposed a cognitive expectancy based theory of learning. Although similar in many ways to that of Tolman (1959), Bolles' theory is rather more clearly stated, and deals with some phenomena not considered by Tolman. According to Bolles, animals acquire expectancies concerning relationships both between stimuli in the environment, and between responses and stimuli. These two forms of expectancy combine to produce behaviour in the presence of certain stimuli. Some expectancies may be innate, and may lead to species specific responses that may be so potent as to prevent incompatible responses from being shaped by environmental contingencies, or may lead to intruding behaviour (freezing, face washing, etc.) in the presence of a stimulus that signals an expectancy of delayed reinforcement (Seligman, 1970). Other expectancies are learned, though the processes involved in this learning are not described. However, Bolles does say that "I would deny that a direct associative linkage between a stimulus and a response is an important or interesting part of what is learned in most learning experiments". He goes on to suggest that such a process does occur, but only to a significant extent with innate, or much repeated behaviour: "But perhaps sheer repetition of a response as a consequence of the law of performance suffices to connect it with prevailing stimuli. Certainly there is little *a priori* reason to expect such behaviour to be governed by the same laws or to depend on the same neural mechanisms as those involved in the laws of learning, performance, and motivation that have just been proposed."

However, quite what Bolles is proposing for expectancy learning processes, and the relationship between expectancy and behaviour is unclear. It would appear that Bolles' interpretation and usage of the term "expectancy" is rather similar to that of Tolman, as he also uses the term in its common language meaning: "The linguistic rules for using 'expectancy' are essentially those of the everyday language. Thus, it seems proper to refer to the animal in a particular situation as 'expecting' a particular outcome."

The relationship between expectancy and behaviour implied by Bolles is also reminiscent of Tolman: "The present account of learning maintains that if an animal is placed in a situation where there are cues predicting food and food is made contingent upon some response, the animal will learn, first, that these cues predict food, and second, that its behaviour produces food. If it is hungry, then the animal is likely to make that response" (1972). This is an explicit statement that contingency learning is a necessary precondition for conditioning, and it is implied that contingency learning is also a sufficient condition for conditioning and extinction: "The rat has a learned S-S* expectancy, cues predict shock, and an innate R-S* expectancy, running away predicts safety. The animal therefore runs away."

Like Tolman, Bolles may be interpreted as saying that an animal will act in accordance with its perception of environmental contingencies in order to obtain rewards and avoid punishments. Conditioning procedures have their effect by informing the subject of contingencies: "If the R-S* expectancy is learned, then the reinforcement contingency will provide effective control over the behaviour, but not otherwise." Bolles admits the incomplete nature of the theory, attributing this to the complexity of the subject matter. As it stands, we are forced to make predictions from the theory on the basis of an "everyday language " interpretation of the nature of expectancy.

Several other theorists (e.g., Smith, 1974; Gray, 1975; Bindra, 1974) have proposed expectancy based theories to retain the general usefulness of the expectancy approach, but have tied the concept of expectancy down very closely, giving it a more exact and mechanistic meaning than that used by Tolman and Bolles, in an attempt to avoid the usual difficulties of imprecision and inaccessibility of concepts common to traditional expectancy theories.

1.2.2(b) Bindra

Bindra (1974) proposes a model in which organismic state factors and certain environmental stimuli interact to produce a central motivational state, which in turn directs behaviour toward (or away from, in the case of aversive motivation) the goal object. The process involved in this directing of behaviour is somewhat complex. Both organismic state factors (e.g., hunger) and distal representations of the goal object interact to excite a central representation of the goal object, which in turn activates the sensory motor co-ordinations developed through maturation and learning that lead to approach and consumption. This approach and consummatory behaviour is not a pre-programmed set of motor acts, but instead a chain of responses given to environmental stimuli that are potent: "according to the present model, the central motive state is generated directly by organismic-state and incentive variables, and, once generated, 'feeds forward' to make certain particular environmental stimuli so potent that the animal must act in relation to them rather than in relation to any other stimuli."

This potency of environmental stimuli is learned by observation of contingent events in the environment, and what is learned is the nature of that contingency; the organism learns that a particular stimulus (SI) is followed, for a period, by an increased or decreased probability of a second stimulus (S2). This contingency learning leads to the development of central representations of the environmental contingencies. These central representations act by exciting or inhibiting central representations of S2 when in the presence of S1 when the contingency is positive or negative respectively. The degree of excitation involved reflects what Bindra refers to as expectancy: "the greater the contingent increase in the probability of S2 predicted by S1, the greater will be the (positive) expectancy or the conditioned excitation of the central representation of S2; the greater the contingent decrease in the probability of S2 predicted by S1, the greater will be the (negative) expectancy or the conditioned inhibition of the central representation of S2."

Contingency learning takes place by observation rather than by reinforcement, and learning is only concerned with relationships between stimuli, not between stimuli and responses. Accordingly, a rat learning to run for food in a runway learns a chain of environmental stimuli, each associated via central representations with the next and eventually to the food itself. The instrumental response of approach given to each stimulus is a general class of response given to all appetitive stimuli, and in each case approach toward the intermediate environmental stimuli is replaced by approach toward the next in sequence, which is more potent. Further, since each stimulus leads to a central representation of the next, and since the central representation itself may excite central representations of subsequent stimuli, the animal may learn to short circuit intermediate steps and approach the goal box directly.

Bindra specifically denies the possibility of response learning. More complex motor acts can only be learned by central representations of response produced stimuli (presumably including kinesthetic stimuli) becoming associated with other stimuli in central representations of environmental contingencies: stimuli produced by a set of circumstances (including previous activity) lead to a central representation of other stimuli which are then "approached". When faced with a situation in which this chain of stimuli is broken, the animal must resort to exploratory behavior, but only after a period of extinction: "The response integration should eventually break down if the spatial layout of the critical conditioned and unconditioned stimuli were to be altered; for example, if the food were to be made available at another part of the runway."

This theory is markedly more mechanistic than those of Tolman or Bolles, and the concept of "expectancy" is given a very different meaning. It has the advantage of relating cognitive events more directly to behaviour than is the case in either of these other theories, but at the same time suggests a simpler cognitive model.

Although Bindra suggests that stimuli have their effect on behaviour owing to their informational, rather than reinforcing value, it is suggested that stimuli are nevertheless tied directly to other stimuli and directly influence behaviour.

1.2.2(c) Razran

Razran (1955) proposed a theory involving two alternative conditioning processes: conditioning and relational learning. Conditioning refers to association by contiguity alone, and takes place in lower animals that lack the mental apparatus necessary for relational learning, and in all animals when perception of contingencies is prevented or not yet present. Relational learning applies to all other circumstances, and involves both conditioning and perception of contingencies, with the latter being dominant. However, "conditioning with perceived relationships is neither mere conditioning nor conditioning plus - but something else: it is relational or perceptual learning" (Razran, 1955). Relational learning operates wherever possible because of its greater efficiency, and, when it operates, it totally dominates the subordinate conditioning process. However, conditioning can take place without perception of contingencies, and contingency learning is not sufficient to account for conditioning: "Human subjects when they 'catch on' to the S-R relations in a C R experiment greatly modify thereby their conditioning, but do not as a rule wholly nullify it..." (Razran, 1955).

In developing his evolutionary view that certain forms of learning are possible only in animals of a given complexity, Razran set out five different levels of non cognitive learning (habituation, sensitisation, inhibitory conditioning, classical conditioning and reinforcement conditioning) and six different levels of cognitive learning (sensory-sensory learning, configuring, eductive learning, symbosemic thinking, sememic thinking, and logicemic thinking). Razran suggests that each of these levels is dominant over preceding levels, and that each requires specific capabilities (Razran, 1971). However, he has not developed hypotheses concerning the role of cognition in acquisition and extinction of conditioned responding that supersede the above statements of his earlier position.

1.2.2.(d) Gray

Gray (1975) proposed a two process theory in which stimuli serve both as information sources, and as classically conditioned reinforcers. He argues that reinforcements have their effect through a positive feedback mechanism (in which consummatory responses such as eating, drinking, sex, etc. serve initially to increase the strength of the command to continue eating) rather than through drive reduction. Reinforcers also, through a classical conditioning process, serve to imbue preceding stimuli with reinforcing value; properties of the unconditioned stimulus may pass to the conditioned stimulus. Although the informational value of stimuli is stressed, this issue is dealt with as a means of accounting for the fact that only some stimuli become conditioned: "Classical conditioning of an initially neutral stimulus which is predictive of the occurrence of an SR+, then, confers both reinforcing and motivational properties on the stimulus" (Gray, 1975).

Gray refers to the concept of expectancy as an important element of his feedback theory, postulating comparator systems that evaluate environmental effects in terms of expected effects. This concept is used to account for the fact that omission of an expected stimulus may lead to an OR, and for the inhibiting effects of reduced reward or nonreward on behaviour: "If the received level of reward is less than the expected level, there is (1) an input to that part of the system which is responsible for evaluating aversive UCSs (whether punishing or nonrewarding) and (2) in consequence an increment to the conditioned frustration properties of stimuli in the animal's environment ...." (Gray, 1975).

This version of expectancy is rather similar to that of Bindra, in that it provides a means of dealing with the effects of organism's past experience on present behaviour, but in a rigid connectionist manner, such that S1 leads to a representation of S2 (which in this case is compared with environmental stimuli, rather than leading directly to action). It is also like Bindra's theory in its stress on motivation of behaviour; both easily account for approach and avoidance behaviour, but are more cumbersome in their attempts to deal with more complex operant behaviour. Gray also uses the term "expectancy" in a closely defined, mechanistic manner. Unlike Bindra, Gray argues that stimuli, in addition to their informational value, acquire true reinforcing value through contingent association with other stimuli. This would suggest that information alone should be insufficient to lead to the abolition of conditioned responding.

1.2.2(e) Smith

Smith (1974) based his theory on operant rather than classical conditioning principles, unlike Bindra and Gray. Like Skinner (1969), Smith argues that cognition constitutes a set of covert responses, which are shaped by environmental contingencies. Cognitive responses are strengthened when they lead to reinforcement: "... if the environment or the organism's own thought processes imposed upon the organism a pairing of cognitive responses, and if that pairing were of a sort which had been useful in the past, there would arise a secondary reinforcement effect and a corresponding strengthening of the tendency for the one cognitive event subsequently to evoke the other."

Having learned these 'cognitive habits', the organism, when placed in a given situation, will emit a series of cognitive responses that typically outline a course of action. If this series ends with reinforcement, then the sequence is likely to be acted out, but if it ends with punishment it will be avoided. Accordingly, responses may be reinforced both by reinforcement following an overt act, and imagined reinforcement following an imagined act. As Smith points out, cognition gives rise to behaviour in a completely deterministic way, "...in accordance with ordinary principles of learning. The notion that there might be some sort of free decision, on the part of the organism, to 'use' its cognitive experience would be, in this framework, completely inappropriate." Expectancies are only learned when they are reinforced (observed contiguity of stimuli is insufficient in itself to lead to an expectancy). However, modelling effects could potentially be accounted for in terms of generalisation of previously reinforced modelled responses, and instructional control of behaviour could be dealt with in the same way. At least in the case of instructional control, this would require a considerable complexity of cognitive events (since a specific, novel set of instructions must somehow lead to a novel arrangement of overt responses).

It is not clear whether Smith meant his model to be mechanistic and simple, in which case it would not predict instructional control of behaviour; or whether he intended it to be sophisticated and flexible, in which case it needs to be considerably more closely defined. In fairness to Smith, the model is proposed as a possible starting point for development rather than a complete theory.

1.2.2(f) Dawson and Furedy

Dawson and Furedy (1976) propose a model in which contingency awareness is said to be either present or absent. A minimal level of awareness is a necessary precondition for human autonomic classical conditioning and extinction. Subjects without this 'threshold' level of awareness of conditioning or extinction contingencies will fail to show acquisition or extinction of behaviour respectively. However, it is explicitly argued that awareness of contingencies is not a sufficient condition for acquisition and extinction, and increments in awareness beyond the threshold are argued to be irrelevant to responding.

Cognition is therefore treated as an essentially passive activity, relevant only in that it allows, when present, conditioning processes to take place in a presumably mechanistic manner. Cognition allows conditioning and extinction to take place; it does not direct behaviour (cognition has a "gate" rather than an "analogue" effect on behaviour).

1.2.2.(g) Bridger and Mandel

Bridger and Mandel (1964, 1965; Mandel and Bridger, 1964, 1967, 1973; Bridger, 1964) have also argued for a two process theory of learning, but one in which neither learning process is dominant over the other. Instead of distinguishing between learning with and without perception of stimulus relationships, they base their two conditioning processes on Pavlov's first and second signalling systems (Pavlov, 1955). This distinction is rather similar to that of Razran, since the second signalling system relating to speech is available only to humans, and is said to be located in the neocortex. According to Bridger (1964), direct experience with conditioned and unconditioned stimuli activates both first and second signalling systems, while verbal instructions activates only the second signalling system. Since the first signalling system has a different neural base and different effects to the second signalling system, responding established by instruction will have different properties to responding established through direct experience with CS-UCS pairings. Further, responding established by instruction alone may be extinguished by instruction alone (since the first signalling system was never involved), while responding established by conventional conditioning trials will not be completely abolished by instruction (since instructions will have no effect on that component of responding established through the first signalling system).

Importantly, since the first signalling system involves limbic activity to a major extent, the strength of associations formed within this sytem will depend on the affective value of the UCS. The more emotionally charged the UCS, the greater the limbic system activity and therefore the greater relative involvement of first over the second signalling system. According to this hypothesis, the more emotionally charged the UCS, the less susceptible conditioned responding should be to instructional control.

This model leads to clearly testable hypotheses, most of which have been extensively researched. Evidence relating to their hypotheses concerning the effects of expectancy manipulation and contingency awareness on responding will be reviewed in the following sections.

1.2.3. Summary of theoretical positions

It will be evident that there is still considerable controversy over the role of cognition in conditioning and extinction. The basic historical positions of Hull and Tolman are still represented in current theories, with the additon of various intermediate positions. Although they also differ along other dimensions, current theories vary from the position that animals learn about the environment and act purposefully to obtain environmental goals (Bolles, 1972) to the position that animals learn associations between stimuli in an automatic and determinate manner, their behaviour being determined directly by these associations (Gray, 1975; Bindra, 1974). Although both extremes refer to the construct of "expectancy" as being central to their theories, the differences in the way that these expectancies operate are very great.

Several current theories refer to an expectancy as a link formed between two stimuli, and perhaps stimuli and behaviour, such that the occurrence of one leads to a central representation of the other. This reduced form of the term is quite different to the common language usage of Tolman and Bolles, who perceive the animal as learning about the contingencies operating in its enviroment; in the former case a central representation of B is evoked by the presence of A, while in the latter the animal has learned the relationship "if A then B". There are two major differences between these approaches. Firstly, the reduced usage is clearly more easily defined, and has the advantage of more direct prediction of behaviour. Secondly, the reduced approach at least allows, and possibly itself implies, the application of formal mathematical relationships to account for expectancy learning and the relationship between expectancy and behaviour. In this way expectancy may be treated as a reasonably simple intervening variable in behavioural formulae. In contrast, the common language interpretation does not lend itself easily to such analysis, and implies a qualitatively different approach to learning principles. This point is directly conceded by Bolles, and his defence is worth repeating; the more complex and ill defined common language interpretation of expectancy is required owing to the complexity of the subject matter.

In short, the 'reduced' conceptions of expectancy have the advantage of apparent rigour and parsimony, while the extended ones have the advantage of flexibility, breadth, and familiarity. The choice between them must be, as far as possible, an empirical one, although if they account for the evidence equally well the 'reduced' conceptions may legitimately be preferred on the grounds of parsimony.

The two kinds of conceptions may also seem to differ in the implied potential predictability of behaviour. Smith (1974) suggests this difference when he comments that "The notion that there might be some sort of free decision, on the part of the organism, to "use" its cognitive experience would be, in this framework, completely inappropriate." The implication might be taken that the more extended conception does provide such a framework, and that the use therefore of an extended conception of expectancy provides a warrant for considering behaviour to be indeterminate, non lawful and 'free'. This implication was expressly rejected by major expectancy theorists, and is also rejected in the present work. If it turns out on empirical grounds that expectancies must be invoked as irreducible processes (i.e., instead of being reduced to hypothetical associative linkages) in order to account for behaviour, the conclusion will merely be about what variables are needed for the prediction of behaviour. The fact would have no negative implication for the presumed lawfulness of behaviour. Indeed, if such turns out to be the case, it will be the more clearly mechanistic conceptions of expectancy that compromise the lawfulness of behaviour. They will retain their apparent rigour while sacrificing their claims to explanatory power, thereby leaving some aspects of behaviour inexplicable and mysterious.

Evidence relevant to the resolution of this issue is reviewed in section 1.3.

1.2.4 Terminological note

As will be obvious from preceding sections, there is considerable variance in the use of a number of key terms. Accordingly, an attempt will be made to reduce subsequent confusion by defining some of these terms as they will later be used in this thesis.

(i) Learning

Learning will be used in its most general sense to refer to a relatively permanent change in behaviour as a result of experience.

(ii) Contingency learning

Contingency learning refers to learning *that* one event is followed by an increased or decreased probability of another event, rather than simply learning *to* respond in one or another way. It is a learning of relationships between events, rather than of responses as such. Unlike other hypothesised forms of learning, contingency *learning* is necessarily reflected in the development of contingency *awareness*. The existence of contingency learning in this, cognitive, sense, is a theoretical and empirical question. While Tolman and Bolles argue that contingency learning is the basis of learning, and some other theorists such as Dawson and Furedy, Mandel and Bridger, and Razran argue that contingency learning is an important or necessary component of learning, others again suggest that contingency learning as it is defined above is irrelevant to the learning process (Skinner, Bindra, Smith, Hull and Gray).

(iii) Expectancy

The term 'expectancy' is used by some authors to refer simply to a central organisation that causes event A to evoke a central representation of event B (e.g., Bindra, 1974). In this thesis, however, the term will be used as it is used by Tolman and Bolles, to refer to the product of contingency learning. That is, expectancy refers to stored information concerning environmental contingencies, that represents and corresponds to those contingencies (Bolles, 1972). Thus, expectancy refers to an awareness by a subject of certain features of its environment. Although expectancies (in conjunction with appropriate motivation) may direct behaviour, they are not in themselves behavioural tendencies.

(iv) Expectancy Theory

An expectancy theory is one that explains all or most behaviour in terms of the expectancies and motivational state of the subject, which are therefore considered sufficient for the determination of behaviour (e.g., Bolles, 1974; Tolman, 1959). Obviously contingency learning is central to such theories. Although Smith (1974) and Bindra (1974) base their theories on what they refer to as expectancy, the important differences in their use of the term, and in their hypotheses concerning the relationship between expectancy and behaviour (outlined in section 1.2.2) preclude their inclusion as expectancy theories.

(v) Conditioning

Conditioning will refer to learning as a result of classical or operant conditioning procedures; that is, through temporal association of conditioned and unconditioned stimuli, or through reinforcement of responses (English & English, 1958). While conditioning procedures may result in learning, conditioning and learning are not synonyms. It is again a theoretical and empirical question as to whether conditioning procedures necessarily result in learning, and whether learning can take place in other ways than through conditioning.

This definition of conditioning is thus a broadly operational one, in contrast to the definition of contingency learning which is strictly conceptual, refers to unobservable processes, and requires operational specification in each instance. This difference in the nature of the two definitions specifically leaves open the question, which must be answered empirically, as to whether conditioning never, sometimes, or always involves contingency learning.

(vi) Conditioning Theory

Conditioning theory will refer to the proposition that behaviour is determined primarily through processes of conditioning, which are therefore sufficient for the determination of behaviour. Conditioning theories thus include not only explicitly mechanistic theories such as those of Hull (1952) and Skinner (1969) but also theories that give a conditioning based account of expectancies (Bindra, 1974; Gray, 1975; & Smith, 1974). Mowrer's (1950) two factor theory also counts as a conditioning theory in this sense, since both of the two factors are based on conditioning processes.

(vii) Two Process Theory

This term will be used to refer to theories which emphasise the place of both conditioning processes and expectancy in learning and in behaviour generally (Razran, 1955; Mandel & Bridger, 1973; and Dawson & Furedy, 1976). It should be noted that the distinction between conditioning, two process, and expectancy theories is one of emphasis rather than of rigid demarkation. Bolles and Tolman both allow for the possibility of some conditioning processes, and many conditioning theorists allow for the possibility of irreducibly cognitive activity (Spence, 1966; Skinner, 1969). Pavlovian theory, though commonly regarded as a conditioning theory, might better be regarded as a two process theory because of the major differences between the operation of the first and second signalling system (Anokhin, 1968).

1.3 CONTROVERSIAL ISSUES IN CONDITIONING AND EXPECTANCY: A REVIEW OF THE EVIDENCE

The theoretical positions outlined in the preceding sections, concerning the role of expectancy in learning and extinction, can in many cases yield differential experimental predictions. However, the experimental investigation of the role of expectancy has not in all cases been clearly tied to any specific theoretical position. Accordingly, the evidence reviewed in the next section will be organised according to the principal experimental hypotheses that have been emphasised in the literature. Where possible, these hypotheses will be related to theoretical positions.

1.3.1 Conditioning without contingency learning

Contingency learning has been defined in the previous section as an irreducibly cognitive concept. Since contingency learning in this sense is basic to the expectancy theories of Tolman and Bolles, these theories predict that conditioning should not take place without contingency learning. Dawson and Furedy specifically argue against the possibility of conditioning without contingency learning. In contrast, other two factor theorists such as Razran and Mowrer, and conditioning theorists such as Hull and Skinner, argue specifically that conditioning is possible without contingency learning. Those expectancy theorists who deal with expectancy in an entirely mechanistic manner, rather than as an irreducibly cognitive concept (Gray, Bindra, and Smith) also argue for the possibility of conditioning without contingency learning. This issue has been investigated in a number of research areas.

1.3.1(a) Conditioning in animals low on the phylogenetic scale.

Conditioning has been demonstrated in Hydra (Zubkov and Polikarpov,

1951) flatworms (Hovey, 1929), and a wide variety of other lower animals (Razran, 1971). Although it is unclear why such animals should be incapable of contingency learning as is argued by Razran (1971), it does seem rather implausible that such animals have 'expectancies' in the sense of the word used by Tolman and Bolles. Accordingly, it could be argued that learning in lower animals may not conform to cognitive expectancy theories.

This does not, however, provide support for the hypothesis that humans and other higher animals operate in the same way: "Because a simple task could, theoretically, be handled by a simple mechanism does not mean in fact that the brain handles it that way. In an uncomplicated nervous system, yes; but in the complex brain of a higher animal other mechanisms may insist on getting into the act and turn the simple task into a complex one" (Hebb, 1958). Similarly, evidence that conditioning can take place in decorticate animals (Razran, 1955) may be of limited relevance, in that decorticate animals may behave quite differently to those with an intact cortex, and may both be incapable of some forms of learning that would be possible with an intact cortex, and capable of other forms of learning not possible with an intact cortex (Hebb, 1958).

While these studies, and similar research demonstrating conditioning in preverbal and non verbal humans (Grings, Lowell, & Honnard, 1961; Lockhart & Grings, 1964) show that verbalised awareness of contingencies is not a necessary precondition for conditioning, at least in some animals (i.e. humans), they do not demonstrate that contingency learning in some equally cognitive form is not involved, or that conditioning without contingency learning is possible in intact animals.

1.3.1(b) Subliminal Conditioning

It has been argued that conditioning can take place using stimuli below the perceptual threshold (Razran, 1955), but there is considerable doubt that subliminal conditioning has ever been demonstrated. One major problem is that of defining the threshold below which stimuli might truly be undetectable. Many studies claiming to demonstrate subliminal conditioning have defined "subliminal" as being below the 50% threshold (Eriksen, 1960). Using this definition there is no doubt that the subject can perceive the stimulus on at least some trials, and the evidence showing that subliminal conditioning is rather slow and unreliable is consistent with the view that conditioning took place only on the occasions that the stimulus was perceived (Dawson, 1973).

Interoceptive conditioning has also been referred to as subliminal, but again there is doubt over just how perceivable interoceptive cues may be. Certainly, some interoceptive cues may be perceived (e.g., Makarov, 1959), and the issue returns to one of threshold determination. While the intensity of stimulation required for interoceptive conditioning, and for awareness of cues, may be further apart for interoceptive than for exteroceptive stimuli, this may in part be due to difficulties in verbalising interoceptive sensations (Dawson & Furedy, 1976). While the interoceptive conditioning literature appears somewhat more convincing as a demonstration of conditioning without awareness of stimuli (and therefore without awareness of contingencies), as Dawson (1973) argues, "... it appears premature to conclude that interoceptive conditioning can occur in the absence of contingency learning."

1.3.1(c) Conditioning with masking and misleading instructions

A number of studies have attempted to prevent contingency learning by distracting attention away from experimental contingencies. Fuhrer and Baer (1969), for example, superimposed an irrelevant probability learning task onto a differential conditioning experiment. A number of subjects given the masking procedure failed to verbalise contingencies when later give a post experimental questionnaire, but nevertheless demonstrated differential GSR conditioning. Although many such experiments suffer from other problems (Chatterjee and Eriksen, 1960), the basic difficulty is that of measurement of awareness. There is no *a priori* reason for expecting masking tasks to preclude awareness of contingencies, and in most experiments a number of subjects will learn the contingencies despite the masking task. Accordingly, evidence for conditioning without awareness of contingencies comes solely from questionnaire measurement of awareness; those who verbalise the contingencies are clearly aware of them, but it is less clear that those who fail to verbalise contingencies are therefore not aware of them.

Dawson and Reardon (1973) found the use of a more sensitive, recognition questionnaire identified a number of subjects who were aware of contingencies but had not verbalised this awareness on the more commonly used recall questionnaire. No conditioning effect was found in the remaining, presumably unaware, group. As Dawson (1973) points out, the current evidence suggests that conditioning does not take place without awareness of contingencies, since those studies that purport to show conditioning effects in unaware subjects have used recall questionnaires. Even if conditioning is demonstrated in subjects who do not report contingency awareness on a recognition questionnaire, it can always be argued that a still more sensitive measure of expectancy would identify some subjects as aware. Similarly, results of experiments that fail to demonstrate a relationship between reported awareness and level of responding may be attributed to weaknesses in questionnaire assessment (Furedy, 1973).

The fact that subjects instructed of contingencies before a masking experiment will condition successfully (Dawson, 1970) suggests that it is the precluding of contingency awareness, rather than interference with the conditioning process by the masking task, that prevents conditioning. Further, it is found that differential responding follows rather than precedes awareness of contingencies when awareness is measured on a trial by trial basis (Dawson & Biferno, 1973; Biferno & Dawson, 1977), and that it is the subject's reported expectancies concerning the contingencies in operation, rather than the contingencies themselves, that relate most closely to obtained responding in both operant (Epstein & Bahm, 1971) and classical conditioning studies (Streiner & Dean, 1968; Epstein & Roupenian, 1970; Hill, 1969). It would thus appear that awareness of contingencies is at least closely associated with, and may be a determinant of, conditioned responding.

However, it may be that expectancies serve only to direct attention toward relevant stimuli, and that expectancies would therefore be unnecessary in the absence of the distracting masking task. The present difficulties in expectancy assessment, and the uncertainty of interpretation of masking task effects in terms of the role of expectancy in conditioning, preclude the possibility of demonstrating conditioning without contingency learning by means of masking tasks until more is known about the mechanisms involved in masking task interference, and until some superior means of expectancy manipulation and/or assessment is available.

1.3.1(d) Verbal operant conditioning

Verbal operant conditioning could be regarded as a special case of masking and misleading instructions, since the nature of the task is such that it is often hard for subjects to deduce the contingencies, and misleading instructions are commonly given. The fact that conditioning is obtained under these circumstances was initially interpreted as evidence for conditioning without awareness (Greenspoon, 1955; Taffel, 1955), although early studies did not assess awareness (e.g., Thorndike & Rock, 1934), or used very crude measures (e.g., Sidowski, 1954). The fact that contingencies other than those specified by the experimenter may be sufficiently accurate to lead to significant responding is an additional problem that can lead to misclassification of subjects' expectancies (Spielberger & DeNike, 1966).

More recent experiments have made more serious efforts to control and measure expectancy. DeNike (1964) had subjects write down their thoughts about the experiment after every 25 trial block, and these reports were evaluated by four independent judges. Those subjects classified as unaware of contingencies (including funcationally related contingencies) failed to demonstrate increments in target responding, while those classified as aware began to show increments in responding only within or following the trial block in which contingency awareness was first expressed. When this experiment was repeated with expectancy assessment following each trial (Kennedy, 1971), the authors interpreted the results as showing that increments in responding were found on the trial just preceding the first report of contingency awareness. However, Brewer (1974) points out that it is the first speculative awareness of contingencies that is important, since subjects will test these (producing target responding) before being certain of the operating contingencies. When Kennedy's data is analysed with uncertain subjects or those with correlated contingency expectancies categorised as aware, increments of responding are only found on trials following contingency awareness

(Brewer, 1974). Further, when subjects have functional, correlated hypotheses their behaviour tends to conform to their contingency expectancy rather than to the operating contingencies. For example, Spielberger and Levin (1962) report that subjects in an experiment that involved reinforcement of a pair of pronouns, but who reported that they believed that reinforcement followed one of these pronouns, showed conditioning specific to that pronoun.

While these results appear to lend strong support to a cognitive view, the standard verbal conditioning experiment has been criticised in terms of its demand characteristics (Orne, 1962). It has been suggested that subjects in these experiments are virtually required to deduce contingencies by virtue of the nature of the task, and by virtue of concurrent measurement of contingency awareness. Accordingly, it is argued that verbal conditioning experiments are the last place that conditioning without awareness is likely to be demonstrated (Rosenfeld & Baer, 1969). These authors went on to demonstrate verbal conditioning of a subject who was not aware that he was a subject, and believed instead that he was conditioning motor responses in an experimental confederate. Verbal responses increased in frequency despite an apparent lack of awareness by the subject of the contingencies. However, the subject did report a correlated contingency, though he was unable to identify experimental contingencies accurately until late in conditioning. The use of a single subject, and the presence of a correlated contingency make this study only weak evidence for the possibility of conditioning without contingency awareness.

A subsequent study (Rosenfeld & Baer, 1970) controlled for possible experimenter bias more carefully. Again significant responding was obtained in two subjects, though it is unclear whether the 12 subjects rejected failed to condition. While the possibility remains that more sensitive assessment of contingency awareness might reveal some level of contingency awareness in the three subjects conditioned in these two experiments, it is also possible that conditioning without awareness may have been obtained.

Similarly equivocal are verbal conditioning masking experiments, of which three (Dixon & Oakes, 1965; Oakes, 1967; and Thaver & Oakes, 1967) purport to show conditioning without awareness, while three essentially similar replications failed to find this effect, finding conditioning only in aware subjects (David, 1967; David & Dielman, 1968; Dulany, Schwartz & Schneider, 1966). All of the above studies have also been criticised on the grounds that the masking task did not affect the proportion of aware subjects or the course of conditioning (Brewer, 1974). Accordingly, these studies should more properly be seen as standard verbal conditioning experiments, in which case the great weight of the evidence suggests that with more sensitive assessment of awareness, conditioning would only be found in subjects aware of contingencies.

Even if it were found that conditioning was always accompanied by contingency awareness, this need not be seen as evidence against conditioning theories. It could always be argued that contingency awareness results from, rather than is a necessary precondition for, successful conditioning.

1.3.2 Extinction without contingency learning

Those theorists outlined in section 1.3.1 who argue that conditioning is impossible without contingency learning maintain this position with regard to extinction, as do those who argue that conditioning is possible without relational learning. Accordingly, the issue of whether extinction can take place without contingency learning provides a test of the various theories of learning. Although extinction in lower and decorticate organisms, and following subliminal conditioning, could be dealt with as separate issues to conditioning, the difficulties of demonstrating awareness or the lack of it in these cases (discussed in the previous section) precludes any useful conclusions. However, two experimental designs have been employed to research this issue specifically.

1.3.2(a) Extinction in masking experiments

Several studies have demonstrated longer extinction in groups with a masking task than in groups without such a task (Spence, 1963, 1966; Spence, Homzie & Rutledge, 1964, Latham & Beach, 1974). This provides some support for the hypothesis that contingency learning is important in extinction, and in this regard is less susceptible to the criticism that processes held to be important by conditioning theory are interfered with by the masking task than is the case for conditioning with a masking task. For example, as was previously argued, theories that include attentional or orienting concepts (e.g., Skinner) can readily deal with the failure to learn in the presence of a masking task as being due to a lack of attention to relevant stimuli. Failure to extinguish cannot be explained in the same way, particularly by theories that deal with extinction in terms of aftereffects of work expended not being counteracted by aftereffects of reinforcement (e.g., Hull, 1952). However, the issue of whether extinction is possible at all without contingency learning cannot be tested by using masking procedures, since it is unlikely that contingency learning could be prevented over an indefinite number of trials. For the same reason, the fact that the above studies show some (although slower) extinction cannot be interpreted as support for the possibility of extinction without contingency learning, owing to the difficulties of manipulation and assessment of awareness outlined in the previous section. Further, all of the above mentioned studies have used a dual assessment of subject awareness in extinction. Both subjects who report awareness of extinction contingencies, and those not reporting such an awareness, but who extinguish in the first five extinction trials, are classified as "aware", and rejected from analysis. The latter criterion biases these studies in favour of long extinction, and precludes testing of the role of awareness in extinction.

1.3.2(b) Concurrent measurement of contingency awareness and responding in extinction

If contingency learning is a necessary condition for extinction to take place, then reduction in responding should only be obtained in subjects aware of extinction contingencies, and then only after awareness of these contingencies. The only study that has used trial by trial assessment of awareness in extinction is that of Biferno and Dawson (1977). These authors used a differential GSR conditioning paradigm with a masking task and two forms of trial by trial assessment of awareness (verbal report and a button pressing mechanism). It was found that subjects who reported awareness of extinction contingencies responded less in extinction than those who did not report such an awareness.

However, an analysis of trials immediately preceding and immediately following reported awareness of extinction contingencies (expressed as a negative expectancy of the UCS during CS+) failed to find evidence for a consequent reduction in responding. This latter result was, however, based on only 6 subjects (the remaining subjects did not fulfil the criteria for analysis), and the authors point out that their measure of contingency awareness may have been inappropriate for use in extinction. While cognitive changes in acquisition appeared to be of the nature of learning that a relationship existed between UCS and CS+ (but not CS-), with a comparatively sudden "insight" reported that a relationship existed, during extinction the change appeared to be a gradual change in the certainty of UCS presentation following CS+. This form of expectancy change may not have been appropriately assessed with the trial by trial measures used in this study. (This issue of expectancy assessment is discussed further in section 1.4.1).

Indirect support for the hypothesis that awareness of extinction contingencies is a necessary precondition for extinction of conditioned responding is provided by an interesting study by Hammond, Baer, and Fuhrer (1980). These authors measured UCS expectancy on a trial by trial basis in subjects tested for retention of differential conditioned responding 28 days after conditioning. Only those subjects reporting differential UCS expectancy following CS+ and CS- showed differential responding.

While these results are clearly consistent with the hypothesis that awareness of extinction contingencies is a necessary condition for extinction of conditioned responding, they do not provide direct support for that hypothesis, since it is not clear that forgetting of CS-UCS contingencies preceded extinction of responding. Instead, it may be that forgetting of contingencies was a consequence of extinction of responding.

Accordingly, while the evidence would suggest that contingency learning may be involved in extinction, there is insufficient evidence to conclude that contingency learning is necessary for extinction to take place. Further, since current research methodology relies very heavily on assessment of awareness, and since no demonstrably satisfactory procedure has been designed to overcome the obvious difficulties of awareness assessment, it is unclear how this issue might be resolved.

1.3.3 Contingency learning without conditioning or extinction procedures

It would appear from previous sections that contingency learning is an important factor capable of influencing responding. The difficulties involved in previously discussed experimental designs in demonstrating whether contingency learning is a necessary factor leave this issue unresolved. It is unclear how the possibibility of cognitive influence could be abolished without affecting important assumptions of conditioning theories. An alternative approach has been to attempt to show that expectancy is sufficient to account for the phenomena that learning theory is based on. If it were shown that conditioning theory alone is incapable of dealing with all of the evidence, and that expectancy theory alone is capable of dealing with all of the evidence, this would provide strong support for strictly cognitive approaches. If, on the other hand, expectancy theory was unable to account for all of the evidence, then one or other of the two process approaches may be supported.

Two major strategies have been employed in an attempt to demonstrate the sufficiency of cognitive approaches: that of establishing responding without conditioning trials, and that of abolishing responding without extinction trials, in each case through expectancy manipulation alone.

1.3.3.(a) Learning without conditioning trials

According to either a strictly cognitive approach (Tolman, 1922; Bolles, 1972), or to some two factor and two process theories (Razran, 1955; Mandel & Bridger, 1973), it is possible for learning to take place without conditioning trials, while conditioning theories, and those of Dawson and Furedy (1976), Bindra (1974), Gray (1975), and

Smith (1974) predict the opposite. A number of experiments have been conducted to resolve this apparently simple issue. Silver and Greco (1975) showed that subjects who observed a model being conditioned to respond to a CS paired with shock exhibited similar (though somewhat smaller) GSR responses to the CS as did the models - apparently a case of learning without conditioning trials. However, as with other modelling experiments, it is always possible to argue that some reinforcing event took place during observation. For example, it could be argued that observation of a model being shocked was aversive, and led to unpleasant physiological concommitants of emotional states such as fear, anxiety, etc. (including GSR) which then became paired with the CS (Berger, 1962).

Accordingly, such studies are unable to convincingly demonstrate learning without conditioning trials. The fact that the obtained GSR is smaller following observation than following conditioning trials is of little interest. Though observers presumably had the same information as models concerning the CS-UCS relationship, they had neither experience with the UCS, nor expectancy of UCS delivery to themselves following CS. Accordingly, no theory would predict an equivalent response.

More interesting are the experiments that use a procedure in which subjects are informed of a CS-UCS contingency and then tested for responding to CS alone either before or without actual CS-UCS pairings. Brewer (1974) reports a total of twenty such experiments to support his claim that "simply telling subjects the CS-UCS relation, with no actual pairings, produced conditioning".

Interpretation of these studies is, however, disputable. The demonstration in the four verbal conditioning studies cited in which subjects showed significant responding after instruction alone is subject to the criticism that the responding obtained is under voluntary control (compliance) and therefore not truly conditioned responding. The issue of voluntary control has for a long time been a matter of concern in the literature, with regard firstly to whether its explanation requires concepts outside traditional learning theories, and secondly to whether results obtained differ markedly from more conventionally conditioned subjects. Although the human ability to follow instructions is an important one in terms of cognitive theories, proponents of traditional conditioning theories have been able to argue that voluntary responding is trivial and outside their realms of interest; a variable to be controlled for by exclusion rather than a topic for analysis (e.g., Spence & Ross, 1959; Spence, 1964, 1966). That this has been defensible is perhaps due to the marked differences often apparent between traditionally conditioned and voluntary responders in acquisition and extinction rate, and in the form of the response (Spence & Ross, 1959). Although the distinction is becoming increasingly less tenable (Gormezano, 1965), the fact remains that voluntary responding has never been accepted as conditioned responding.

One solution to this problem has been the use of autonomic responses generally believed not to be under voluntary control (Woodworth & Schlosberg, 1966). Brewer's remaining 16 cited examples all use such responses, but again their interpretation is disputable. All autonomic studies in this area have used responses such as heart rate and GSR, which can be interpreted as anticipatory or attentional generalised responses: "to account for such 'one trial conditioning', we prefer a simpler explanatory construct, namely, identifying it as an orienting response to the changed stimulus" (Stern & Walrath, 1977). Such generalised responses are given to a wide range of stimuli including internal emotional states such as anxiety, fear, or simply attentiveness, and in the above mentioned response systems are not reliably distinguishable from conditioned responses (Gormezano, 1965). The nature of such generalised responses, particularly whether they should be considered as equivalent to conditioned responses, remains an unresolved issue (Stern & Walrath, 1977). While such studies clearly show instructional effects on responding, they may or may not be interpreted as evidence for the existence of learning without conditioning trials, depending on the interpretation of the responding so obtained. While these studies should remind us that traditional conditioning concepts need not be invoked to explain all changes in behaviour (and even that conditioning theory has great difficulty in accounting for certain such changes; any instructional effects on responding are hard to account for), they do not provide conclusive evidence that learning may occur through instruction alone.

On the other hand, the evidence suggesting that instruction leads to a qualitatively different form of responding is equally weak. Several studies suggest that instruction leads to responding that is not as resistant to extinction as that produced by conventional conditioning procedures. Bridger and Mandel (1964), for example, found that subjects threatened with shock but never shocked showed 'no trial' extinction of the GSR when informed that UCS would no longer be presented, while traditionally conditioned subjects did not. However, they later conceded that: "with the clarity of hindsight, we must admit that the SHOCK group may have contained some subjects who did not fully believe that they would no longer be shocked" (Mandel & Bridger, 1973). This maintained expectancy could account for the maintained responding found in that group and not found in the group that was simply threatened with shock. McComb (1969) found greater responding in extinction following contingency instructions and reinforced conditioning trials than following contingency instructions and pseudoconditioning trials, but since the contingency instructions were demonstrably false in the latter case (for the pseudoconditioning trials were explicitly unpaired) and not the former, it is not surprising for any theory that there was a difference in responding in extinction. Dawson and Grings (1968) found greater responding on test trials following instruction alone than was found in a group given reinforced trials and a masking task. There was no conventionally conditioned group to allow comparison, and the failure of the masked group to condition is open to several interpretations (discussed in section 1.3.1). While it would be interesting to ascertain whether responding can be established using an autonomic response not susceptible to interpretation in terms of unconditioned generalised responses, and whether such responding is equally resistant to extinction, the necessary experiment has not yet been done.

As it stands, this area of research constitutes an irritant to conditioning theories, which cannot readily deal with any form of behaviour change brought about by instruction. Experiments such as these have forced proponents of conditioning theories to concede the possibility that some forms of behaviour may be under cognitive control (the term 'voluntary responding', though used by proponents of conditioning approaches, could as easily have been coined by Tolman), and to argue for information/attentional explanations of apparently generalised responses. These concessions represent a major shift from the formal position that all behaviour may be explained in terms of automatic mechanistic processes.

1.3.3(b) Extinction without extinction trials

The key factor held to be important in extinction according to conditioning theories is the number of unreinforced trials, while expectancy theories see extinction as being determined by a change in expectancy concerning the CS-UCS relationship. Accordingly, the most fruitful design in this area concerns manipulation of expectancy by instruction at the onset of extinction, which should, according to expectancy theories, lead to 'no trial extinction' (abolition of responding before the first extinction trial); and according to conditioning theories, to the usual gradual extinction.

Although extinction can be seen as simply a case of learning not to respond to the old CS, or else to respond to a competing CS, for two reasons it is a special and important case. Firstly, many conditioning theories argue that response strength will gradually dissipate over extinction trials, some residual responding remaining for a time after the last reinforcement independent of the subject's expectancies (since cognition is held to be irrelevant). Some two process theories also make the same assumption (Dawson & Furedy, 1976; Mandel & Bridger, 1973), as do some conditioning theories which attempt to incorporate expectancy effects (Bindra, 1974; Gray, 1975; Smith, 1974; Mowrer, 1950; Razran, 1955), while expectancy theory makes a directly opposite prediction of immediate extinction under these circumstances. This provides an unusually strong test case for competing approaches. Acquisition performance does not provide such a clear test, since all approaches allow for gradual acquisition even following contingency instructions (due to the need to acquire relevant skills and information).

Secondly, much more powerful manipulation of expectancy is available (in the case of expectancy reduction) at the onset of extinction. While the subject may reasonably disbelieve the instruction that UCS will follow CS+ but not CS- in informed acquisition experiments, since he has no further information beyond that instruction, this is potentially less so in extinction where the experimenter may remove or otherwise manipulate the apparatus necessary for UCS presentation.

One of the earliest studies in this area (Gibson et. al., 1932), is often cited as the definitive conditioning experiment in support of expectancy theory. Subjects' hands were strapped palm down to a metal plate, and were conditioned to flex their fingers away from the plate at a signal which preceded shock as a means of shock avoidance. After this conditioning phase, the subjects' hands were strapped palm up - the conditioned response of flexing now being counter productive. As predicted by expectancy theory the subjects immediately resorted to flexing their fingers away from the plate.

Although this result appears to be rather persuasive evidence in favour of expectancy theory, there are two problems in the interpretation of this experiment. The first is that it can be argued that at some, perhaps autonomic level, the conditioned response remains, but is overcome to produce a voluntary motor act in the opposite direction. The second is that, if the conditioned response is defined as "finger withdrawal", rather than as a specific set of motor acts, it is possible to account for these results without referring to acquisition or extinction at all. While this redefinition is somewhat problematic for some theorists, who perceive conditioning as the formation of links between stimuli and motor acts (e.g., Hull, 1940), others would have no such difficulty (e.g., Mowrer, 1950).

A stronger and more direct test is provided by the experiments classified by Brewer (1974) as "informed unpairing experiments". In this design subjects are informed at the onset of extinction that UCS will no longer follow CS. The classic study is that by Cook and

Harris (1937), who demonstrated a marked reduction in GSR responding by instructing subjects of extinction contingencies at the onset of extinction. The authors interpreted this, along with the demonstration that GSR could be established in the same way, as a demonstration that GSR conditioning was suspect, and may result from what they call 'verbal conditioning' (awareness of contingencies) leading to attitudes of expectation and surprise rather than from an experimental series of paired stimuli. They apparently regarded this 'verbal conditioning' as an interfering variable to be controlled for, but reported that, when they had attempted to condition the GSR in the conventional manner, "it was found impossible to prevent such verbal conditioning from taking place".

Since that time research has concentrated on determining whether the reduction in responding consequent on unpairing instructions is complete; whether it can be attributed to factors such as drive or anxiety reduction rather than to extinction as such; and whether this reduction is always obtained.

1.3.3(c) Extinction following unpairing instructions: Complete or incomplete?

Like the Cook and Harris (1937) study, many early experiments were not designed to test between complete and incomplete extinction. One major requirement is that, where spontaneous responding is not zero, some baseline level of responding must be established to compare with instructed groups. Two major strategies have been adopted for this purpose: the use of differential conditioning procedures, where responding to CS+ may be compared with responding to CS-, and the use of control groups.

The series of experiments by Bridger and Mandel (1964, 1965;

Mandel & Bridger, 1967) are a good example of differential conditioning studies. In all cases residual conditioned differential GSR responding was obtained following unpairing instructions and removal of shock electrodes. While these experiments would appear to provide support for the existence of a component of the conditioned response not susceptible to cognitive control, there are two major difficulties in interpreting them. The first is that, despite removal of shock electrodes, a number of subjects did not believe the instruction that UCS would no longer follow CS+. Although subjects who reported any degree of shock expectancy other than zero were rejected, it is reasonable to suppose that a more sensitive measure of expectancy might reveal additional subjects who disbelieved the experimenter (Creelman, 1966). Further, subjects may choose, owing to situational demand, not to report any suspicions that they might have had about UCS presentation in extinction (Jennings, Crosland, Loveless, Murray & George, 1978). This problem leaves open the question of whether responding in extinction was due to maintained and unreported expectancy of UCS presentation, or, as is claimed by Mandel and Bridger, to a conditioned response exhibited contrary to cognitive expectancy.

This problem of assessment of expectancy is a general one, but may be particularly severe in studies using shock as the UCS and GSR as the CR. Since GSR electrodes must remain in place on the subject during extinction in order to record responding, there is a clear possibility that subjects will expect shock via GSR electrodes, despite the experimenter's instruction that shock will not be presented and despite removal of shock electrodes. Consequently, although supporting other studies which show that instructions can facilitate extinction, differential GSR studies showing residual responding in informed extinction (e.g., Wickens & Harding, 1967; Colgan, 1970; Mandel & Bridger, 1967;

Bridger & Mandel, 1964, 1965) cannot be interpreted as providing unequivocal support for the proposition that there may be residual responding maintained contrary to cognitive expectancy.

Comparable experiments using other response mediums are, however, rather rare. Shean (1968) conditioned vasoconstriction to shock in a differential classical conditioning experiment and found residual responding following unpairing instructions in extinction. However, shock electrodes were not removed to ensure belief in unpairing instructions, and data was not reported concerning the effectiveness of the expectancy manipulation. Chatterjee and Eriksen (1962) found residual differential heart rate responding after instructions that shock would no longer be presented, but again shock electrodes were not removed at the onset of extinction. Therefore, these studies again suffer from the difficulty that responding obtained could equally be residual responding contrary to expectancy, or responding consistent with a maintained expectancy of shock presentation. Accordingly, those studies using the differential conditioning procedure have been unable to resolve this issue.

There have been a number of studies using control group procedures. Silverman (1960), Wickens, Allen and Hill (1963), and Dawson and Grings (1968) found more residual GSR responding in conditioned than in pseudoconditioned control groups. Again, this result is uninterpretable owing to the failure to demonstrate abolition of UCS expectancy, since GSR electrodes were not removed at the onset of extinction.

The only study yet found to have demonstrated convincing expectancy manipulation at the onset of extinction is that of Jennings *et al.* (1976). Pupillary dilation was conditioned to shock, and then tested in extinction after instruction that UCS would no longer be presented.

This instruction was reinforced by varying degrees of additional information, from a sham adjustment of the wrist strap used for shock presentation to its complete removal. Since the CR was measured photographically and no additional electrodes were employed, it is unlikely that subjects could have expected shock in the latter group. A progressive reduction in responding over extinction trials was obtained in all groups, but this was interpreted as continuing adaptation to the CS rather than to progessive extinction of the CR, on the grounds that a pseudoconditioning control group showed a similar reduction of responding over trials,and at a similar level.

Unfortunately, this similarity in the level of obtained responding does not support their contention that responding in conditioned groups was therefore artifactual. First, while experimental groups were given unpairing instructions, pseudoconditioned subjects were not. This allows for the possibility that expectation of UCS was present in the pseudoconditioned but not the experimental groups, and therefore that generalised responding may have been greater in the pseudoconditioned than the experimental groups. Consequently, some conditioned responding may have been obtained in extinction in experimental groups. Second, pseudoconditioning control groups are in principle unsuitable for use in extinction, for reason which are considered in detail in section 1.4.2. Because of these problems, obtained responding in experimental groups of the Jennings *et al.* (1976) study could be due either to residual counter expectancy responding, or to artifact.

While the studies reviewed in this section provide further support for the finding that instructions can reduce responding at the onset of extinction, appropriate experiments have yet to be conducted to demonstrate whether this reduction is complete. Unlike other unresolved issues reviewed in earlier sections, this one is in principle capable of resolution, given a preparation capable of the sort of convincing expectancy manipulation obtained in the Jennings *et al.* study, while in addition allowing separation of conditioned responding from artifact by the use of better control groups. Artifact control and expectancy manipulation problems will be considered in detail in sections 1.4 and 1.5

1.3.3(d) Genuine versus artifactual effects of instruction

Much of the argument on this topic concerns the issue of whether the GSR, which has been the preferred conditioned response in this area, can be truly conditioned. If it can be demonstrated that elicitation of the GSR is always due to non specific factors such as sensitisation, orienting responses etc. rather than conditioning, then the demonstration that it may be established and abolished by expectancy manipulation has less consequence than if it is shown to be a legitimate conditioned response. As Stern and Walrath (1977) point out, the GSR is unusually labile, making it most sensitive to confounding, and further: "no one has demonstrated that the waveform of the skin conduction response to the CS differs grossly from that to the UCS, nor that the form of the unconditioned OR to the CS differs from that of the 'CR' to CS onset. This lack of response differentiation produces a phenomenal confounding of conditioning with sensitisation, habituation and pseudoconditioning." Since the classical conditioning paradigm also includes sensitisation and pseudoconditioning of necessity, there is no way to eliminate this confounding (Stern & Walrath, 1977).

Grings (1965) suggests the verbal control in the form of conditioning-like responses consequent on instruction, and abolition of apparently conditioned responding, may be found in other autonomic systems where responses comprise a part of behaviour complexes like alerting, orienting, etc. He suggests that "... instruction leads to a response of expectation or anticipation, one part of which is autonomic discharge". This is rather like Mowrer's (1938) view that instructional effects are due to "... changes in the nature and extent of the subject's preparedness or readiness to make the particular response under investigation and have no relation to learning proper". This view, however, can only apply to responses such as the GSR that are components of generalised responses, and only in some simple experimental situations, since changes in generalised arousal cannot account for acquisition or extinction of differential responding, or for acquisition and extinction of motor responses such as finger withdrawal which are not components of arousal states. However, the point needs to be taken that controls for artifactual responses are of considerable importance.

1.3.3(e) Instructional control following procedures that maximise resistance to extinction

Are there conditions under which instructions are insufficient to lead to extinction of conditioned responding? The strong suggestion was made in the previous section that reponse systems other than the GSR may be less susceptible to instructional control, and accordingly it might be expected that response systems may be found that are resistant to instructional control. However, instructions have been demonstrated to be effective at least in facilitating extinction in a number of other response systems including eyeblink (McAllister & McAllister, 1958), pupil size (Jennings *et al.*, 1977), salivation (Razran, 1949), finger withdrawal (Lindley & Moyer, 1961), and vasoconstriction (Shean, 1968). While the possibility remains of discovering a response system not susceptible to cognitive control, there is no reason to expect to find such a system. In fact, the area expected to be least susceptible to cognitive control, that of autonomic conditioning, has provided the best evidence in favour of instructional control (Brewer, 1974).

A second possibility is that different conditioning procedures may lead to responding that is resistant to instructional manipulation at the onset of extinction. The following sections examine evidence concerning instructional control of extinction following partial reinforcement, different numbers of reinforced acquisition trials, different magnitude of reinforcement and various ISI lengths.

1.3.3(e)

(i) Partial Reinforcement

The standard learning theory explanation of the partial reinforcement extinction effect (longer extinction following partial reinforcement)is that after-effects of nonreward experienced on unreinforced trials in PRF conditioned subjects become conditioned reinforcers by association with the UCS on reinforced trials (Hull, 1940; Amsel, 1962; Capaldi, 1967), and so lead to greater resistance to extinction.

In contrast, not only does expectancy theory predict abolition of responding by instruction regardless of conditioning procedures (assuming that instructions are effective in manipulating expectancy), but it also argues specifically that the partial reinforcement extinction effect (PREE) is due to the difficulty in discriminating changed contingencies in extinction (Bolles, 1972), and that therefore if this discrimination could be made as easy as it is following continuous reinforcement (for example, by instruction), the PREE would be abolished.

In addition to studies showing reduction in responding in extinction in partially reinforced subjects given unpairing instructions (Colgan, 1970; Notterman, Schoenfield & Bersh, 1952; Dawson & Grings, 1966), two studies have more directly tested the issue of whether partial reinforcement leads to responding resistant to unpairing instructions. Hartman and Grant (1962) and Bridger and Mandel (1965) both found greater responding following partially reinforced than following continuously reinforced acquisition trials in subjects given no instructions, but not when subjects were informed that there was to be no further shock at the onset of extinction.

Although both studies found maintained responding in extinction, in neither case can this be interpreted as unequivocal evidence for residual counter expectancy responding. The Hartman and Grant study had no control groups, and responding in extinction may have been due to reinstated orienting responses to the CS in extinction, since the CS alone, without the UCS, constituted a novel stimulus. While the Bridger and Mandel study used a differential conditioning paradigm, their results do not support their contention that residual responding was obtained. Examination of the extinction data for those subjects aware that UCS would no longer be presented reveals that responding to CS+ drops on the first extinction trial to a low level that is maintained throughout the ten extinction trials. The appearance of maintained responding that extinguishes over trials is due to the fact that responding to CS-, initially lower than to CS+, increases to the same level as to CS+ over the second block of five extinction trials. This increase cannot be due to pseudoconditioning or sensitisation as is argued by Bridger and Mandel, for UCS was not presented in extinction. In this case, therefore, the greatest responding to either artifact would be expected on the first extinction trial. It is extremely difficult to account for this phenomenon in terms of any conditioning effect.

Further, in neither of the above studies is expectancy manipulation entirely convincing. The Bridger and Mandel study has already been criticised in this regard (see section 1.3.4), and although Hartman and Grant could have maximised expectancy manipulation by removing the apparatus for UCS presentation (they conditioned eyeblink with an air puff as a UCS), they did not take advantage of this feature of their preparation. Since we cannot be certain that expectancy of UCS was abolished at the onset of extinction, we cannot be certain that expectancy was equated across groups. The interpretation of the obtained maintained responding contrary to instruction, and the demonstration of abolition of the PREE is therefore in doubt. It may be that these results are artifacts of maintained, counter instructional expectancy, or that they demonstrate counter expectancy responding.

1.3.3(e)
(ii) Number of reinforced trials

The number of reinforced trials is one of the most frequently cited parameters related to responding in extinction. It is typically found that the duration of extinction is positively related to the number of reinforced trials (Kimble, 1961). Conditioning theories argue that response strength is literally reinforced over trials, gradually acquiring greater and greater resistance to extinction (e.g., Hull, 1940). A more interesting possibility, however, is that responding may become qualitatively as well as quantitatively different following many conditioning trials. Although there has been relatively little direct interest in this possibility, it was argued nearly a century ago that cognitive processes come to have less and less influence over the performance of an act with repetition, the response becoming less and less susceptible to cognitive control and more and more automatic after a great many repetitions (James, 1890). Similar proposals have been put forward by Kimble and Perlmuter (1970), Bindra (1969), and by Bolles (1972), who suggests that: "... Perhaps sheer repetition of a response as a consequence of the law of performance suffices to connect it with prevailing stimuli. Certainly there is little *a priori* reason to expect such behaviour to be governed by the same laws or to depend on the same neural mechanism as those involved in the laws of learning, performance and motivation that have just been proposed." That is, much repeated responding may not conform to expectancy theory predictions. Tolman (1948) also suggested that overlearned responses may become "fixated" and peculiarly resistant to extinction.

Evidence for this hypothesis in the conditioning literature is sparse. Grings and Lockhart (1963) found no increase in resistance to extinction following unpairing instructions in subjects given 36 GSR shock conditioning trials in comparison with those given only 9. In addition to the previously discussed problems concerning expectancy manipulation in GSR studies (section 1.3.4), it could be argued that this study used too few conditioning trials to demonstrate effects predicted only for highly practised responses. The same can be said for the majority of other informed unpairing experiments which have used between 10 and 20 reinforced trials. The notable exception is a study by Hartmann and Grant (1962) who used 60 reinforced trials in their CRF conditioned group. This group showed no suggestion of the reduction in responding consequent on instruction found in other groups and in other experiments.

While this cannot be taken as strong support for the suggestion that many acquisition trials lead to responding resistant to extinction by instruction, owing to lack of controls for artifact and unconvincing expectancy manipulation (discussed in the previous section), it does reinforce the possibility that such responding may be obtained. Further indirect support for this hypothesis is provided by a number of findings in the paired associate learning and motor skill learning literature.

A number of studies employing introspective reporting of cognitive activity suggest that mediational activity is at its greatest in early stages of learning, reported mediation decreasing over trials (O'Brien, 1921; Barnes & Underwood, 1959; Dean & Martin, 1966). Lashley (1951) found that, although feedback of response produced stimuli is important early in skill learning, some highly practised performances occur too rapidly to allow use of such feedback. Indeed, instruction to attend to feedback may lead to disruption of overlearned performance (Smith, 1966). This supports Bryan and Harter's (1899) conclusion that, with overlearning, behaviour is organised into larger and larger units, one element of the unit automatically leading to the next without cognitive intervention.

While such findings are consistent with the hypothesis that there may be qualitative differences between highly practised and recently learned behaviour, such studies do not provide direct support for the suggestion that overlearned conditioned responding may be unusually resistant to instructional control.

1.3.3(e)
(iii) Magnitude of reinforcement

Consistent with the conditioning theory prediction that resistance to extinction is an increasing function of UCS magnitude (Hull, 1943), there is a positive correlation between UCS magnitude and responding in extinction (Kimble, 1961). It has also been argued that certain sorts of reinforcement, notably aversive, anxiety provoking reinforcers, will lead to responding that is resistant to instructional control (Mandel & Bridger, 1973). However, Wickens, Allen and Hill (1963) found no support for this hypothesis, finding no difference in GSR responding between subjects conditioned with weak shock and those conditioned with strong shock following unpairing instructions. As with other GSR conditioning studies, interpretation of these results is equivocal on the grounds that expectancy was not controlled adequately, but the fact that large instructional effects have consistently been demonstrated with a shock UCS suggests that if resistance to cognitive control is to be established solely through the use of large reinforcements, then shock as used in previous research is insufficient.

It is interesting to note that Campbell, Sanderson and Laverty (1964) found that the use of a very traumatic UCS (respiratory paralysis) leads to CRs very different from those produced with a milder UCS such as electric shock and loud noise, though there is no evidence that such responses are any less susceptible to cognitive control. It is clear only that the differential effect on response strength of intense, traumatic, or emotionally charged UCSs remains a problem for investigation. Existing data and theory are insufficient to warrant any assertions.

1.3.3(e)

(iv) The interstimulus interval

The suggestion has been made, particularly with regard to the GSR, that not only are certain ISI's optimal in conditioning (Kimble, 1961), but also that while some may lead to conditioning proper (and at the same time contingency learning), others may lead only to contingency learning. Mandel and Bridger (1967) found differential GSR responding in subjects informed in extinction that UCS would no longer be presented following 500msec but not following 5000msec, or 1000msec backward conditioning (though these latter procedures did lead to differential responding in extinction in subjects not so informed). Wickens and Harding (1967) also found subjects conditioned with a 500msec ISI more resistant to instructional control than those conditioned with a longer ISI of 2000msec. in an experiment in which subjects were informed that one of two previously reinforced stimuli would no longer be reinforced. However, when subjects were informed whether the impending stimulus was to be a CS+ or a CS-, all ISIs were equally susceptible to instructional control. The authors' suggestion that this result is due to the relative slowness of the discrimination process, leading to the emission of a response to a short ISI stimulus is inadequate, since Mandel and Bridger demonstrated differential responding (requiring discrimination between the two stimuli) even at very short ISIs.

An alternative explanation is that orienting responses to the novel stimulus (CS+ alone) would be more likely to contribute to measured responding in a short ISI than in a long ISI group. Mandel and Bridger (1967) scored responses in the period between one and five seconds from CS onset, while Wickens and Harding (1967) defined the CR as any response starting within two seconds of CS onset. Since the CS only becomes novel in extinction when UCS is no longer paired with it, an orienting response will only begin after the UCS fails to be presented on each extinction trial. In the case of the short ISI used in these studies, this is during the scoring period, but this is not so for longer ISIs studied.

Both studies also suffer from the problem of inadequate expectancy manipulation, and the associated problem that expectancy may not have been equated across groups common to all such GSR experiments (see section 1.3.4). While there remains the interesting possibility that ISI may affect resistance to extinction in subjects given unpairing instructions, testing this hypothesis requires a preparation in which CRs may be separated from generalised artifact, and in which expectancy may be convincingly manipulated.

1.4 PROCEDURAL DIFFICULTIES

It has been argued that the informed unpairing design (Brewer, 1974) provides a particularly strong test of important theoretical predictions while not suffering from the presently insurmountable problems in dissociating factors held to be important by conditioning theory, and those held to be important by expectancy theory, that are found in other designs reviewed. Additionally, extension of this design as in the Bridger and Mandel studies (1964, 1965; Mandel & Bridger, 1967) allows for the direct testing of hypotheses reviewed in the previous section. The success of this design, however, depends on the resolution of the two methodological difficulties referred to in previous sections; those of expectancy manipulation and artifact control.

1.4.1 Expectancy manipulation

Most previous studies have used rather weak expectancy manipulation procedures, and have relied on introspective reporting of subjects' contingency expectations to eliminate those who had maintained expectation of UCS in extinction (discussion in previous sections). For example, in GSR conditioning studies it is common for subjects to report that they expected shock via GSR electrodes despite instructions that shock would no longer be presented, and despite removal of shock electrodes. This suspicion is entirely justified given that painful electric shock *can* be administered through GSR electrodes, and deception has been so commonly employed in psychological research that it is not unreasonable that subjects should be suspicious of instructions given by experimenters. This procedure depends heavily on the assumption that subjects who have such an expectancy will report it in introspective reports. This assumption is not justified, for two reasons.

Firstly, questioning procedures may be insufficiently sensitive to identify all subjects who had any expectation of UCS presentation in extinction (Creelman, 1966). Although there now appears to be some reason to believe that trial by trial recognition procedures may be superior to post-experimental recall procedures of expectancy assessment (as criticised by Creelman) in acquisition, though not necessarily ideal (Furedy, 1973), this appears not to be the case for expectancy assessment in extinction (Biferno & Dawson, 1977). This may be due to the different issues involved. While in acquisition we are interested in knowing whether the subject perceives any relationship between CS and UCS, in extinction we are interested only in the subject's certainty that UCS will no longer be presented. It is quite possible that for this purpose, trial by trial procedures such as those used by Biferno and Dawson may actually be less sensitive than the recall procedures criticised by Creelman (1966), and may have contributed to the apparent weakness of such procedures demonstrated in extinction (Biferno & Dawson,1977). Accordingly, there is no clear agreement at present as to which expectancy assessment procedure is most appropriate in extinction, let alone any suggestion that any procedure is adequate to preclude the possibility of including subjects with maintained expectancy of UCS presentation in groups that are supposed to have abolished expectation of UCS.

The second reason is that demand characteristics of the experimental situation may preclude reporting of UCS expectation by subjects who did have such an expectancy (Jennings *et al.*, 1977). This is particularly the case following unpairing instructions in extinction, where reporting maintained UCS expectation contrary to instructions amounts to accusing the experimenter of lying. Experience with unreinforced trials in extinction may compound this difficulty, as subjects may feel that their disbelief had been unreasonable. While, in principle, trial by trial expectancy assessment should overcome this difficulty, the use of such procedures may well be inappropriate in extinction, as discussed above. Even subjects who initially believe unpairing instructions are likely to become suspicious if asked on every trial whether they still believe the unpairing instruction.

These difficulties are at present insurmountable, and while introspective reports provide a useful measure of the effectiveness of expectancy manipulation, they are inadequate as a means of separating subjects with some low level of UCS expectation in extinction from those who have none.

An alternative but little used procedure is to make expectancy manipulation as powerful as possible by making the apparatus for UCS delivery as far as possible dissimilar to, and incompatible with, the apparatus for measuring the CR in order that when the former is removed alternative means of UCS presentation are not available, thus validating unpairing instructions. This procedure was used by Jennings *et al.* (1977), and it is interesting that no subject reported expecting UCS delivery in extinction when UCS presentation apparatus was removed. This procedure is only appropriate for use with certain response preparations. Those such as the GSR to shock are unsuitable owing to the fact that GSR electrodes capable of shock delivery must remain on the subject in extinction.

1.4.2 Artifact Control

An additional but frequently related problem found with all unidirectional responses such as the GSR, heartrate, eyeblink, etc. is that of confounding of the CR with artifact such as the orienting response, which can be distinguished from the CR only with the use of latency and topography criteria. Distinctions made on such bases are fraught with methodological difficulties. For example, a latency criterion has traditionally been applied to eyelid conditioning research in order to reject responses other than conditioned responses from analysis (e.g., Spence & Ross, 1959). However, obtained latencies vary considerably with minor changes in experimental procedure (Hartman & Ross, 1961; Gormezano & Moore,1962), necessitating different latency criteria for each specific experimental procedure (Gormezano, 1965). Further, classification of responses according to such criteria is highly unreliable, even with sophisticated judges (Gormezano, 1965). Worse, there is no agreement on the proper criteria for discriminating between orienting and conditioned responses (Ohman, 1972; Grings, 1977).

Distinctions made on the basis of latency and form of the response are also based on contentious theoretical issues. Prokasy (1977) argues that first interval responses (those conforming to traditional latency criteria for orienting responses), may sometimes be conditioned responses, and may depend on CS-UCS contingencies. Other authors sometimes refuse to consider responses of this form as CRs on the basis that they do not always conform to traditionallearning theory predictions: for example, studies demonstrating one trial conditioning of electrodermal first interval responding have sometimes been interpreted as evidence against the possibility that such responses are true conditioned ones, since traditional learning theories suggest that conditioned responding should not be established so readily (e.g., Stern & Walrath, 1977). While it was traditionally argued that it was important to exclude short latency responses on the basis that they may be orienting responses (e.g., Spence & Ross, 1959), the more recent position is that important conditioned components may erroneously be rejected in this way (Furedy & Boulos, 1977; Prokasy, 1977). Accordingly, discrimination between orienting and conditioned responses on the basis of form and latency of the response is of dubious validity.

An alternative procedure is the use of experimental controls for artifact. Three techniques of experimental control have commonly been used, but all have major flaws. The simplest is the attempt to habituate the orienting response through the use of CS habituation trials. Habituation procedures were once considered to be important in conditioning experiments, due to the implicit expectation that orienting responses, once habituated, would not be reinstated. It is now accepted, however, that CS habituation before acquisition is ineffective, as the CS, when combined with the UCS on the first conditioning trial, constitutes a novel stimulus which again elicits an orienting response (Stern & Walrath, 1977). Subsequent changes in experimental procedures, such as the unpairing of CS and UCS at the onset of extinction, can also be expected to lead to renewed orienting responses (Sokolov, 1963; Stern & Walrath, 1977).

Differential conditioning procedures could be expected to resolve the problem of artifact control if the level of artifact to CS+ and CS- were the same. However, only the pairing of CS+ with non-reinforcement is novel in extinction, the CS- always having been associated with non-reinforcement. This procedure would therefore result in more orienting responses being emitted to CS+ than to CS- in extinction, and therefore lead to the possibility of finding a spurious effect.

The third commonly employed control procedure, the pseudoconditioning control, is also in principle problematic. Pseudoconditioning control groups were designed specifically to control for the possibility that obtained responding may be pseudoconditioned rather than truly conditioned. This distinction is made on a procedural basis: pseudoconditioned responses are those which are established as a result of experience with CS and UCS, but without paired conditioning trials.

Pseudoconditioning is not well understood, and explanations of the processes involved range from Harlow and Toltzein's (1940) suggestion that it is due to a generalised state of expectancy (and therefore only an artifact according to conditioning theories) to Wickens and Wickens' (1942) hypothesis that pseudoconditioning is due to generalisation of a CS conditioned to stimuli present concurrently with UCS presentation (and therefore not an artifact at all). The issue of pseudoconditioning arises mainly in studies involving acquisition of responding in circumstances where the possibility of conditioning is disputed (e.g., backward conditioning), or in research concerning initial acquisition of responding following CS and UCS adaptation trials (where the possibility of pseudoconditioning is both very real and very important). Pseudoconditioning is also most likely when a noxious UCS is used (Kimble, 1961).

Although the pseudoconditioning control group has frequently been used in these circumstances, and has also been used as a control for other forms of generalised artifact (e.g., Jennings, 1978), there are basic methodological difficulties with this procedure. Since the pseudoconditioning control group can be given similar CS and UCS exposure to experimental groups, it has sometimes been assumed that the same levels of artifactual responses will be obtained in control and experimental groups. If this were so, comparison of experimental and control groups would allow separation of conditioned and artifactual (including pseudoconditioned) responding. However, since the control group cannot undergo acquisition procedures identical to those of the experimental groups, there is always the possibility that certain artifacts will be more or less present in the control than in the experimental groups. For example, at the onset of extinction the conditioning group has experienced only the CS-UCS complex, while the pseudoconditioning control has experienced only the CS alone, unpaired with the UCS. Since the CS alone is novel only in the conditioning group, this group could be expected to give more orienting responses at the onset of extinction than the pseudoconditioning control. Thus, if more responding is obtained in the conditioned than the pseudoconditioned group at the onset of extinction, this could be due to maintained conditioned responding, reinstatement of the orienting response, or both.

Further, since the pseudoconditioning control group must involve the scheduling of both CS and UCS, the possibility that true conditioning will take place is always present. Pseudoconditioning controls must have CS and UCS scheduled on either a truly random or explicitly unpaired schedule. In the former case, CS will on some trials be paired with UCS, transforming the pseudoconditioning control into a partial reinforcement conditioning group. In the latter, CS signals a safe period in which UCS will not be presented, which could be expected to lead to inhibition of the conditioned response (Prokasy, 1965; Rescorla, 1967). These difficulties render the pseudoconditioning control group uninterpretable for the purposes of separating pseudoconditioned and other artifactual responses from conditioned responding, particularly at the onset of extinction.

If Kimble (1961) is correct in his assertion that pseudoconditioning may be a case of ordinary conditioning, then the elimination of pseudoconditioned responses may be no more desirable than it is at present possible. In the absence of agreement on the processes involved in pseudoconditioning, such as would permit unequivocal controls, the issue of pseudoconditioning is best dealt with by the use of a preparation that requires neither adaptation trials, the use of a noxious UCS, nor strong interpretation of performance on initial acquisition trials. A proposed solution to the more general problem of artifact control is presented in the next section.

1.5 RESOLUTION OF METHODOLOGICAL DIFFICULTIES

The present study incorporates methodological innovations designed to overcome the problems of artifact control and expectancy manipulation discussed in the previous section. The first problem is methodologically the more fundamental of the two. Its resolution calls for a preparation that allows for the elimination of sensitised and orienting responses from measured responding, while at the same time not being susceptible to the criticism that obtained responding is 'voluntary' rather than conditioned (as discussed in section 1.3.3). The bidirectional vasomotor response offers solutions to all of the above problems.

The major advantage of bidirectional autonomic responses such as the vasomotor response in isolating conditioned responding from artifact were long ago recognised (e.g., Luria & Vinogradova, 1959), but they have not been frequently used. The one vasomotor study involving expectancy manipulation in extinction (Shean, 1968) conditioned constriction alone to shock, rather than dilation and constriction to thermal stimuli, and so did not take advantage of its bidirectional nature. Other studies involving heart rate (Engel & Chism, 1967; Engel & Hanse, 1966) and pupil size (Jennings *et al.*, 1978) have also used only one of the two available directional components. With all bidirectional responses, adaptive unconditioned responses may be in either direction, while generalised artifactual responses will usually be in only one direction. With the digital vasomotor response, the UCR to warm thermal stimuli is dilation, to cold, constriction, and to novel, startling, or noxious stimuli the response is constriction (Sokolov, 1963; Zimny & Miller, 1966). The CR to thermal stimuli is in the same direction as the UCR (Bykov, 1959). By conditioning one half of each group to dilate to a warm stimulus paired with CS, and the other half to constrict to a cold stimulus paired with CS, an artifact free measure of conditioned responding may be obtained by taking the overall frequency of responses in the direction of the conditioned response for the group as a whole. Since artifactual responses such as the OR lead only to constrictions, they will lead to an increase in measured responding in the group conditioned to constrict, and a corresponding decrease in the group conditioned to dilate. Similarly, any generalised responses to the CS will be in the same direction in both warm and cold UCS conditioned subgroups, and will therefore not lead to an increase or decrease in measured responding for the group as a whole.

It should be stressed that in this design, the warm and cold conditioned subgroups act as controls for one another. Accordingly, neither can be interpreted alone, but the two together provide a powerful means of eliminating generalised artifact from the conditioned response measure. This procedure thus does much to preclude the possibility noted in previous studies that maintained responding in extinction may be attributed to artifact.

The vasomotor response is also less susceptible than other autonomic responses to the criticism that apparently conditioned responding is due to voluntary manipulation by the subject, directly through cognitive strategies, or indirectly through muscular activity. The vasomotor response is relatively unaffected by voluntary motor activity (Shmavonian, 1959), is relatively inaccessible to direct cognitive control (Surwit, Shapiro & Feld, 1976), and has been argued to be less susceptible than other autonomic responses to the criticism that responses obtained are due to pseudoconditioning or other artifact (Shean, 1968; Smith, 1954). Accordingly, any instructional effects on vasomotor responding that may be obtained could not as easily be attributed to trivial 'voluntary' effects as is the case for operant and GSR conditioning studies (section 1.3.3).

Expectancy manipulation problems can be minimised since the means of UCS presentation is independent of that of CR measurement. This independence allows for the removal of UCS presentation apparatus in extinction. When the thermal stimulator used for UCS presentation is removed at the onset of extinction, no comparable means for thermal stimulation is available. Although subjects may expect some other consequence of CS in extinction after removal of the thermal stimulator (there is a ubiquitous tendency for undergraduate volunteer subjects to expect electric shock in psychology experiments), this expectation would result in orienting rather than conditioned responding, and would not contribute to overall group performance. Some previous studies such as that of Jennings *et al.* (1978) have also been able to preclude all possibility of UCS presentation in extinction by removal of UCS presentation apparatus, and may therefore be equally powerful in abolishing expectation of the unconditioned stimulus. However, none have been able to do this and at the same time eliminate possible artifacts resulting from the use of unidirectional sympathetic response measures which may produce responding due to the generalised expectancy that 'something' may follow CS in extinction.

These methodological innovations make it possible to begin the task of addressing again the question of the role of expectancy in conditioning and extinction. The question of whether contingency learning is sufficient to lead to extinction of conditioned responding will be investigated through the use of unpairing instructions coupled with removal of the thermal stimulator at the onset of extinction.

This procedure will be used following three classical conditioning acquisition procedures to determine whether the responding obtained is equally susceptible to abolition through expectancy manipulation. The three acquisition procedures to be investigated are twenty five trials of continuous reinforcement (CRF 25), one hundred trials of 25% partial reinforcement (PRF), and one hundred trials of continuous reinforcement (CRF100)

According to expectancy theory predictions, it is hypothesised that responding following the first two of these procedures will be abolished on the first extinction trial following unpairing instructions and removal of the thermal stimulator. While expectancy theory in general might be expected to make the same prediction for the third, highly practised group, there are a number of cogent reasons (reviewed in section 1.3.3) for suspecting that the prediction will not hold for highly practised responding. At the same time, existing theory and evidence are insufficient to warrant a clear prediction in the opposite direction. Accordingly, while the performance in extinction of the highly practised group is of great theoretical interest, no directional hypotheses will be made concerning these groups. Assessment of the performance of these groups in extinction must therefore be regarded as exploratory research.

Other schedule effects such as the effect of varying ISI and magnitude of reinforcement cannot be investigated using the present procedure. ISI cannot be investigated with a thermal UCS owing to the relatively slow apparatus and sensation rise times which preclude comparison of very short (500 millisecond) and rather longer (2000 millisecond) ISI as would be required to resolve this issue. Investigation of this effect must await the development of a procedure allowing more precise temporal arrangement of stimuli while at the same time overcoming the associated problems of expectancy manipulation and artifact control. Testing of the hypothesis that only aversive, anxiety provoking stimuli lead to responding resistant to instructional control is also precluded, since such stimuli lead only to vasoconstriction, and so prevent the use of the bidirectional nature of the vasomotor response. The same difficulty also applies to other bidirectional responses.

To investigate the question of whether contingency learning is sufficient alone for learning to take place, two groups will be given experience of UCS alone, and CS-UCS pairing contingency instructions. These groups will then be tested for responding to CS alone without experience of CS-UCS pairing. It is hypothesised that both groups will show significant responding consequent on continency instructions alone. One of these two groups will be given contingency instructions designed to lead to an expectancy of partial reinforcement, while the other will be given instructions designed to lead to an expectancy of continuous reinforcement.

Additionally, one group given twenty five continuously reinforced trials, and another given one hundred continuously reinforced trials, will be given instructions designed to lead to an expectancy of partial reinforcement at the onset of extinction. It is predicted that groups given partial reinforcement instructions will show greater responding on subsequent test trials (in the case of the two groups with no acquisition experience), or greater resistance to extinction (in the case of continuously reinforced groups) than groups given continuous reinforcement instructions or no instructions respectively. This prediction is derived from the discrimination hypothesis of the partial reinforcement effect.

Finally, the rate of extinction following unpairing instructions alone will be compared with the rate of extinction following unpairing instruction and removal of the thermal stimulator. This is designed to test the relative efficacy of the two procedures in manipulating responding in extinction. It is hypothesised that less responding in extinction, and less reported expectancy of UCS, will be obtained in a groups with the thermal stimulator removed than in groups given instruction alone. This hypothesis is derived from Brewer's (1974) suggestion that maintained responding in extinction in studies using unpairing instructions alone may be due to inadequate expectancy manipulation.

In addition to the above groups, three groups conditioned with either 25CRF trials, 100 25% PRF trials, or 100 CRF trials will be given traditional (noninformed) extinction procedures. These groups are included for comparison with instructed groups in extinction.

Questionnaire assessment of expectancy will be included as a check on the effectiveness of expectancy manipulation procedures. It is predicted that informed unpairing (stimulator off) subjects will be less likely to report maintained expectancy of UCS in extinction than informed unpairing (stimulator on) subjects; who in turn will be less likely to report expecting UCS in extinction than noninformed subjects. According to the discrimination hypothesis of the PREE it is predicted that subjects in PRF conditioned groups, and in PRF instructed groups, will be more likely to report expecting UCS throughout extinction than in noninformed groups.

These hypotheses, and a statement of experimental design, are listed in the following section.

M E T H O D

2.1 DESIGN AND HYPOTHESES

The acquisition procedures and expectancy manipulation procedures to be applied to the thirteen experimental groups were outlined in the previous section, and are illustrated in figure 1. Three acquisition procedures (CRF25, PRF, and CRF100) are incompletely crossed with four extinction procedures: informed unpairing (stimulator off), informed unpairing (stimulator on), noninformed and instructed PRF . The crossing is incomplete because PRF acquisition is not paired with instructed PRF extinction. The design and subsequent analyses would have been neater if such a group were included, but the neatness would be spurious. PRF instructions in extinction in the PRF acquisition group would not be predicted to increase resistance to extinction, as they are in the remaining acquisition groups. Thus, while filling the missing cell in the design would make it easier to test for main effects, it would seriously compromise what the main effects are predicted to be. In addition, two no acquisition groups are included in the design, on the rationale outlined in the previous section.

Each group includes ten subjects, each tested for responding over four blocks of five extinction trials. Five subjects in each group will be conditioned to dilate to a warm UCS, and five will be conditioned to constrict to a cold UCS. This procedure is employed to control for artifact, as discussed in the previous section. The variable of UCS temperature is not included in the figure.

Experimental groups will be referred to in terms of acquisition and extinction procedures, as indicated in figure 1. The following hypotheses will be tested:

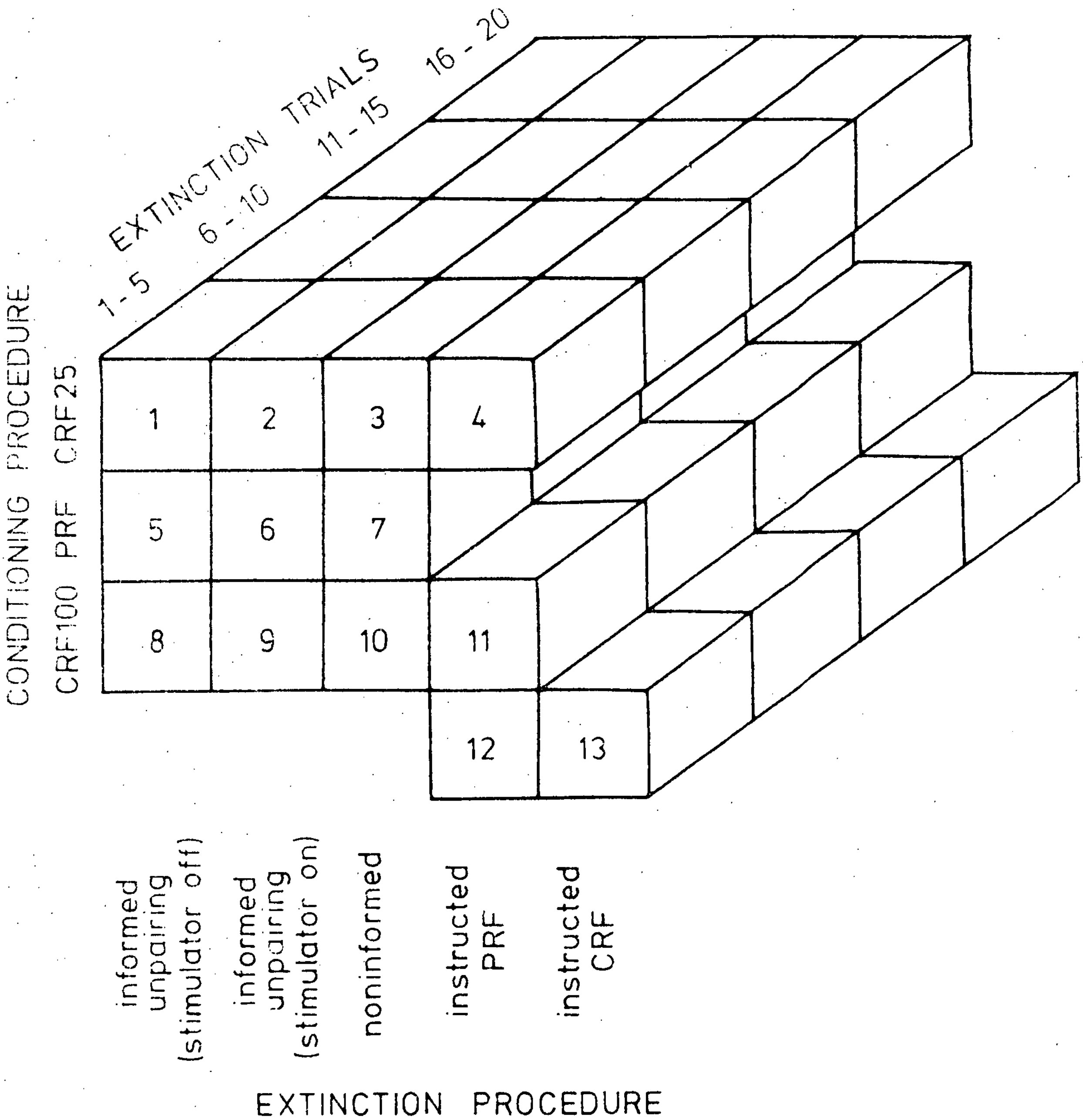

Figure 1. Arrangement of experimental groups.

(1) That responding in CRF 25 and PRF informed unpairing (stimulator off) groups will be abolished at the onset of extinction.

(2) That responding will be generated by instruction alone in the two no acquisition groups. Subject to significant responding being obtained in these groups, it is further hypothesised that the group given PRF instructions will respond more on test trials than the group given CRF instructions.

(3) That responding in CRF 25 and PRF informed unpairing (stimulator on) groups will be significantly greater in extinction than in CRF 25 and PRF informed unpairing (stimulator off) groups.

(4) That responding in CRF 25 and PRF informed unpairing (stimulator on) groups will be significantly less than responding in CRF 25 and PRF noninformed groups.

(5) That the CRF 25 instructed PRF groups will show significantly greater resistance to extinction than the CRF 25 noninformed group.

(6) That fewest subjects will report expecting UCS in extinction in informed unpairing (stimulator off)groups, next fewest in informed unpairing (stimulator on) groups, and most in noninformed groups.

(7) That more subjects in PRF instructed groups will report expecting UCS throughout extinction than in noninformed groups, and more subjects in PRF than CRF conditioned groups will report expecting UCS throughout extinction.

No directional hypotheses will be made concerning performance in extinction of CRF100 groups.

2.2 SUBJECTS

150 undergraduate volunteer subjects were recruited in introductory psychology laboratory classes. All subjects were aged between 17 and 40. They were told before volunteering that the experiment involved conditioning, and that nonpainful thermal stimuli would be used. 17 subjects were eliminated for failing the arrive at their first or second experimental sessions, and 3 subjects were eliminated due to equipment failure. The remaining 130 subjects were divided into 13 equal groups, and then each group was divided into two subgroups, each containing two male and three female subjects. One of these sub-groups was assigned to the warm UCS temperature condition, and the other to the cold UCS temperature condition. Assignment to groups and sub-groups was randomly determined by order of arrival for the first experimental session. Subjects in groups 1, 3, 4, 5, 7, 8, 10 and 11 were run concurrently in the first half of 1978. Subjects in groups 2, 6, 9 and 12 were run concurrently in the first half of 1979, in order to match between groups for possible effects of climate. The only group not so matched was group 13, which was run in the second half of 1978. All subjects were run in late summer and early autumn (except for group 13, which was run in spring) when outside temperature varied between 10°C and 25°C.

2.3 APPARATUS

Subjects sat supine in a reclining armchair in an experimental 3m x 2m room maintained at 23°C (± 1.5°C). This room was connected via a plugboard to a similar room housing a Beckman 4 channel recorder model R511A. The thermal stimulator was a small copper box 5cm x 5cm x 1cm held to the subject's chest just below the sternum by a crepe rubber bandage. This site was chosen on the basis of pilot testing and previous work by Wilson (1972) as being maximally sensitive to warm and cold thermal stimuli. A thermal stimulator rather than water immersion or heated and cooled air was chosen for reasons of convenience, ease of removal, and because pilot testing suggested that the thermal stimulator led to a more reliable UCR.

The stimulator was gravity fed by water from three tanks outside the subjects' room via solenoid switching valves and a $^{3}/_{8}$" internal diameter plastic pipe. A drain pipe from the stimulator to a sink in an adjoining room allowed a continuous flow of water through the stimulator. The temperature of the stimulator between UCS presentations was maintained at 29°C (± 2°C) for all subjects. This temperature was within the range of stimuli judged by subjects in pilot testing to be subjectively neutral. The cold UCS was 8°C (± 2°C), and was maintained at that temperature by adding ice to the water at least 30 minutes before each session. Owing to the large volume of water (12 gallons) and the short duration of sessions, water temperature was always maintained within the set limits. The warm UCS was 40°C (± 2°C), and was maintained at that temperature by means of a thermostatically controlled immersion element, as was the neutral tank (29°C ± 2°C). These temperatures were determined by pilot testing as leading to maximal UCRs.

UCS was normally presented by switching off the solenoid from the neutral temperature tank, and simultaneous switching of the solenoid for either the warm or cold tanks. It was also possible to bypass the solenoid valves by means of manual taps in order to present the UCS silently as was required for UCS presentation in the two no acquisition groups. Water flow could be interrupted by the experimenter by means of a silent manual valve.

The time delay between switching of the solenoid and temperature change at the stimulator was maintained at 10 seconds by tuning the pipe length and tank height and constituted the ISI (CS onset - UCS onset). A 52 db tone of 4,500 Hz switched concurrently with the audible solenoids constituted the CS. CS and UCS duration were both 30 seconds, and owing to the ten second ISI there was a 20 second overlap between CS and UCS.

Response measures were: (1) *Blood volume*. A Beckman radial photocell transducer model 215660 was attached to the subject's right index finger. The signal was fed to the pen recorder through a bridge circuit and a Beckman 9853A general purpose coupler in D.C.mode. The bridge circuit was used to correct for individual differences in tissue opacity by adjusting the photocell light source until the photocell resistance measured 150k ohms. For all subjects amplification was set at 5 mv/mm. For most subjects this led to a small pulse wave on the blood volume record of approximately 1mm. (2) *Pulse size* was measured by amplifying the blood volume signal until the pulses were between 3cm and 6cm. A time constant (0.3sec) was used to maintain the pen within the limits of its travel. (3) *Respiration*. A mercury in rubber strain gauge encircled the subject's chest just above the thermal stimulator. The signal was fed into a Beckman 9806A coupler in channel 3 of the recorder via a Parks Electronics Laboratory plethysmograph model 270 in A.C. mode with a time constant of 5 sec. (4) *Surface temperature of the thermal stimulator*. A digitron patch thermocouple model 175/9 was attached with tape to the outside surface of the stimulator, and connected by fine wires to a Digitron digital thermometer (Model 275). The signal was fed into a Beckman 9806 coupler in D.C. mode in channel 4 of the recorder. This measure provided a check on the operation of switching apparatus.

2.4 PROCEDURE

2.4.1 Acquisition

2.4.1(a) CRF 25

Groups 1, 2, 3 and 4 were conditioned using 25 trials of continuous reinforcement. On arrival for their first experimental session, subjects were informed that they would have to attend for two sessions, and were told whether the stimuli would be warm or cold. The experimenter explained the purpose of the pickup transducers and the thermal stimulator while attaching them. A brief explanation was given as to how the photocell plethysmograph and strain gauge operated, and subjects were told that the temperature of the thermal stimulator was changed by running different temperature water through it. The sonalert mounted on the plugboard was pointed out, and subjects were told that this would produce a tone a few seconds before the temperature change was presented. Subjects were also told that they may find on some trials that the temperature change would not follow the tone, and that if this happened they were not to worry, as it was a normal part of the procedure in some groups, and that the experimenter was constantly monitoring the temperature and temperature changes via the thermal probe mounted on the thermal stimulator. This instruction was included since it was found in pilot testing that many subjects called out to the experimenter that UCS had not been presented during the first few extinction trials. This was a problem, since it led to movement and breathing artifacts that precluded the scoring of these important trials. Subjects were told that the responses given were automatic, and that therefore they were not required to do anything beyond relaxing, listening for the tone, and trying not to make any unnecessary movement such as coughs or sneezes while the tone was on. They were also informed that there would be a delay of five minutes while they accommodated to room temperature, and were told of the expected duration of the session.

During the five minute accommodation period neutral temperature water was circulated through the stimulator. At the end of the five minutes the first trial was presented by switching the solenoids to the appropriate tank concurrently with the tone for 30 seconds. Trials were presented at sixty second intervals, but were withheld for up to a further 30 seconds if there was instability in the blood volume record. Fifteen acquisition trials were presented in the first session, after which the experimenter returned to the subject room, removed pickup transducers, thanked the subject for his participation and booked a time for the second session.

On arrival for the second session, subjects were treated as before, except that instructions concerning the purpose of pickup transducers were not repeated. There were ten conditioning trials in the second session, after which the experimenter went in to the subject room and delivered instructions appropriate to each extinction condition.

2.4.1(b) PRF

Groups 5, 6 and 7 were conditioned using 100 trials of 25% partial reinforcement.[1] On arrival for their first experimental sessions, subjects were informed that they would have to attend for four sessions, and were told whether the stimulus would be warm or cold. The experimenter gave the same instructions concerning pickup transducers, the nature of the response and contingencies, duration of the sessions and so forth, as were given to the previous groups. At the end of the five minute accommodation period the first trial was presented by switching the solenoids to the appropriate tank, concurrently with

1. Thirty acquisition trials in each of the first three sessions, ten acquisition and twenty extinction trials in the final session.

the tone, for 30 seconds. Trials were reinforced on a 25% semi-random partial reinforcement schedule. Trials 1, 7, 11, 18, 19, 21, 29 and 30 were reinforced in the first session, trials 4, 6, 9, 12, 23, 26 and 27 were reinforced in the second session, trials 2, 7, 8, 10, 15, 20 and 26 were reinforced in session three, and trials 1, 3 and 10 were reinforced in the final session. This schedule was obtained with the use of a table of random numbers, the only modification being to ensure that the first and last conditioning trials were reinforced. On trials where UCS did not follow CS, the solenoid valves were still switched with the tone, but water flow and therefore presentation of the UCS was precluded for the duration of the trial by turning off the silent manual water tap. This ensured that unreinforced trials were signalled to the subject only by the failure of the temperature to change.

This procedure was repeated for sessions two and three, the only difference being that instructions concerning the nature of pickup transducers were not repeated. Session four differed from previous sessions in that only ten conditioning trials were presented, after which the experimenter entered the subject room and delivered instructions appropriate to each extinction condition.

<u>2.4.1(c)</u> CRF100

Groups 8, 9, 10 and 11 were given the same acquisition procedures as groups 5, 6 and 7, except that all conditioning trials were reinforced. This resulted in 100 continuously reinforced trials.

<u>2.4.1(d)</u> No Acquisition

Groups 12 and 13 were given procedures designed to preclude any possibility of the tone and temperature change being associated before extinction. On arrival for their first experimental session, subjects were informed that they would have to attend for one session only, and were told whether the stimulus would be warm or cold. The experimenter gave the usual instructions concerning the pickup transducers and the nature of the response, but no mention was made of stimulus contingencies or the existence of the tone. Subjects were asked to try to avoid violent movements such as coughs and sneezes, were told that there would be a delay of five minutes while they accommodated to room temperature, that after this period there would be a single presentation of the temperature change and that after this the experimenter would return to explain the procedure from then on.

During the five minute period, neutral temperature water was circulated through the stimulator. At the end of the five minute period the first trial was presented by operating silent manual taps to the appropriate tanks, without, of course, sounding the tone. In this way the single experience of UCS of subjects in these groups occurred without experience of either component (tone or solenoid) of the CS. After presentation of the temperature change, the experimenter returned to the subject room and delivered instructions appropriate to each extinction condition.

2.4.2 Extinction

2.4.2(a) Informed Unpairing (stimulator off)

Groups 1, 5 and 8 were given procedures designed to abolish expectancy of UCS presentation in extinction. On returning to the subject room after the final conditioning trial, the experimenter removed the thermal stimulator, and said:

> "From now on there will be no further temperature changes. However, there will be a series of trials with just the tone alone for the rest of the session. As before, try not to move around, cough or sneeze in periods when the tone is on. There will now be a break of two minutes before

the next trial; during that time you can move about as much as you please."

The experimenter then returned to the other room, turned off the manual water tap, preventing circulation of the water through the system. There were twenty presentations of the CS (tone and solenoids) alone, scheduled as before.

At the end of the twenty trials, pickup transducers were removed from the subject and a structured post experimental recall questionnaire was given. Subjects were asked a series of questions concerning their expectation of UCS in acquisition and in extinction, their degree of belief in instructions given at the onset of extinction and changes in these expectancies over extinction trials. They were also asked to report what in general they had been thinking about during the experiment, whether they detected thermal sensations following the CS in extinction, whether they had used any cognitive strategies in an attempt to influence their responding, whether they had been comfortable during the experiment, and whether the UCS had been experienced as pleasant or unpleasant (see appendix D)

2.4.2(b) Informed unpairing (stimulator on)

Groups 2, 6 and 9 were given extinction procedures designed to reduce expectancy of UCS at the onset of extinction by instruction alone. The same procedures and instructions were used as for groups 1, 5 and 8 above, except that the thermal stimulator was not removed at the onset of extinction.

2.4.2(c) Noninformed

Groups 3, 7 and 10 were given traditional noninformed extinction procedures. On returning to the subject room after the final conditioning trial the experimenter said:

> "there will now be a break of 2 minutes before the next trial; during that time you can move about as much as you please."

No further instructions were given concerning the nature of the ensuing trials, and the thermal stimulator was not removed. In all other respects groups 3, 7 and 10 were given procedures identical to groups 1, 5 and 8.

2.4.2(d) Instructed PRF

Groups 4 and 11 were given extinction procedures designed to simulate the same expectancy of UCS in extinction as is found in subjects conditioned with PRF procedures. On returning to the subject room after the final conditioning trial, the experimenter said:

> "From now on a random partial reinforcement schedule will be used. That means that the temperature change will only follow the tone on about one trial in four on average. Of course, owing to the random nature of this schedule, it is possible that there could be a long series of trials on which the temperature change would not come, or a string of trials on which the temperature change always comes. There will now be a break of 2 minutes before the next trial; during that time you can move about as much as you please."

The thermal stimulator was not removed, and no further instructions were given concerning the nature of the ensuing trials. In all other respects groups 4 and 11 were given the same extinction procedures as were groups 1, 5 and 8. There were no reinforced trials in extinction.

2.4.2(e) No Acquisition: Instructed PRF

Group 12 was given instructions designed to produce an expectancy of reinforcement similar to that found in subjects given partial reinforcement procedures. On returning to the subject room after presentation of the temperature change, the experimenter informed subjects:

> "From now on there will be a tone that comes on a few seconds before the temperature change. You will find, however, that the temperature change will only follow the tone on about one trial every four on average, as a random partial reinforcement schedule is

> being used. Of course, owing to the random nature of this schedule, it is possible that there could be a long series of trials on which the temperature change would not come, or a string of trials on which the temperature change always comes. Whatever happens, don't worry, as I always know when the temperature changes and when it doesn't from the temperature pickup on the stimulator. Try not to move about, cough, or sneeze in periods when the tone is on. There will now be a break of two minutes before the next trial; during that time you can move about as much as you please."

The manual water tap was turned off, precluding circulation of water through the system regardless of the operation of the solenoids. There were twenty presentations of the tone alone scheduled in the same way as previous groups. The solenoids were switched with the tone in order to ensure that the CS complex was of the same salience as in other groups. At the end of the twenty trials pickup transducers were removed from the subject and a structured post experimental questionnaire was given as in previous groups.

2.4.2(f) No Acquisition: Instructed CRF

Group 13 was given instructions designed to produce an expectancy of reinforcement similar to that found in subjects given continuous reinforcement procedures. On returning to the subject room after the presentation of the temperature change, the experimenter said:

> "From now on there will be a tone that comes on a few seconds before the temperature change. You may, however, find that on some trials the temperature change will not follow the tone. If this happens, don't worry; it is quite normal for that to happen in some groups. Anyway, I always know when the temperature changes and when it doesn't from the temperature pickup on the stimulator. Try not to move about, cough or sneeze in periods when the tone is on. There will now be a break of two minutes before the next trial, during that time you can move about as much as you please."

In all other respects group 13 was given procedures identical to group 12. There were no reinforced trials in extinction.

2.5 SCORING PROCEDURE

The major advantage of the vasomotor response in conditioning experiments is that, because of its bidirectional nature, it is possible to isolate conditioned responding from artifact such as the orienting response by comparing responding in subject conditioned to dilate to a warm UCS with that in subjects conditioned to constrict to a cold UCS (Sokolov, 1963). In order to take advantage of this feature it is first necessary to devise a scoring procedure sensitive to both dilations and constrictions that would allow treatment of the records of subjects conditioned to dilate and those conditioned to constrict in the same way. Such a scoring procedure must be able to deal with several characteristics of the vasomotor system.

Firstly, it cannot be assumed that the latency and rise times of constrictions and dilations will be the same. Vasoconstriction is an active process, controlled by sympathetic vasomotor fibres. Vasodilation, however, is due entirely to the release of vasoconstrictor tone (Lader, 1967). Accordingly, it is to be expected that latency and rise time will be slower for dilations than for constrictions. A search of the literature failed to reveal data that could be used to determine comparative latencies for dilations and constrictions, and the available data on normative latencies for constrictions serves only to demonstrate the importance of using only data derived from an identical experimental paradigm using the same procedures. Latencies are known to vary widely with different room temperature and measurement techniques (Shmavonian, 1958), pickup sites and subject variables (Brown, 1967). Analysis of pilot test data, however, revealed that while for constrictions the median time for a deflection of .5mm or greater to take place in the appropriate direction was less than 5 seconds, the median for dilations was over ten seconds, with both dilations and constrictions showing a wide range of latencies within and between subjects.

Secondly, and for the same reason, the magnitude of constrictions is much greater than for dilations. Examination of pilot test data revealed that this effect also holds within and between subjects. Even in subjects conditioned to dilate to a warm UCS, the magnitude of trials characterised by constriction (such as an OR) are considerably larger than those characterised by dilation. Similar results were obtained by Zimny and Miller (1966). A wide range of scoring procedures have been used with the vasomotor response, but the majority can be categorised under three headings: digital pulse volume, maximum change, and area under the curve (mean change) measures.

Digital pulse volume is perhaps the most commonly used measure of vasomotor change (e.g., Furedy, 1967; Ginsberg & Furedy, 1974). This procedure involves isolation of the two pulses representing response onset and termination, and measuring the difference in magnitude between them. Owing to the difference in latencies between dilations and constrictions, and their great variance, this procedure is inappropriate for scoring records in which responses in both directions are of interest. Relaxing the latency criteria as much as would be required to overcome this problem would result in the measure becoming one of variance within the selected period.

Maximum blood volume change is also a common scoring procedure, and involves measuring the maximum deflection of a response starting within a given period (e.g., Zimny & Miller, 1966). Taking account only of the maximum deflection is perhaps appropriate where the topography of the response and close time locking of scoring are used to identify a particular segment of the response period as the response of interest. Under these circumstances it can be argued that maximum deflection of a response starting within a closely defined interval represents the magnitude of the response. Where latencies cannot be so closely defined, as in the present experiment, such a procedure is, however, clearly inappropriate. When wide latency criteria are applied, as would be required to accommodate both constrictive and dilative responses, this procedure amounts to taking the maximum deflection within a given trial as the sole representation of responding within that trial. As well as the usual problems of reliability associated with taking a single score to represent a group of scores, in this case taking maximum deflection as the score for each trial would result in a bias in favour of the relatively more labile constrictive component of the vasomotor response. For example, on trials with a brief constriction (for example, an OR to the CS) followed by a sustained but relatively small dilation, a measure of maximum change would classify the trial as constrictive even when the mean tendency is dilative.

Area under the curve is less commonly used, but is appropriate where close time locking of responses is not available or not required. In this procedure a relatively long response interval is selected, typically starting at the onset of an event of interest and ending with the termination of that event, where this period is known to be longer than the rise time of the response involved (e.g., Lovallo & Zeiner, 1975). This procedure takes account of all responses occurring within the selected period. Because the area under the curve is a measure of mean rather than maximum response change it takes account of all features present in a given period, and is therefore equally sensitive to small magnitude but long duration dilations and large magnitude but relatively short duration constrictions such as are frequently found at the beginning of dilatory responses. For these reasons a measure based on the area under the curve was selected as most appropriate for determining whether a given response period should be considered constrictive or dilative. Determining the magnitude of a dilation or constriction by this means would, however, present further difficulties arising from the consistently greater amplitude of constrictions. As outlined in section 1.5, artifact control with this preparation is based on comparing conditioned dilations and conditioned constrictions in each experimental group; the response measure must therefore be equally sensitive to dilations and constrictions. Since, by any straightforward measure, constrictions are larger than dilations, any measure based on response magnitude would bias the results towards constrictions. Conceivably dilations and constrictions could be made equivalent by scoring them in standard deviation units based on the response distribution of each response component separately. The between subject variation in response magnitude would make such a measure extremely difficult to interpret, however. Instead, it was decided to score each response simply as dilative or constrictive, or, where necessary, as no response, by the area under the curve criterion. This measure sacrifices some of the information in the response record. For this reason it is a conservative measure, and less likely than a more extreme one to capitalise on the idiosyncratic features of the experimental preparation.

Accordingly, the final ten conditioning trials in groups 1-11, and the twenty extinction trials in all groups were scored in the following way. A line was drawn horizontally along the blood volume record at the height of the small pulse wave immediately preceding CS onset for all trials. The 30 second CS duration (incorporating a 20 second interval in which UCS was presented on conditioning trials) was divided into six 5 second periods. For each five second period the average deviation of a line drawn through the peaks of the small pulse waves of the blood volume record from the horizontal line was scored to the nearest .5mm. These average deviations were summed across the six intervals for each trial to produce a mean change score. These mean changes were transformed to +, -, and 0 scores. Trials with a positive mean score were assigned a +, those with a negative mean score were assigned a -, and those with a mean score of 0 were assigned a 0. 0 scores represented 10.5% of the total number of scores. Non parametric data has been used by Baer and Fuhrer (1970) to overcome similar distributional difficulties in blood volume data. Trials on which major respiratory changes or body movements coincided with changes in the blood volume record were not scored (Brown, 1967). This procedure resulted in the rejection of 3% of trials from scoring. *On target* responses were defined as dilations in subjects conditioned with a warm UCS and constrictions in subjects conditioned with a cold UCS. *Off target* responses were defined as constrictions in subjects conditioned with a warm UCS and dilations in subjects conditioned with a cold UCS. The proportion of on target responses to the total of on and off target responses (excluding 0 responses) given by each subject for each block of five trials was determined. Proportions, rather than absolute number of on-target responses, were used since absolute number of on-target responses would be spuriously greater in more labile subjects. 0 responses were deleted, rather than added to off-target responses, for the same reason. These proportions were then Arcsin transformed as Winer (1971) recommends for proportional data, using the formula $X' = 2 \arcsin\sqrt{X}$. This transformation resulted in a normalisation of data. Prior to this transformation Bartlett's test for homogeneity of variance was significant.

In order to avoid the spuriously inflated variance that would otherwise result from the fact that generalised responding adds to measured responding in cold UCS subgroups, but subtracts from it in warm UCS subgroups, UCS temperature is treated as an additional variable in analyses of variance between groups.

Figure 2 illustrates the scoring procedure. The sample responses shown were selected from the data record to illustrate the constraints on scoring discussed above.

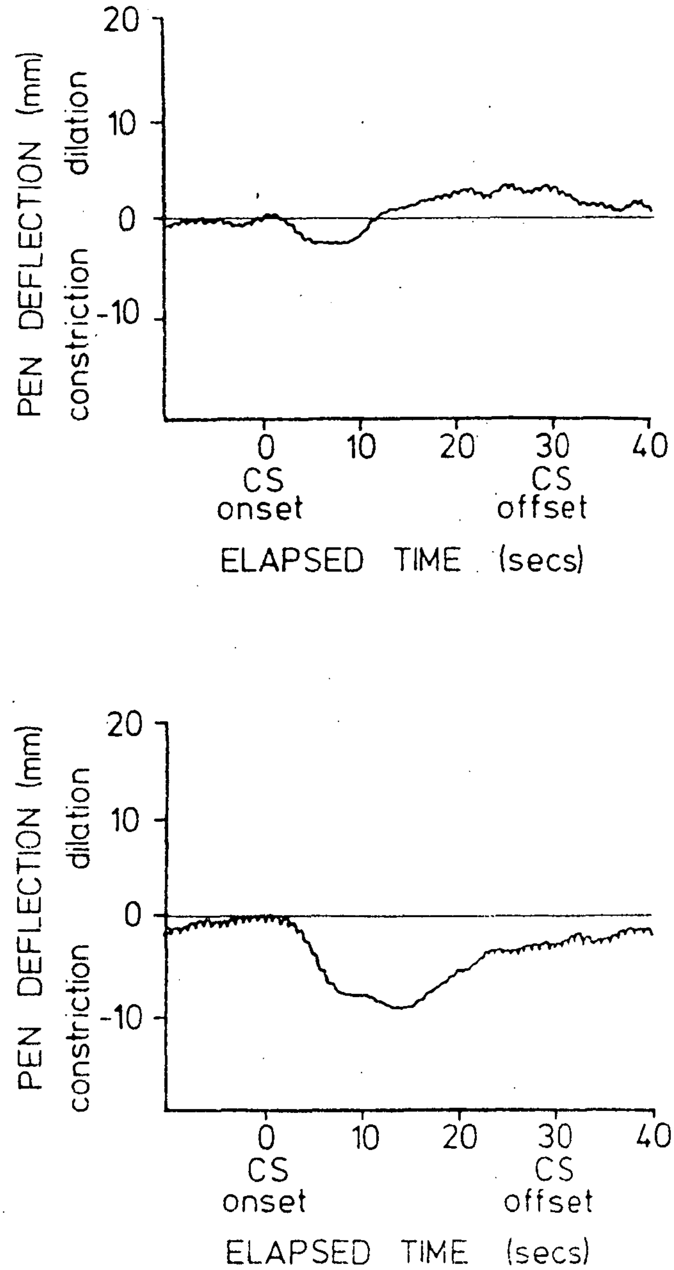

Figure 2. Samples of the blood volume record showing dilation (above) and constriction (below) to illustrate the scoring procedure.

RESULTS AND DISCUSSION

3.1 ACQUISITION DATA

It is necessary to establish whether acquisition procedures were successful in generating responding before determining the effects of expectancy manipulation on responding in extinction. The measure of conditioned responding for groups will be taken over each group as a whole, since, as was argued previously, the level of responding in warm and cold UCS subgroups separately is not interpretable. It is nonetheless of interest to establish whether responding to the CS-UCS complex is in the appropriate direction, and whether above chance on-target responding to the CS is obtained in both warm and cold UCS subgroups. Accordingly, in this section, evidence for above chance on-target responding in each subgroup separately as well as for the groups as a whole will be considered. In all cases, chance level of responding = .7854 (arcsin transformation of .5).

3.1.1 Responding to the CS-UCS complex in acquisition

In order to demonstrate that the response to the CS paired with the warm UCS was consistently dilation, and that the response to the CS paired with the cold UCS was consistently constriction, the mean proportion of on-target responding on the final ten reinforced trials of all eleven groups given acquisition trials was examined. Significantly above chance on-target responding to the CS-UCS complex was obtained in warm UCS subgroups of CRF25 conditioned groups, $t\ (19) = 1.78$, p (one tailed) $< .05$; the PRF conditioned groups, $t\ (14) = 1.82$, p (one tailed) $< .05$; and in the CRF 100 conditioned groups, $t(19) = 2.14$, p (one tailed) $< .05$. Similarly, significantly above chance on-target responding to the CS-UCS complex was obtained in cold UCS subgroups of CRF25 conditioned groups, t (19) = 4.64, p (one tailed) < .001; in the PRF conditioned groups, t (14) = 6.36, p (one tailed) < .001 and in the CRF100 conditioned groups, t (19) = 4.37, p (one tailed) < .001. This shows that the response to the CS-UCS complex was in the predicted direction in both warm and cold UCS subgroups. Table 1 shows mean responding in warm and cold UCS subgroups of each of the three conditioning procedures over the final ten acquisition trials. The trend for greater on-target responding in cold UCS subgroups cannot be interpreted as evidence for greater conditionability of constrictions than dilations, owing to the fact that artifact adds to measured responding in cold UCS subgroups but subtracts from it in warm UCS subgroups (as discussed in section 2.5). As was argued in that section, artifact can only be avoided by dealing with warm and cold UCS subgroups together.

Analysis of variance performed on the 11 conditioned groups over the two final five trial acquisition blocks revealed no significant differences between groups, F (10,68) = .45, n.s. This shows that any differences obtained in responding between groups in extinction are not due to initial differences in their level of responding. There was also no significant trials effect, F (1,68) = 1.59, n.s. The lack of difference between groups suggests that the three acquisition procedures led to essentially similar terminal response rates, and this, coupled with the lack of a significant trials effect, suggests that additional trials beyond 25 given to CRF100 groups were overlearning trials.

3.1.2 Responding to the CS alone in acquisition

To determine whether conditioned responding to the CS was obtained in PRF conditioned groups, an analysis of the seven unreinforced trials of the final ten conditioning trials of PRF conditioned groups was performed. Above chance responding was obtained, $t = 3.58$, p (one tailed) $< .01$. Above chance responding was also obtained in warm and cold UCS subgroups tested separately, $t\ (14) = 2.07$, p (one tailed) $< .02$ and $t\ (14) = 3.45$, p (one tailed) $< .005$ respectively. This shows that conditioned responding to the CS was obtained in PRF conditioned groups, and confirms Bykov's (1959) finding that the CR to the CS was consistently dilation in warm UCS subgroups and constriction in cold UCS subgroups.

Analysis of responding during the CS-UCS interval on reinforced trials was potentially available to demonstrate conditioned responding to the CS alone during acquisition in CRF conditioned groups. Analysis of variance performed on responding in the ten second CS-UCS interval over the two final five trial acquisition blocks revealed no significant differences between groups, $\underline{F}\ (7,64) = .72$, n.s., and there was no significant trials effect, $\underline{F}\ (1,64) = .12$, n.s. Significantly above chance on-target responding to the CS alone was established in these groups over the final ten acquisition trials, $t\ (79) = 2.76$, p (one tailed) $< .005$. However, the warm UCS subgroups responded non significantly below chance $t\ (39) = 1.13$, n.s. This failure to demonstrate significant responding in the CS-UCS interval of warm UCS subgroups was predicted, owing to the relatively slow rise time of dilations as compared with constrictions, and is part of the justification for the use of the entire thirty second interval in the scoring of responding (see section 2.5). Because responding in warm UCS subgroups cannot be assessed on acquisition trials, it is not possible to examine the rate of acquisition, or the interesting issue of whether responding was established by instructions alone from the first acquisition trial in conditioned groups. This issue will be dealt with in section 3.3 by analysis of responding in the two no acquisition groups.

TABLE 1. Mean on-target responding in warm and cold UCS subgroups of CRF25, CRF100, and PRF conditioned groups over the final ten conditioning trials (Arcsin transformed). Chance level of responding = .7854.

	CRF25	CRF100	PRF
Warm UCS	.8571525	.859555	.9076766
Cold UCS	1.11894	1.1071975	1.0425733

TABLE 2. Mean on-target responding in warm and cold UCS subgroups of PRF conditioned groups over the final seven unreinforced trials (Arcsin transformed). Chance level of responding = .7854.

Warm UCS	.91923
Cold UCS	.92414

TABLE 3. Mean on-target responding in warm and cold UCS subgroups of CRF25 and CRF100 conditioned groups in the CS-UCS interval over the final ten conditioning trials (Arcsin transformed). Chance level of responding = .7854.

	CRF25	CRF100
Warm UCS	.701435	1.181255
Cold UCS	.708815	1.0319775

TABLE 4. Mean on-target responding in warm and cold UCS subgroups of CRF25, CRF100, and PRF groups over the first five extinction trials (Arcsin transformed). Chance level of responding = .7854.

CRF25	Warm UCS	1.0150
	Cold UCS	1.1020
CRF100	Warm UCS	1.0391
	Cold UCS	1.2042
PRF	Warm UCS	.9425
	Cold UCS	1.1840

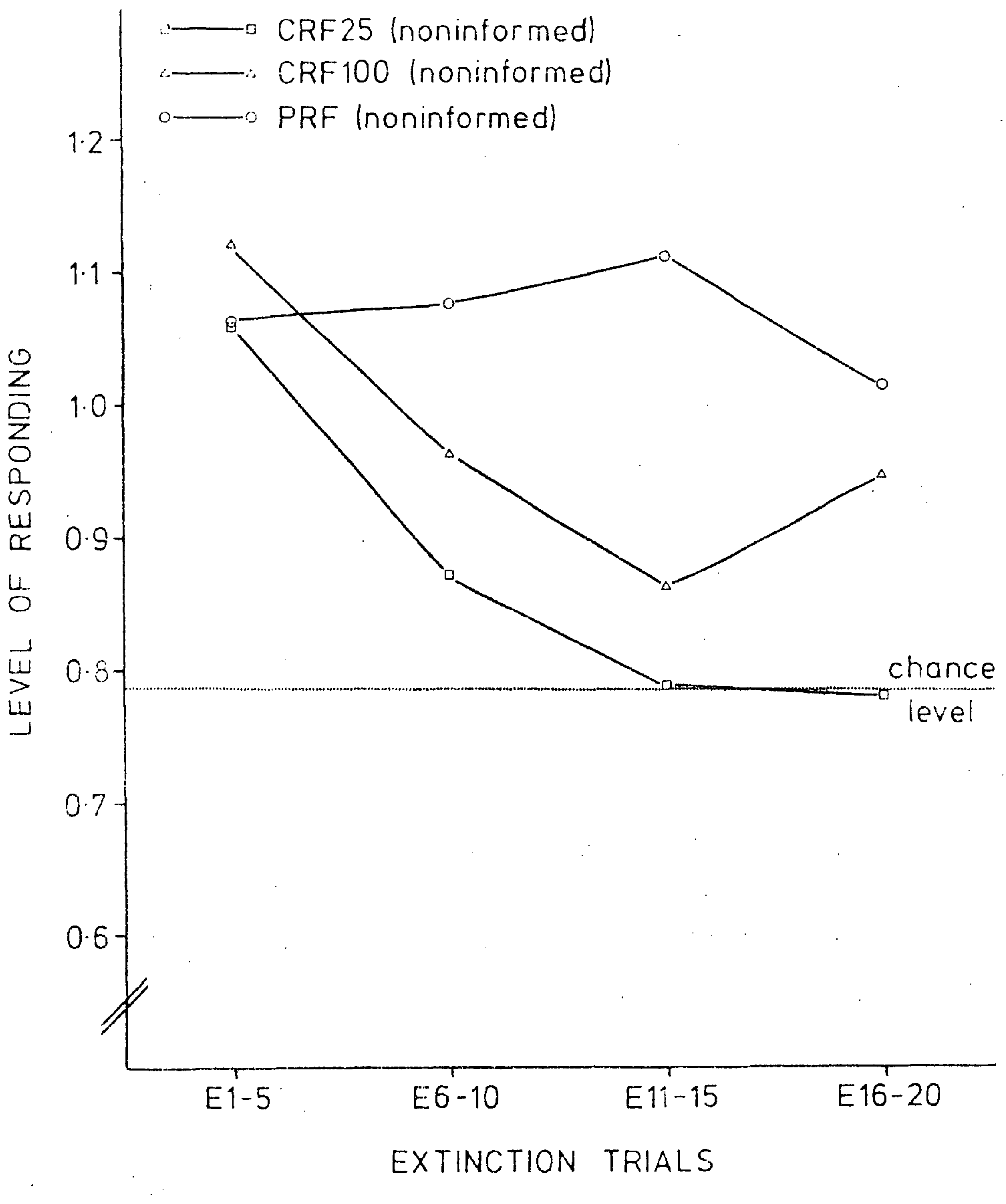

Figure 3. Mean proportion of on-target responding over the four extinction trial blocks in the three noninformed groups.

3.1.3 Responding in noninformed groups in extinction

Analysis of responding in the three traditionally extinguished (noninformed) groups provides additional evidence that conditioning has taken place. Significantly above chance on-target responding was found in the first block of five extinction trials in the CRF25 noninformed group, $t\ (9) = 2.57$, p (one tailed) $< .05$; the PRF noninformed group, $t\ (9) = 2.15$, p (one tailed) $< .05$; and in the CRF100 noninformed group $t\ (9) = 2.75$, p (one tailed) $< .05$. Both warm and cold UCS subgroups of the three groups showed significantly above chance responding over the first extinction trial block, $t\ (14) = 2.65$, p (one tailed) $< .01$, and $t\ (14) = 4.54$, p (one tailed) $< .001$ respectively. Interestingly, the CRF25 noninformed group shows a traditional extinction curve, while CRF100 and PRF groups show the expected greater resistance to extinction, responding throughout the four extinction trial blocks (see Fig. 3). These findings will be analysed in later sections.

3.1.4 Summary of acquisition data

The above evidence demonstrates that conditioning was successfully obtained with all three conditioning procedures. Specifically, the results presented in this section show that responding to the CS-UCS complex was consistently in the predicted direction in both warm and cold UCS subgroups, that significantly above chance on-target responding to the CS was obtained in the CS-UCS interval, and that significantly above chance on-target responding was obtained over the first block of extinction trials in the three noninformed groups. While, as was pointed out in section 2.5, it is not possible conclusively to demonstrate conditioned responding in either the warm or cold UCS conditioned subgroups separately, the overall on-target responding obtained, with above chance on-target responding in both the warm and cold UCS conditioned subgroups, is strong evidence that conditioning has taken place within the group as a whole.

3.2 EXTINCTION IN GROUPS GIVEN UNPAIRING INSTRUCTIONS AND WITH THE THERMAL STIMULATOR REMOVED

In order to determine the effects of unpairing instructions and removal of the thermal stimulator on responding in extinction, analysis of variance was performed on responding over the four extinction trial blocks in the three groups given unpairing instructions coupled with removal of the thermal stimulator at the onset of extinction, and the three groups given traditional noninformed extinction procedures. This analysis revealed an expectancy manipulation effect, $\underline{F}$ $(1,144) = 13.14$, $p < .001$, a conditioning procedure effect, $\underline{F}$ $(2,144) = 3.28$, $p < .05$, and an expectancy by conditioning procedure interaction, $\underline{F}$ $(2,144) = 3.35$, $p < .05$. Examination of Figs. 4, 5 and 6 showing mean responding in noninformed and informed unpairing (stimulator off) groups given CRF25, CRF100, and PRF acquisition procedures respectively over the four blocks of extinction trials, suggests that this interaction is due to the PRF and CRF25 groups showing a greater expectancy manipulation effect than the CRF100 group. Analysis of variance performed on responding over the four extinction trial blocks in each of the three pairs of informed unpairing (stimulator off) and noninformed groups revealed that while for both the PRF and CRF25 groups significantly more responding was obtained in the noninformed than in the informed groups, $\underline{F}$ $(1,48) = 11.11$, $p < .005$, and $\underline{F}$ $(1,48) = 6.37$, $p < .025$ respectively, there was no significant difference between the two CRF100 groups, $\underline{F}$ $(1,48) = .32$, n.s. This shows that unpairing instructions coupled with removal of the thermal stimulator led to reduced responding in extinction only in CRF25 and PRF groups.

Examination of the means for the PRF and CRF25 informed unpairing (stimulator off) subgroups (see Table 5) reveals that their responding was below chance on the first extinction trial, the first block of

TABLE 5. Mean on-target responding on the first extinction trial, over the first extinction trial block, and over the four extinction trial blocks in CRF25, CRF100, and PRF informed unpairing (stimulator off) and noninformed groups (Arcsin transformed). Chance level of responding = .7854.

	First Extinction Trial	First block of five extinction trials	Four blocks of five extinction trials
CRF25 informed unpairing (stim.off)	.73531	.78535	.75513
CRF25 noninformed	.99116	1.0585	.87469
CRF100 informed unpairing (stim.off)	.83548	1.03708	.92832
CRF100 noninformed	1.24905	1.121615	.97367
PRF informed unpairing (stim.off)	.68472	.67061	.74914
PRF noninformed	1.07658	1.06326	1.06658

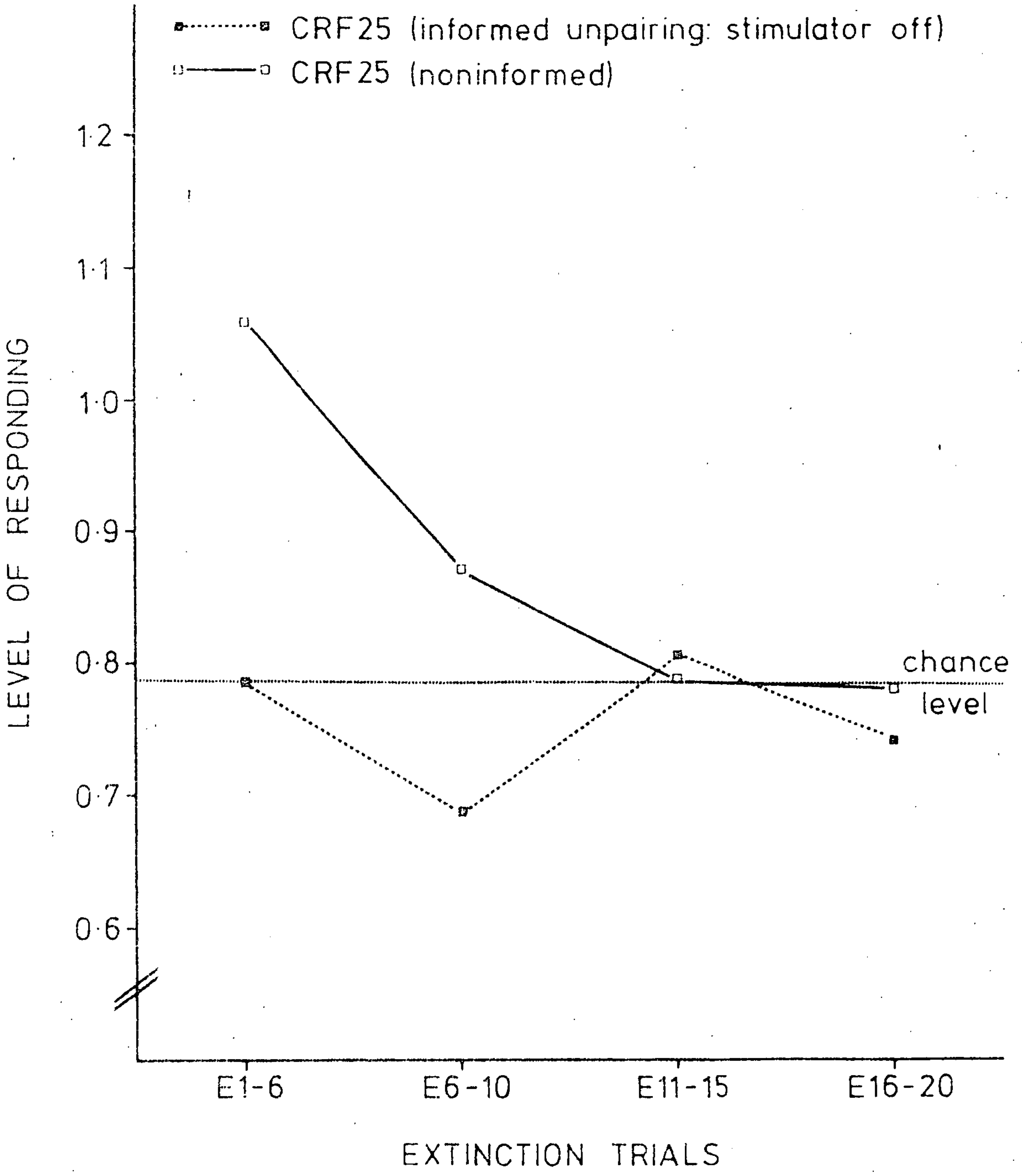

Figure 4. Mean proportion of on-target responding over the four extinction trial blocks in the CRF25 informed unpairing (stimulator off) and noninformed groups.

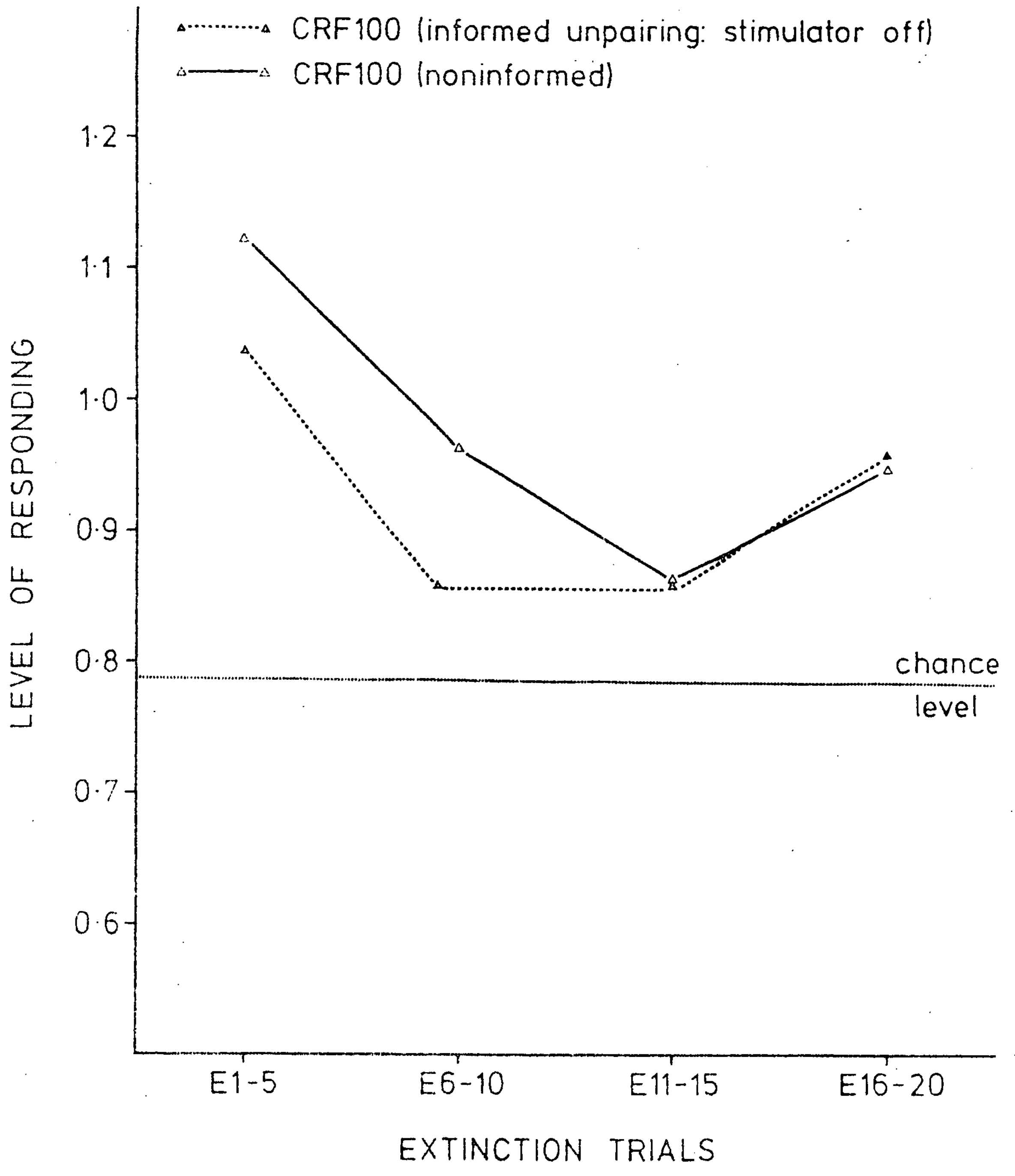

Figure 5. Mean proportion of on-target responding over the four extinction trial blocks in CRF100 informed unpairing (stimulator off) and noninformed groups.

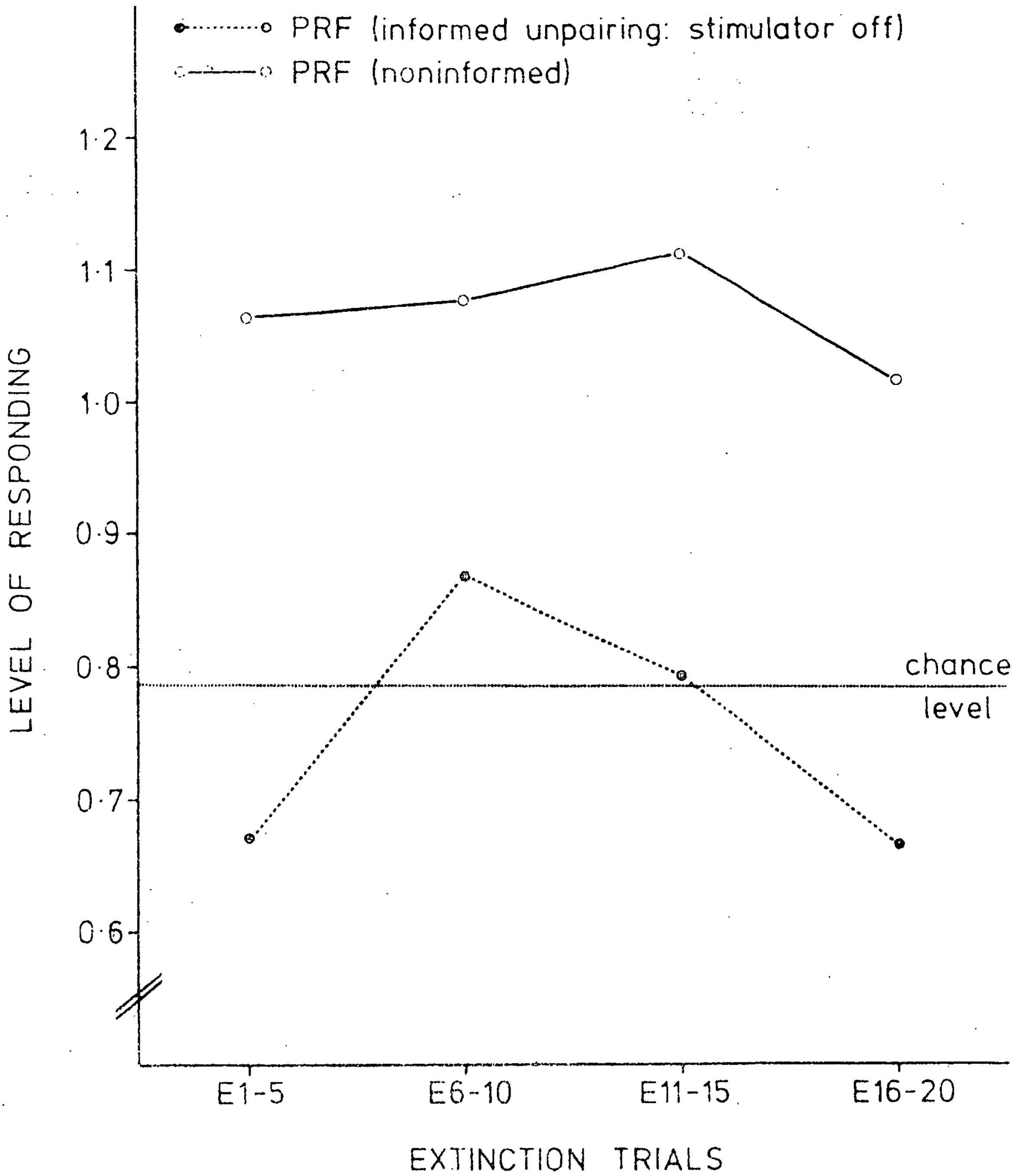

Figure 6. Mean proportion of on-target responding over the four extinction trial blocks in PRF informed unpairing (stimulator off) and noninformed groups.

extinction trials, and over the average of all four extinction trial blocks. Separate t tests performed on each of the four extinction trial blocks in each of these groups showed that none of the fluctuations above or below the chance level approached significance. Responding in the CRF100 informed group, and in the three noninformed groups, was above chance on the first extinction trial. Since individual responses are categorised as +, -, or 0, this effect was tested by sign test. Significantly above chance responding was obtained, $N = 37$, $a = 10$, p (one tailed) $< .01$. As was discussed in the previous section, significantly above chance on-target responding was obtained over the first block of five trials in each of the three noninformed groups. Significantly above chance on-target responding was also obtained over the four extinction trial blocks in PRF and CRF100 noninformed groups, $t\ (9) = 3.43$, p (one tailed) $< .005$; and $t\ (9) = 2.81$, p (one tailed) $< .02$ respectively. Additionally, significantly above chance on-target responding was obtained over the four extinction trial blocks in the CRF100 informed unpairing (stimulator off) group, $t\ (9) = 3.44$, p (one tailed) $< .005$. Although significant responding was not obtained in extinction in CRF25 and PRF informed unpairing (stimulator off) groups, it is interesting to note that significantly more on-target responding was found in the cold than in the warm UCS subgroups of the CRF25 informed unpairing (stimulator off) group, $\underline{F}\ (1,24) = 12.95$, $p < .01$. A non significant trend in the same direction was also obtained in the PRF informed unpairing (stimulator off) group, $\underline{F}\ (1,24) = .59$, n.s. This finding, however, cannot be interpreted as evidence for residual conditioned responding in the cold UCS subgroups of these groups, as there are a comparable number of constrictions shown in the warm UCS subgroups (as indicated by their below chance on-target responding, and the overall below chance on-target responding for the group as a whole). Instead, this effect should be interpreted as artifact, such as orienting responses, inflating measured responding in the cold UCS conditioned subgroup and deflating it in the warm UCS conditioned subgroup.

The finding of no trial extinction in CRF25 and PRF informed unpairing (stimulator off) groups supports hypothesis 1; that responding in CRF25 and PRF informed unpairing (stimulator off) groups will be abolished at the onset of extinction. This finding also supports a cognitive account of extinction, as it shows that awareness of extinction contingencies is a sufficient condition for abolition of conditioned responding following these conditioning procedures. Attempts to account for this no trial extinction on the basis of a lack of generalisation of conditioned responding to the novel situation in which the thermal stimulator was removed (and therefore in which the conditioned response, although present, was simply not evoked by the novel stimulus complex) can be discounted unless the novelty is couched in cognitive terms. That is to say, it is not the difference between stimuli present during the conditioning and extinction phases as such that led to extinction; it is the meaning to the subject of this stimulus change. This conclusion is based on the interesting study by Jennings *et al.* (1978) mentioned in section 1.3.3(c).

Although, as was argued earlier, the Jennings study cannot be used to conclude that there was no residual responding in subjects aware that the UCS will no longer follow CS, intergroup comparisons performed on the effect on extinction of various changes in the stimulus array are meaningful. The stimulus changes they used varied from the relatively major intervention of the removal of an arm band used for presentation of UCS to the more minor change to the stimulus array involved in the cutting of the wire that fed power to the band. All of these procedures were equally effective in reducing responding, while a meaningless but equally major stimulus change (adjustment of the arm band) had no effect on responding.

The finding of no trial extinction in CRF25 and PRF informed unpairing (stimulator off) groups, while at variance with traditional concepts of conditioning and conclusions drawn from many previous experiments, is quite consistent with Brewer's (1974) suggestions that residual responding found in earlier experiments is due to imperfect expectancy manipulation, and that better experimental designs will lead to a demonstration that there is no counter expectancy residual responding. However, the lack of any instructional effect in the CRF100 groups is inconsistent with these suggestions. This finding will be discussed in section 3.5.

3.3 ATTEMPTS TO ESTABLISH RESPONDING THROUGH INSTRUCTION ALONE

In the previous section it was shown that responding in CRF25 and PRF conditioned groups could be abolished without extinction trials, solely through expectancy manipulation (unpairing instructions and removal of the thermal stimulator). Since expectancy appears to be sufficient to account for extinction in these groups, it is important to establish whether responding may also be established through expectancy manipulation alone. Accordingly, two groups with no CS-UCS pairing experience (but with experience of the UCS alone), were given instructions designed to induce a CS-UCS pairing expectancy.

The two No Acquisition groups did not differ from one another in their rate of responding over the four blocks of five test trials, $\underline{F}$ (1,16) = 4.11, n.s., and neither group showed significantly above chance responding; the group given instructions designed to induce a PRF expectancy performing slightly below chance, and the group given instructions designed to induce a CRF expectancy responding non-significantly above chance, t (9) = 1.35, n.s. That is, responding was not obtained in the two no acquisition groups. Responding in these groups is graphed in Fig. 7.

It is interesting to note the significant interaction between expectancy manipulation and relative contribution to overall responding by warm and cold UCS subgroups of the two no acquisition groups, $\underline{F}$ (1,16) = 6.21, p > .025. The group given instructions designed to induce a CRF expectancy had a considerably higher rate of on target responding in cold UCS subgroups than in warm UCS subgroups, and significantly more difference in the rate of on target responding between warm and cold UCS subgroups than was found in the group given instructions designed to induce a PRF expectancy. This difference cannot be

TABLE 6. Mean on-target responding in warm and cold UCS subgroups of no acquisition CRF instructed and PRF instructed groups over the first and second ten extinction trials (Arcsin transformed). Chance level of responding = .7854.

		Trials 1-10	Trials 11-20
CRF Instructed	Warm UCS	.72425	.628365
	Cold UCS	1.11557	1.14908
PRF Instructed	Warm UCS	.56676	.86586
	Cold UCS	.614175	.874695

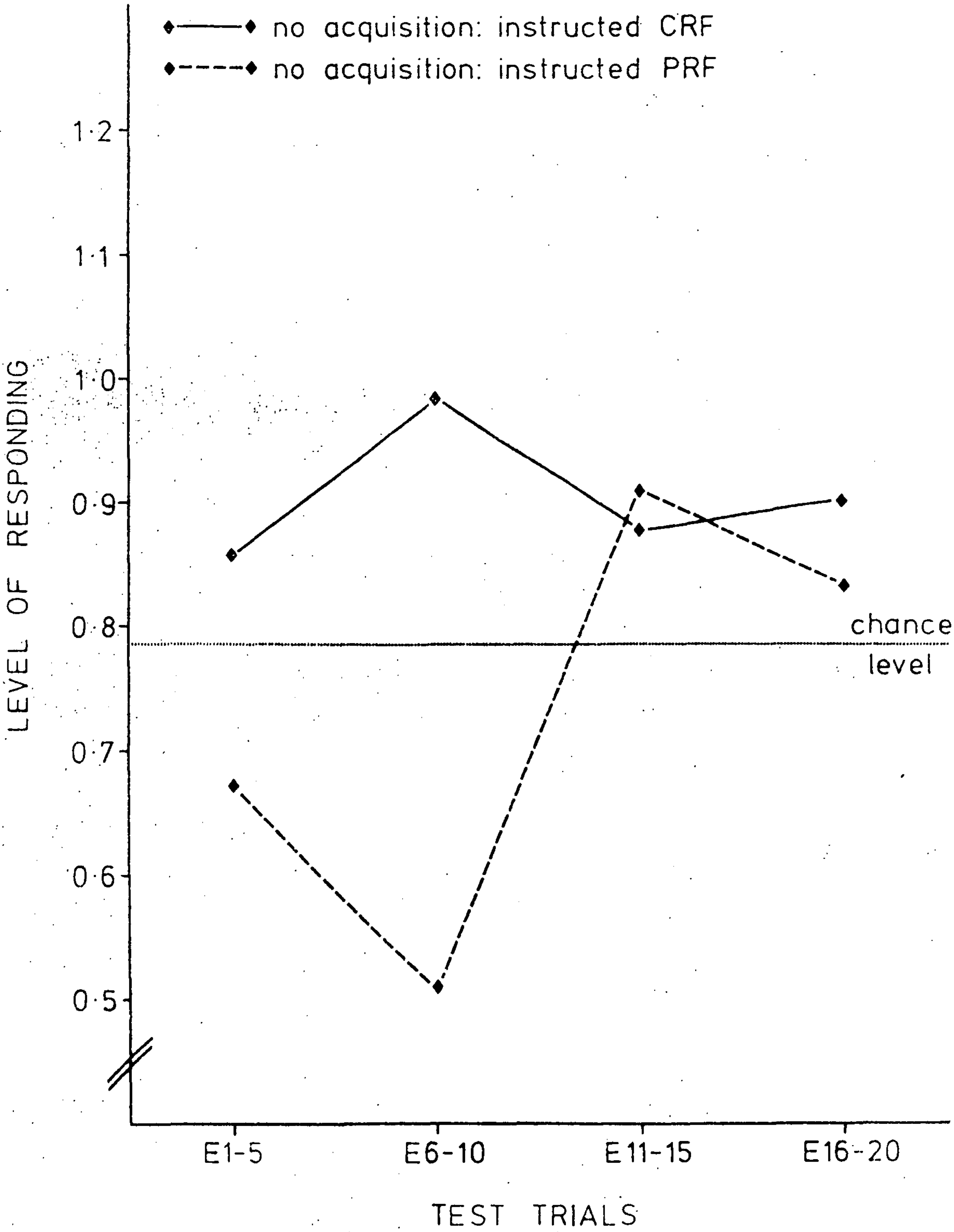

Figure 7. Mean proportion of on-target responding over the four blocks of test trials in the two no acquisition groups.

interpreted as evidence for significant responding in the cold UCS subgroup of the CRF instructed group, for the warm UCS subgroup also shows an above chance rate of constriction (reflected in their below chance rate of on target responding). Instead, it would appear that this effect is due to the greater number of orienting responses in the CRF instructed than in the PRF instructed group; presumably due to the greater disparity between instructions and subsequent experience in the CRF instructed group. Responding in the warm and cold UCS conditioned subgroups of the two experimental groups over the first and second block of ten extinction trials is shown in Table 6.

The high rate of generalised responding found in the CRF instructed group is consistent with Grings' (1965) hypothesis that 'instruction leads to a response of expectation or anticipation, one part of which is autonomic discharge', and provides a possible explanation for the failure to replicate some previous studies that have obtained significant responding consequent on instruction alone. Such studies have usually employed unidirectional responses such as the GSR (e.g., Hygge, 1976; Fenz & Dronsejko, 1969; Katz, Webb & Stotland, 1971; McComb, 1969) in which nonspecific responses such as the OR would contribute to measured responding.

However, not all previous research can be explained solely in terms of non specific responding or a state of generalised arousal consequent on instruction. Bernal and Berger (1976), for example, demonstrated vicarious conditioning of an eyeblink response in subjects who watched a model undergoing eyeblink to airpuff classical conditioning procedures. The response obtained in this study was restricted to the eyeblink, and was not a component of a generalised arousal response. Although modelling procedures were earlier criticised on the grounds that emotional responses to observation of subjects being conditioned with painful UCS may be paired with the CS (and so constitute a conditioning paradigm), this study is less susceptible to that criticism than most others owing to its use of non noxious UCS.

Wilson (1968) demonstrated reversal of conditioned differential responding by instruction that UCS would now follow CS- rather than CS+. Again this experiment cannot be accounted for in terms of a generalised arousal effect of instruction, since responding to the previous CS+ was actually greatly reduced.

It appears that instructions are capable of producing more specific effects than generalised arousal, yet are not sufficient to generate conditioned-like vasomotor responding. There are several possible explanations for this failure. As has been argued above, it cannot be argued that instructions serve only to disinhibit generalised responding though it is possible that this was their only effect in the two no acquisition groups. Equally, the failure of instructions to generate responding cannot be attributed to a general inaccessibility of the vasomotor response to instructional control, since CRF25 and PRF conditioned groups showed considerable instructional effects on vasomotor responding in extinction.

Instead, it may be that the vasomotor response is initially relatively inaccessible to direct cognitive control. Kimble and Perlmuter (1970) argue that voluntary control of initially involuntary (reflexive) responses is only acquired with practice. There is some evidence, in addition to the present results, that this is the case for vasomotor responding. Wilson (1972), for example, found that cognitive control of vasomotor responding was possible only following biofeedback from conditioned vasomotor responding; subjects with no conditioning experience who were instructed to dilate or constrict were unable to do so, while subjects given feedback experience were able to dilate or constrict according to instructions. While subsequent studies have sometimes demonstrated instructional effects on vasomotor responding prior to conditioning (e.g., Keefe, 1978; Surwit, Pilon & Fenton, 1978), and have on some other occasions failed to do so (e.g., Surwit, Shapiro & Feld, 1976), it appears that feedback experience at least facilitates such instructional control (Surwit & Fenton, 1980).

The failure of instructions alone to consistently generate conditioned-like responding is therefore not necessarily at odds with expectancy theory. In addition to providing information concerning the nature of the CS and UCS, and the relationship between them, conditioning trials in classical conditioning experiments may also serve to familiarise subjects with the nature of the response (which consistently follows the CS). Such a feedback function of conditioning trials could account for the fact that responding was subject to cognitive control only after conditioning experience. However, the results obtained are not consistent with hypothesis 2; that responding will be generated by instruction alone in the two no acquisition groups.

3.4 THE EFFECT OF INSTRUCTIONS ALONE ON RESPONDING IN EXTINCTION

A number of groups were given instructions designed to increase or decrease resistance to extinction. In addition to the previously discussed no acquisition groups (not considered in this section owing to their failure to demonstrate significant responding), CRF25, CRF100 and PRF acquisition groups were given unpairing instructions designed to reduce resistance to extinction (without removal of the thermal stimulator) and CRF25 and CRF100 groups were given instructions designed to increase resistance to extinction by inducing an expectancy of partial reinforcement at the onset of extinction. To test whether instructions alone influenced responding, a number of analyses were performed. A single analysis was inappropriate owing to the incomplete crossing of conditioning procedure and expectancy manipulation (necessitated by the fact that the effect of PRF instructions following PRF acquisition would be uninterpretable).

Analysis of variance performed on responding over the four extinction trial blocks in the three pairs of groups given unpairing instructions alone (without removal of the thermal stimulator), and the comparable three noninformed groups, revealed a marginally non-significant interaction between conditioning procedure and expectancy manipulation, $\underline{F}$ (2,144) = 2.64, p = .08, with a strong reduction in responding following unpairing instructions found only in CRF25 and PRF conditioned groups; the CRF100 groups showing non significantly more responding in extinction after being informed that UCS would no longer be presented than after no such instruction, $\underline{F}$ (1,48) = .44, n.s. This failure to obtain a reduction in responding in the CRF100 group following unpairing instructions is consistent with the previous finding that unpairing instructions coupled with the removal of the thermal stimulator did not lead to a reduction in responding in extinction in CRF100 groups (see section 3.2). However, the reduction in responding following unpairing instructions alone found in CRF25 and PRF conditioned groups was significant, $\underline{F}$ (1,96) = 5.00, p < .05. This shows that unpairing instructions alone were effective in reducing responding in extinction. This supports hypothesis 4; that responding in CRF25 and PRF informed unpairing (stimulator on) groups will be significantly lower than responding in CRF25 and PRF noninformed groups. Responding in the three pairs of noninformed and informed unpairing (stimulator on) groups over the four extinction trial blocks is illustrated in Figures 8, 9 and 10 respectively.

Analyses of variance were performed to test the hypothesis that greater responding in extinction will be obtained in CRF25 and PRF informed unpairing (stimulator on) than in CRF25 and PRF informed unpairing (stimulator off) groups. In view of the previously obtained finding that CRF100 groups may be affected differently by instruction than the CRF25 and the PRF groups, the CRF100 groups were compared independently of the CRF25 and PRF groups. No significant difference in responding over the four extinction trial blocks was obtained between CRF100 informed unpairing (stimulator on) and CRF100 informed unpairing (stimulator off) groups, $\underline{F}$ (1,48) = 1.97, n.s. In the CRF25 and PRF informed unpairing (stimulator on) and informed unpairing (stimulator off) groups, a predicted trend was found for greater responding following unpairing instructions alone than following unpairing instructions coupled with removal of the thermal stimulator, but it did not reach significance, $\underline{F}$ (1,96) = 3.59, p = .067. This provides tentative support for hypothesis 3, that responding in CRF25 and PRF informed unpairing (stimulator on) groups will be significantly greater in extinction than in CRF25 and PRF informed unpairing (stimulator off) groups.

TABLE 7:

Mean on-target responding in warm and cold UCS subgroups of CRF25, CRF100, and PRF informed unpairing (stimulator off) and noninformed groups over the first and second ten extinction trials (Arcsin transformed). Chance level of responding = .7854.

			Trials 1 - 10	Trials 11 - 20
CRF25	informed unpairing (stimulator on)	Warm	.77533	.776565
		Cold	.903025	.86988
	noninformed	Warm	.919135	.63523
		Cold	1.010855	.93355
PRF	informed unpairing (stimulator on)	Warm	.71972	.74631
		Cold	.911585	1.05068
	noninformed	Warm	1.00083	.78947
		Cold	1.08335	1.021015
CFR100	informed unpairing (stimulator on)	Warm	1.077885	1.047195
		Cold	1.01406	.997995
	noninformed	Warm	.91909	1.014105
		Cold	1.22034	1.111218

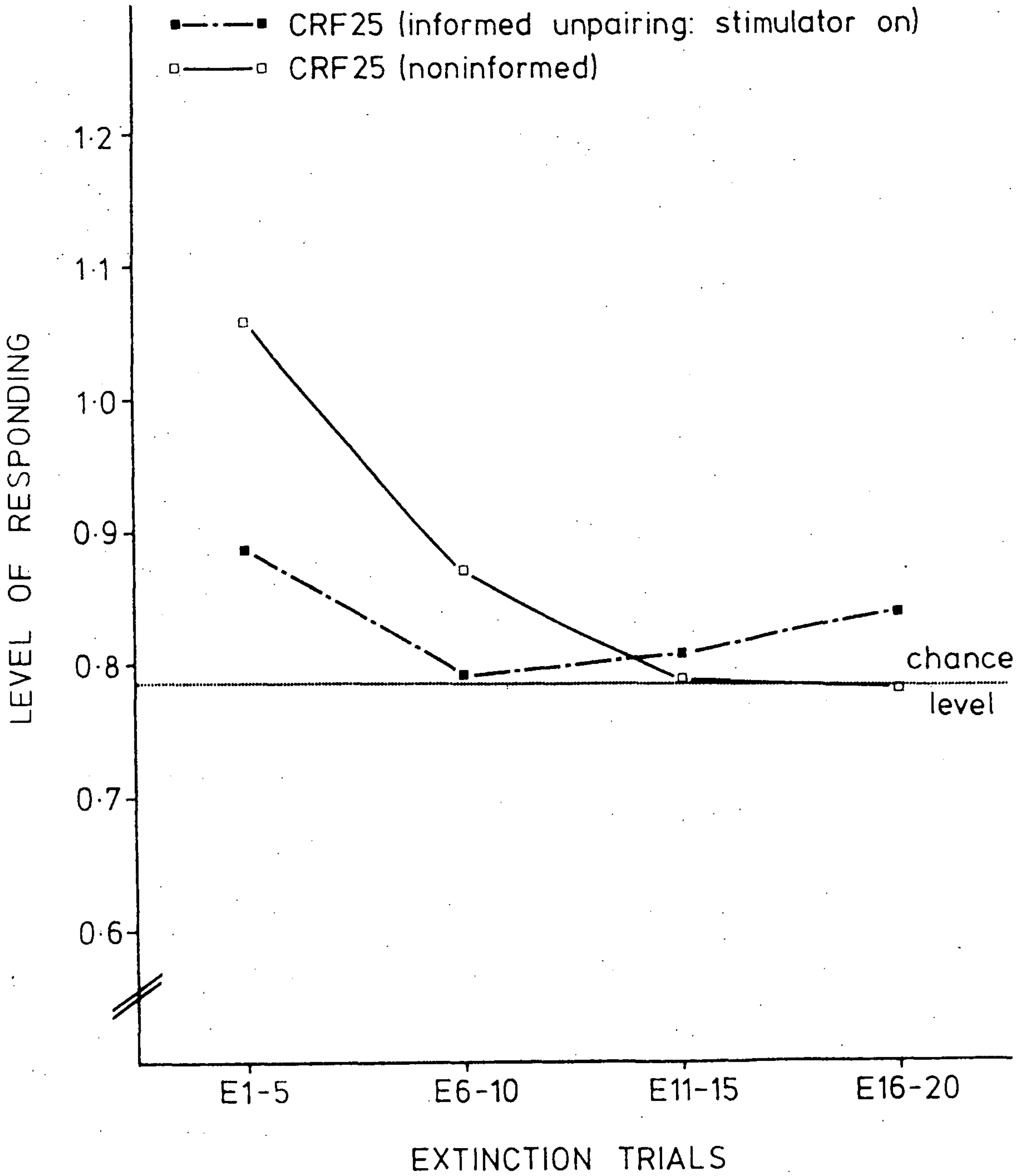

Figure 8. Mean proportion of on-target responding over the four extinction trial blocks in CRF25 informed unpairing (stimulator on) and noninformed groups.

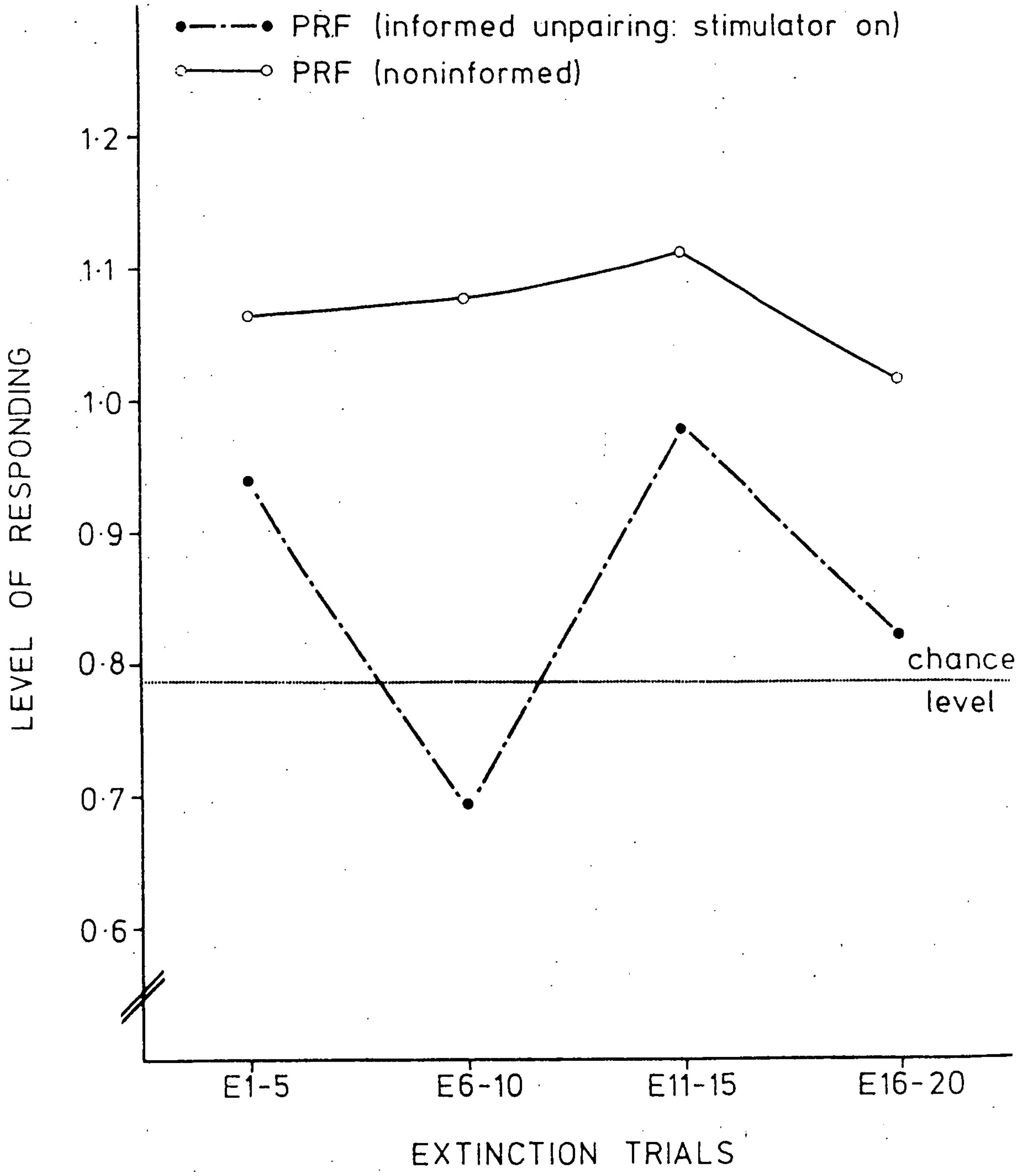

Figure 9. Mean proportion of on-target responding over the four extinction trial blocks in PRF informed unpairing (stimulator on) and noninformed groups.

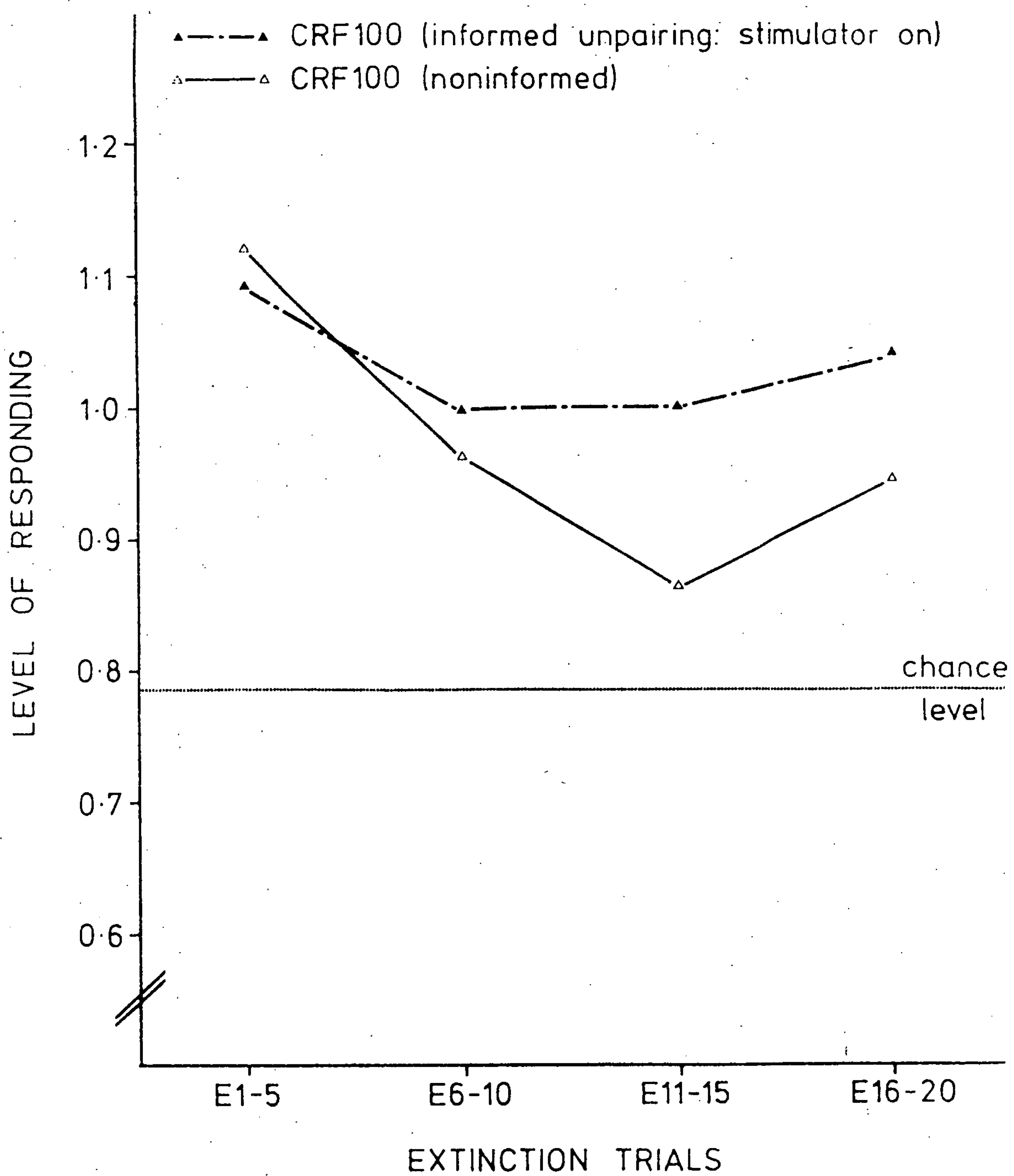

Figure 10. Mean proportion of on-target responding in CRF100 informed unpairing (stimulator on) and noninformed groups over the four extinction trial blocks.

Examination of questionnaire data revealed that groups given unpairing instructions alone were significantly less likely to report expecting UCS presentation in extinction than noninformed groups, $\chi^2 = 12.38$, $p < .001$, but were also significantly more likely to report expecting UCS in extinction than were groups given extinction instructions and with the thermal stimulator removed at the onset of extinction $\chi^2 = 6.41$, $p < .02$. These results support the contention that instructions alone were less effective in reducing the expectancy of UCS presentation than were instructions plus removal of the thermal stimulator. They are therefore consistent with the contention that maintained responding following unpairing instructions alone, as found in some previous studies, may be due to residual counter instructional-expectancy rather than to residual counter-expectancy responding.

However, since many studies that have reported such responding have also rejected subjects who reported expecting UCS in extinction from their analysis, a separate analysis was performed on responding in extinction in those subjects from informed unpairing (stimulator on) groups who did not report any level of UCS expectancy in extinction. These groups were chosen for this analysis as they parallel previous research which used relatively weak expectancy manipulation procedures, either as a result of leaving UCS presentation apparatus intact, or as a result of alternative means of UCS presentation being available in extinction (see section 1.3.3).

The three subjects in the CRF100 informed unpairing (stimulator on) group who reported expecting UCS in extinction were not included in this analysis, owing to the previous finding that CRF100 groups were differently affected by expectancy manipulation, and to the lack of directional hypotheses for this group. Mean responding over the four extinction trial blocks by subjects with and without maintained expectancy of UCS presentation in extinction in CRF25 and PRF informed upairing (stimulator on) groups combined is shown in Fig. 11.

Analysis of variance on those reporting and those not reporting maintained expectancy of UCS in extinction revealed no significant difference in levels of responding in extinction, $\underline{F}$ (1,16) = 1.33, n.s. Indeed, the (non significant) trend was for greater responding by subjects who reported no expectancy of UCS in extinction.

This apparent independence of expectancy and responding is most likely to reflect the inadequacy of questionnaire assessment of expectancy for the purpose of discriminating between those with little expectation of UCS presentation and those with no such expectation on a subject by subject basis, owing in part to the demand characteristics specific to this group (discussed in section 1.3.3). This is because the more powerful expectancy manipulation of removal of the thermal stimulator succeeded in abolishing responding. It may also be that verbal expectancy report reflects Pavlovian second signalling system activity, while conditioned autonomic responding may in this case relate more to the first signalling system. If this were so it would support Bridger's (1964) suggestion that instructions may differentially affect responding under the control of the first and second signalling systems.

To test the hypothesis that PRF instructions lead to more resistance to extinction in CRF conditioned groups, analysis of variance was performed on the CRF25 and CRF100 noninformed and instructed PRF groups. There was no main effect for expectancy, $\underline{F}$ (1,32) = .01, n.s., and no interaction between conditioning procedure and expectancy manipulation, $\underline{F}$ (1,32) = .69, n.s. Despite the failure to demonstrate a significant interaction, separate pairwise comparisons were performed on these

TABLE 8: Mean on-target responding in warm and cold UCS subgroups of CRF25 and CRF100 instructed PRF and noninformed groups over the first and second ten extinction trials (Arcsin transformed). Chance level of responding = .7854.

		Noninformed		Instructed PRF	
		Trials 1 - 10	Trials 11 - 20	Trials 1 - 10	Trials 11 - 20
CRF 25	warm UCS	.919135	.63523	.755195	.80151
	cold UCS	1.010855	.93355	1.090725	1.04907
CRF 100	warm UCS	1.00083	.78947	1.00962	.67189
	cold UCS	1.08335	1.02105	1.116855	.939635

TABLE 9: Mean on-target responding in warm and cold UCS subgroups of combined PRF and CRF25 informed unpairing (stimulator on) with and without reported expectancy of UCS in extinction (Arcsin transformed). Chance level of responding = .7854.

		Trials 1 - 10	Trials 11 - 20
reported expectancy of UCS in extinction	warm UCS	.65166	.739085
	cold UCS	1.01802	.88641
No reported expectancy of UCS in extinction	warm UCS	.84178	.82764
	cold UCS	.928885	.88351

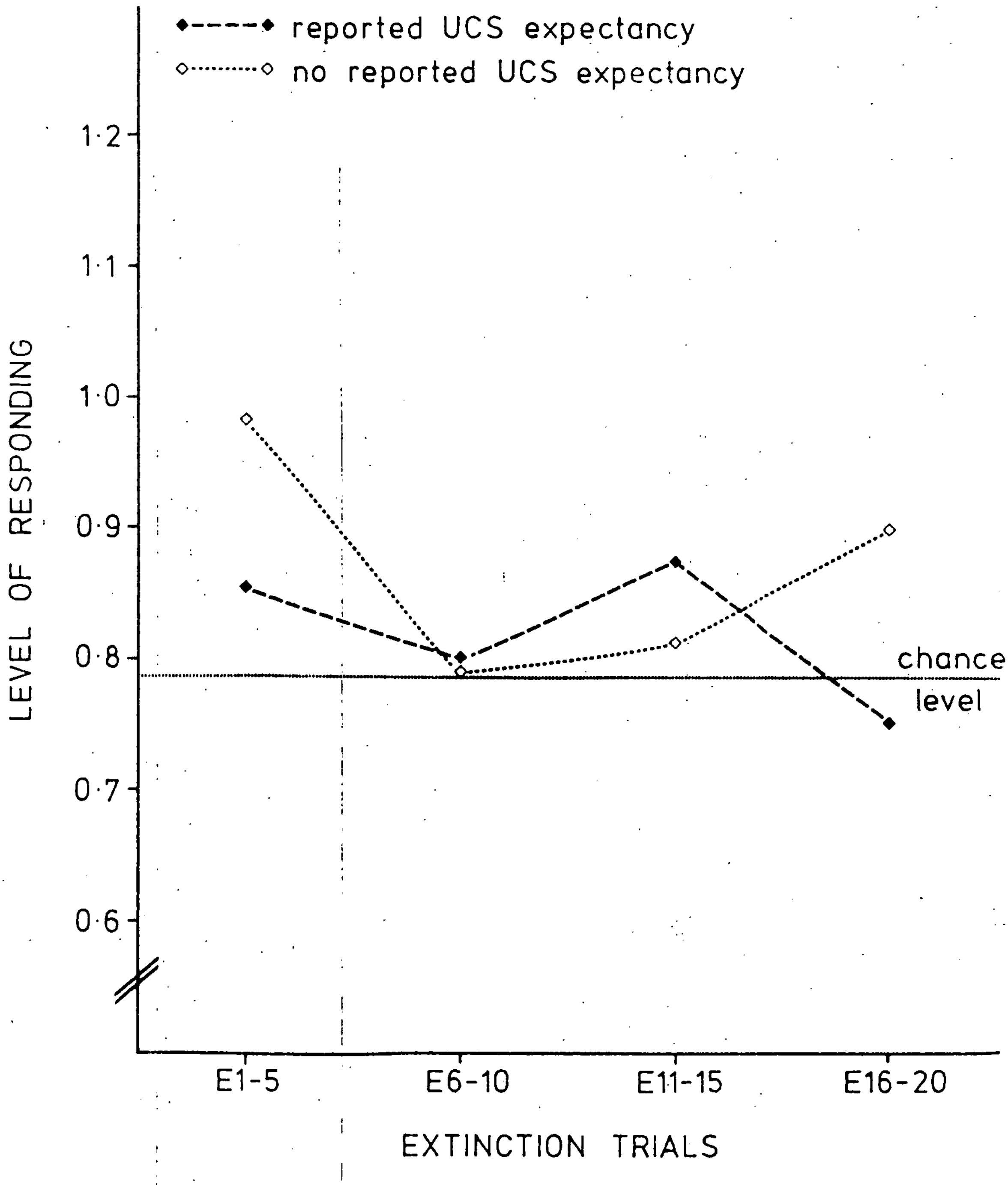

Figure 11. Mean proportion of on-target responding over the four extinction trial blocks in subjects with and without reported UCS expectancy. in combined PRF and CRF 25 groups.

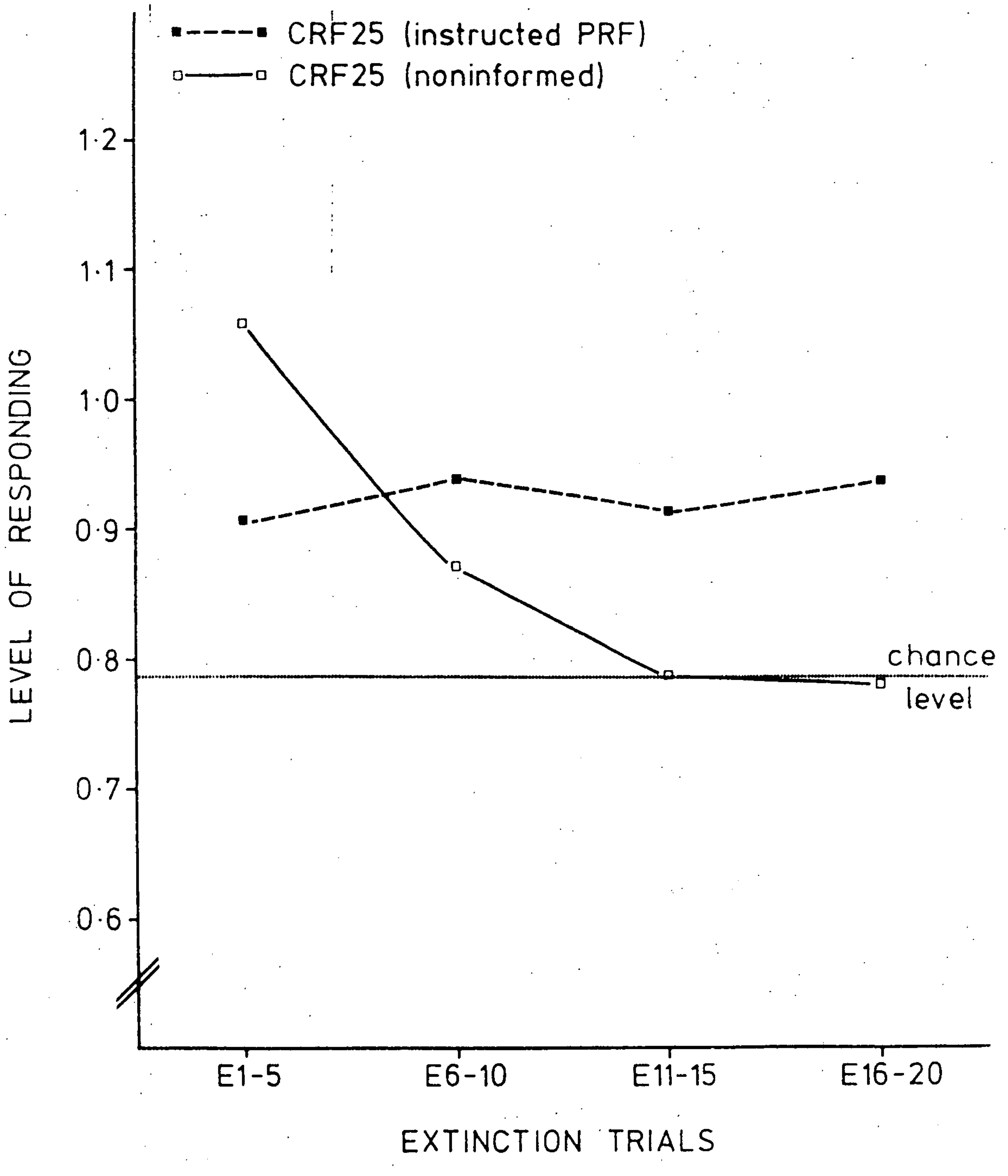

Figure 12. Mean proportion of on-target responding over the four extinction trial blocks in CRF25 instructed PRF and noninformed groups.

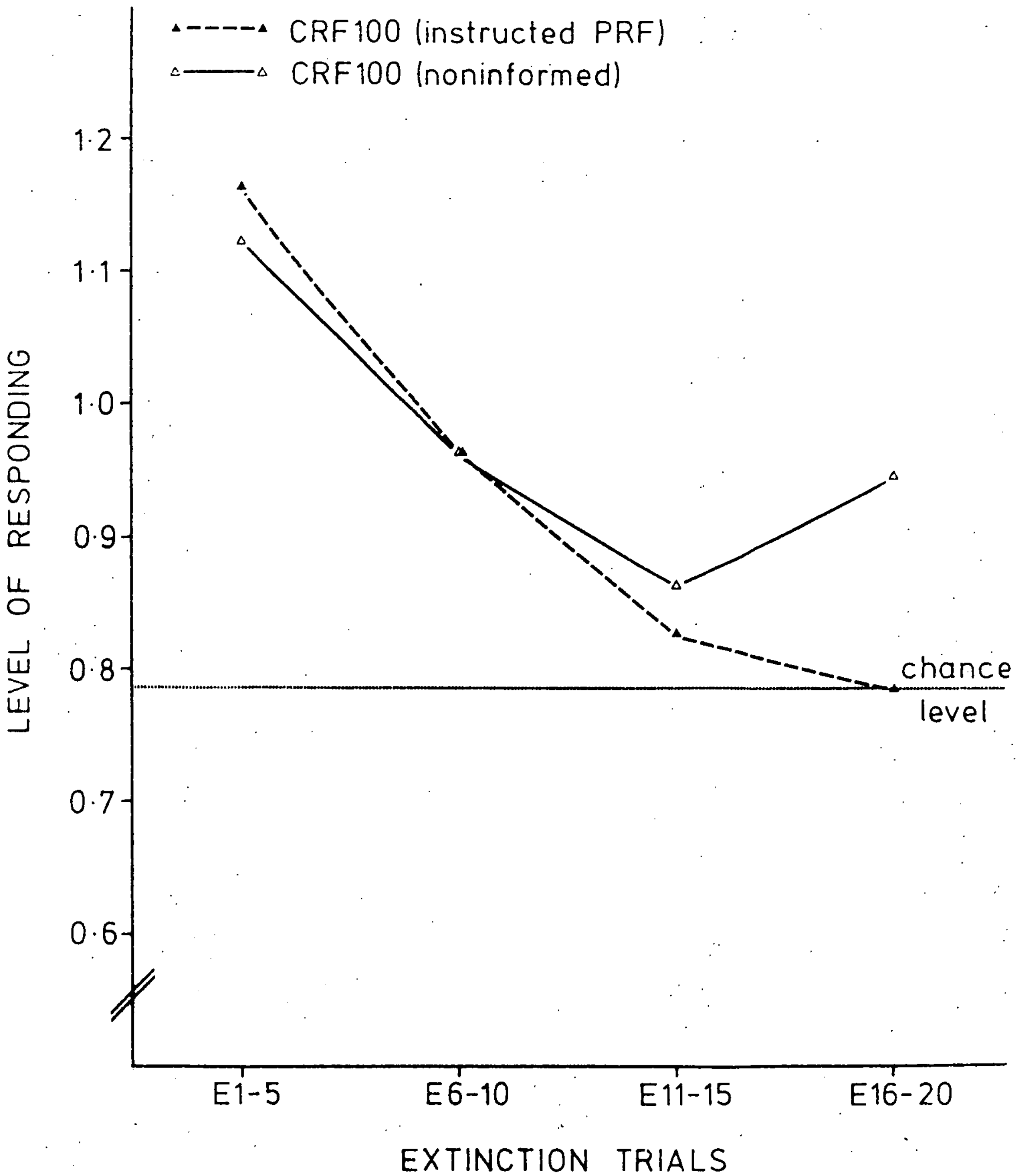

Figure 13. Mean proportion of on-target responding over the four extinction trial blocks in CRF100 instructed PRF and noninformed groups.

groups owing to the difference in hypotheses between CRF100 and other groups, and the previous finding that instructions had no effect on responding in CRF100 groups. Again, no significant effect for expectancy manipulation was obtained in CRF100 groups, in which PRF instructions led to non significantly less responding over the four extinction trial blocks than no instruction, $\underline{F}$ (1, 48) = .24, n.s. There was a non significant trend in the opposite direction in CRF25 instructed PRF and noninformed groups, $\underline{F}$ (1,48) = .50, n.s.

The relevant comparison, however, is between these groups late in extinction, since it was hypothesised that PRF instructions would lead to greater resistance to extinction, rather than simply more responding in extinction. Responding was therefore compared in the two groups over the final two trial blocks combined. The trend for greater responding in the PRF instructed than the noninformed CRF25 group over these two trial blocks was non significant, $\underline{F}$ (1,16) = 4.15, p = .0586. This non significant trend provides tentative support for hypothesis 5; that the CRF25 instructed PRF group will show more responding in extinction than the CRF25 noninformed group. Responding in the instructed PRF and noninformed CRF25 and CRF100 groups is shown in figures 12 and 13 respectively. Mean responding in warm and cold UCS subgroups of the four groups over the first and second ten extinction trials is shown in Table 8.

Analysis of questionnaire data revealed that CRF25 and CRF100 PRF instructed groups were significantly more likely to report expecting UCS throughout extinction than were CRF25 and CRF100 noninformed groups, χ^2 = 3.96, p (one tailed) < .025, but were also less likely to report expecting UCS throughout extinction than were the PRF noninformed group, χ^2 = 3.33, p (one tailed) < .05). These findings again support the suggestion that instructions alone lead to only imperfect expectancy manipulation.

It is clear that PRF instructions after CRF25 acquisition were unable to generate as much responding as was found in the PRF non-informed group. PRF instructions were also less powerful in manipulating reported UCS expectancy in extinction than were instructions paired with experimental manipulations such as removal of the thermal stimulator or PRF acquisition trials. However, it is unclear whether the failure to significantly enhance responding by PRF instructions is due to the weakness of instructions in manipulating expectancy (as is indicated by the questionnaire analysis), or whether expectancy manipulation procedures may lead to a reduction, but not an enhancement of responding (as is indicated by the failure to generate responding through instruction alone in the two no acquisition groups, the failure to significantly enhance resistance to extinction through PRF instructions, and the powerful effects of unpairing instructions on responding in extinction in PRF and CRF25 conditioned subjects).

This distinction is of some importance, for, while the first explanation requires only expectancy theory concepts, the second explanation depends on both expectancy assumptions and some additional mechanism. Further, if the second explanation were accepted, longer extinction following partial reinforcement acquisition procedures would have to be explained in some terms other than the increased difficulty of discrimination between acquisition and extinction contingencies. That is, PRF would have to have some other effect than on expectancy. Such explanation would be difficult given the complete and immediate extinction following unpairing instructions and removal of the thermal stimulator that was found in PRF acquisition groups.

While it is tempting to propose an explanation for these results in terms of different mechanisms for acquisition and for extinction, it should be pointed out that, while acquisition and extinction are often traditionally seen as different processes, they are also sometimes seen as precisely the same. In acquisition, the organism is learning to respond in the presence of a CS+ (and not in the presence of other stimuli not paired with UCS). In extinction the organism certainly learns not to respond in the presence of the old CS+, but while he is not giving the CR to the CS, he must be giving some alternative response: learning a new response in the presence of the old CS+ rather than simply "wearing out" the old conditioned response (Guthrie, 1952). Such a position is also implied by Hull's hierarchy of responses (1940), and by Zeiler's concept of "differential reinforcement of other behaviour" (1970, 1971).

Since acquisition and extinction may be the same except for the fact that in the former the experimenter is interested in the response that is acquired, and in the latter case he is not, it is desirable that both should be explained according to the same principles. Accordingly, in the absence of a theory able to account for abolition of responding through instruction, but acquisition of behaviour through some other process (where the two processes are not incompatible with one another), the preferred explanation is that chance variables in conjunction with the small size of the instructional effect (due to the weakness of instruction alone in manipulating expectancy) account for the failure to obtain significant enhancement of responding through PRF instruction.

An alternative explanation is that vasomotor response production may be to some extent a learned skill, dependent on response feedback experience (as discussed in section 3.3). Subjects given 100 trials of 25% PRF may respond more than those given only 25 continuously reinforced trials and instructed that UCS will be presented on a partial reinforcement schedule owing to their greater feedback experience.

In summary, the results analysed in this section show that unpairing instructions alone were effective in significantly reducing responding in extinction in CRF25 and PRF groups, though this reduction was not as great as was found following unpairing instructions coupled with removal of the thermal stimulator. A non significant trend was obtained for greater resistance to extinction in CRF25 groups given PRF instruction than no instruction. No effects of any of these expectancy manipulations were found on responding in extinction in CRF100 groups. However, effects of expectancy manipulation on reported expectancy were obtained following all three conditioning procedures.

3.5 THE EFFECT OF OVERLEARNING TRIALS IN ACQUISITION ON INSTRUCTIONAL EFFECTS IN EXTINCTION

It has previously been shown that CRF100 conditioned subjects do not show the abolition of responding consequent on instruction and removal of the thermal stimulator found in CRF25 and PRF acquisition groups (section 3.2), nor do they show the reduction in responding consequent on unpairing instruction alone found in the other two groups (section 3.4). This radical difference in the effect of instructions on responding in extinction in CRF100 groups, and CRF25 and PRF groups, lends support to the hypothesis that much repeated responding may be less accessible to cognitive control, as was suggested in section 1.3.3. In order to test this hypothesis, responding over the four extinction trial blocks in the four CRF100 acquisition groups, representing a hierarchy of expectancy manipulation from removal of the thermal stimulator to instruction that UCS will be presented on a PRF schedule, were compared by analysis of variance. No effect due to instruction was obtained, $\underline{F}$ (3,96) = .78, n.s. That is, instruction had no significant effect on responding in the four CRF100 groups. A significant trials effect was obtained for responding in the four groups over the four extinction trial blocks, $\underline{F}$ (3,96) = 3.06, p < .05. A Duncans new multiple range test revealed that this was due to the significant reduction in responding between the first and second extinction trial blocks (p < .01), with no significant reduction in responding obtained between the second and third or third and fourth extinction trial blocks. There was no significant expectancy manipulation by trials interaction, F (9,96) = .42, n.s.

Each of the four groups (informed unpairing (stimulator off); informed unpairing (stimulator on); noninformed; and instructed PRF) showed significantly above chance responding over the four extinction

TABLE 10: Mean on-target responding in warm and cold UCS subgroups of the four CRF100 groups over the first and second ten extinction trials (Arcsin transformed). Chance level of responding = .7854.

		Trials 1 - 10	Trials 11 - 20
CRF 100 informed unpairing (stimulator off)	warm UCS	.92508	.96261
	cold UCS	.969845	.855745
CRF 100 informed unpairing (stimulator on)	warm UCS	1.07785	1.047195
	cold UCS	1.01406	.997995
CRF 100 non-informed	warm UCS	.91909	1.014105
	cold UCS	1.22034	1.111278
CRF 100 instructed PRF	warm UCS	1.00962	.67189
	cold UCS	1.116855	.939635

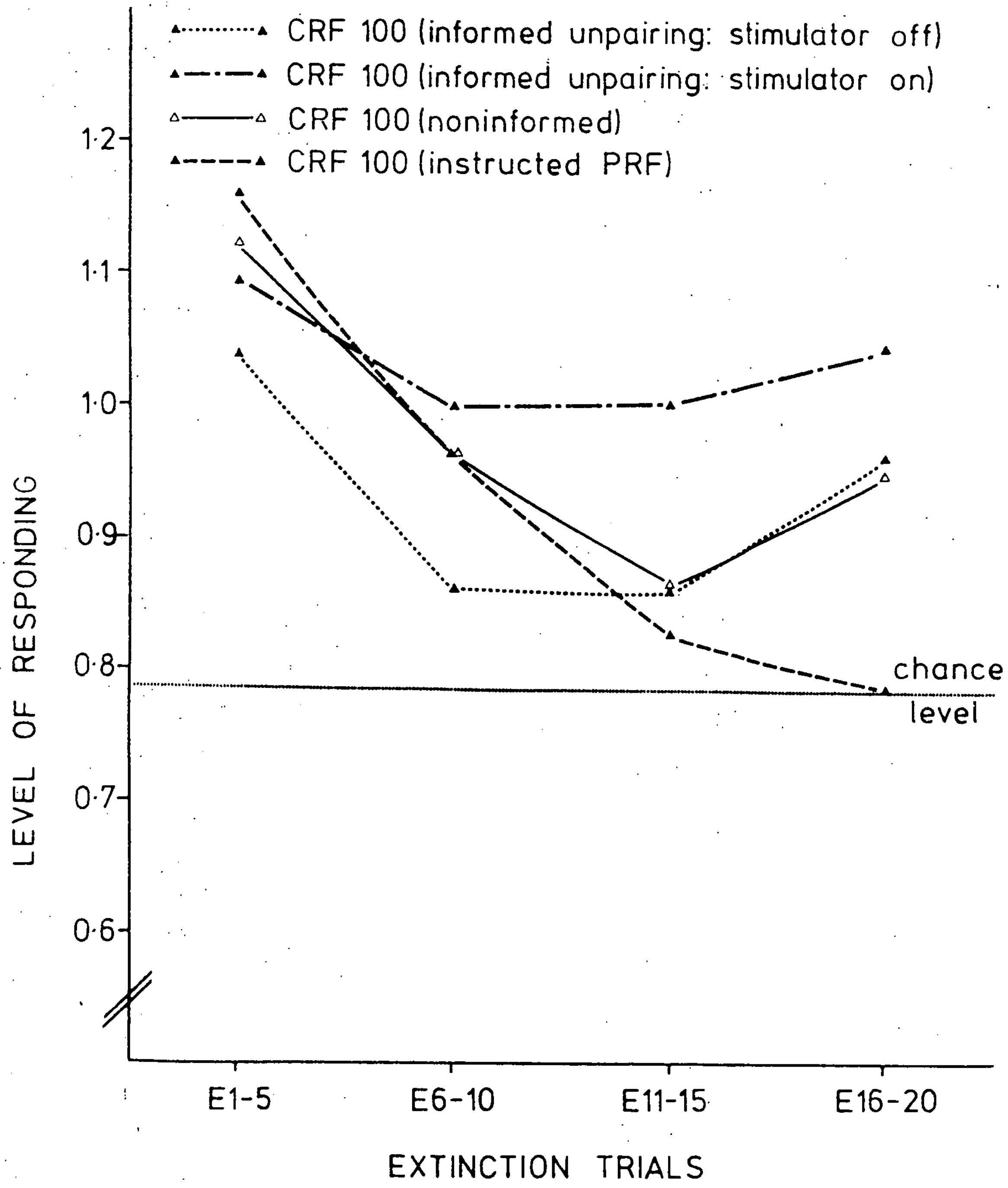

Figure 14. Mean proportion of on-target responding over the four extinction trial blocks in the four CRF100 groups.

trial blocks, $t(9) = 3.44$, p (one tailed) $< .01$; $t(9) = 4.24$, p (one tailed) $< .001$; $t(9) = 2.75$, p (one tailed) $< .02$; and $t(9) = 2.88$, p (one tailed) $< .01$ respectively. This shows that significant responding in extinction was obtained in each of the CRF100 groups. The four groups combined showed above chance responding on each of the four extinction trial blocks, $t(39) = 5.34$, p (one tailed) $< .001$; $t(39) = 3.21$, p (one tailed) $< .001$; $t(39) = 2.06$, p (one tailed) $< .02$; and $t(39) = 2.54$, p (one tailed) $< .01$. This shows that the lack of a trials effect over the last three blocks of extinction trials is not due to extinction having occurred after the first reduction in responding found between the first two trial blocks. These results suggest that after an initial reduction in responding found in all four groups, no further extinction took place. Although the instructed PRF group appears to extinguish by the fourth trial block, it should be noted that there is no difference between groups in level of responding, no groups by trials interaction, and significant responding is obtained in the four groups combined for the final extinction trial block. It is therefore appropriate to conclude that the lower responding obtained in the instructed PRF group at the end of the extinction trials is due to chance variables. This is especially so given the fact that this group would be expected to show the greatest, rather than the least, resistance to extinction.

Interestingly, there was no significant difference in the relative contribution of warm and cold UCS subgroups to overall on-target responding by the four groups, $\underline{F}(1,96) = 1.37$, n.s., no significant expectancy manipulation by UCS temperature interaction, $\underline{F}(3,96) = 1.31$, n.s., and no significant UCS temperature by trials interaction, $\underline{F}(3,96)$, .36, n.s.

The fact that there was no effect of expectancy manipulation, and no expectancy manipulation by trials interaction, suggests that the initial reduction in responding obtained over the first trial block is not due to a reduction in expectancy of UCS presentation, for otherwise there should have been a greater or more rapid reduction in responding in groups given information concerning extinction contingencies than in groups given no information or PRF instruction. No such trend was obtained (see fig. 14). Instead it seems that the initial reduction in responding in extinction is due to variables customarily invoked to explain conditioning effects, such as time since last reinforcement or to the number of unreinforced trials (independent of the effect that these would have on expectancy).

This rather Hullian conclusion is of course quite different from that arrived at to explain extinction in CRF25 and PRF acquisition groups. Whereas responding in the latter groups is generally consistent with expectancy theory predictions, expectancy appears to be irrelevant to responding in CRF100 conditioned groups. That it was the failure of expectancy to influence responding in the CRF100 groups, rather than a failure to manipulate expectancy, is demonstrated by the significant differences in UCS expectancy reports between groups. CRF100 groups given informed unpairing instructions and with the thermal stimulator removed were significantly less likely to report expecting UCS presentation in extinction than were noninformed subjects, $\chi^2 = 25$, p (one tailed) $< .001$. Subjects given unpairing instructions alone were also less likely to report UCS expectation than were noninformed subjects, $\chi^2 = 2.78$, p (one tailed) $< .05$.

These results are consistent with the Hartmann and Grant (1962) study which also found no suggestion of any reduction in responding consequent on unpairing instructions in subjects conditioned with 60 reinforced trials. While, as we argued in section 1.3.3, the

Hartmann and Grant study is no more than suggestive of an overlearning effect on instructional control in extinction, owing to its weak expectancy manipulation and artifact controls, the present study provides stronger evidence that responding in subjects given 100 acquisition trials (of which many may be overlearning trials) is not affected by expectancy manipulation procedures. This finding, in conjunction with the finding that CRF25 and PRF acquisition groups show considerable effects of expectancy manipulation procedures, suggests that control of conditioned responding passes from cognitive control to some other centre with repeated conditioning experience.

Although a number of theorists have mentioned the possibility of such a change in cognitive control of responding with repetition (section 1.3.3), there has been surprisingly little interest in this important issue, and no attempt to integrate it into a major learning theory. It would be ironic if the learning theory assumptions of automatic, mechanistic responding were to apply best to overlearned, much practised responding,when most research on which important theoretical principles are based does not employ these procedures. As has been argued earlier, effects such as the partial reinforcement extinction effect appear to be due to factors related to expectancy factors that do not appear to influence overlearned responding. Accordingly, theoretical analysis of overlearned classically conditioned responding must be based on research using an appropriately large number of trials. It would appear at this stage that all we can conclude is that such responding follows different laws to less highly practised behaviour, in that it is quite resistant to instructional control and other means of expectancy manipulation.

It may be that the overlearning effect obtained in this research of increasing resistance to instructional control following overlearning trials is specific to the procedure used. It is interesting to note that overlearning trials may, beyond a certain point, lead to decreased resistance to extinction (at least in noninformed subjects). This effect appears to apply particularly to operant procedures involving large reinforcements (e.g., Clifford, 1968; Birch, 1961; Tombaugh, 1967; Traupman & Porter, 1968), and may only appear after a very great number of reinforced trials: sometimes as many as 720 overlearning trials are required before a reduction in resistance to extinction is obtained (Schramm & Kimmel, 1970). However, a reduction in resistance to extinction following overlearning trials has also been obtained in autonomic conditioning studies (e.g., Silver & Kimmel, 1969; Lanning & Yaremko, 1971).

This effect has been interpreted in terms of production of learned inhibition resulting from overlearning trials transferring to extinction to accelerate the rate of response diminution (Schramm & Kimmel, 1970). This interpretation is supported by Lanning and Yaremko (1971), who showed that a pre-extinction rest period of five minutes, and/or spaced acquisition trials with an ITI up to 70 seconds (as were used in the present study), led to increasing resistance to extinction with increased numbers of acquisition trials. This suggests that inhibition may dissipate in the intertrial intervals and rest periods. There is an extensive literature showing the superiority of distributed over massed trials (Kimble, 1961).

The possibility therefore exists that very great numbers of reinforced trials with a short ITI and with extinction following immediately after acquisition trials may lead to reduced resistance to extinction. However, it is not known whether such procedures will lead to reduced resistance to instructional control of responding, or to the increased resistance to instructional control of responding obtained in the present study.

Note: significant responding was found in the stimulator removed group even after rejection of subjects who reported thinking about UCS in extinction, $t(6) = 2{\cdot}62$, $p < {\cdot}02$.

3.6 QUESTIONNAIRE DATA

In addition to the questionnaire results reported in other sections, answers to all questions were tabulated as follows:

Q1: What were you thinking about during the experiment?

Most subjects (84) reported that they thought only about things outside the experiment; study, daily affairs, or simply daydreaming. 13 subjects reported that they frequently thought about the temperature change and whether it was about to come, and 11 wondered about the purpose of the experiment. 7 subjects reported timing the CS-UCS and intertrial intervals, and six reported that they thought about whether and in what way they might be responding. 3 subjects reported that they thought about breathing regularly, two each thought about relevance for study and avoided thinking about the experiment. 1 subject reported thinking about staying awake.

While subjects are frequently depicted as actively problem solving during an experiment (Orne, 1962; Brewer, 1974), in this case it would appear that little time was spent thinking about issues relevant to the experimental situation.

Q2: When asked directly whether they thought about the UCS in the interval between tone and UCS presentation on acquisition trials, 62 replied that they usually or always did, 31 that they sometimes did, and 35 that they never did. Two subjects, one in the warm and one in the cold UCS subgroups, reported being startled by the tone in extinction.

Q3: When asked whether they thought about UCS after the tone in extinction, 46 said that they usually or always did, 25 that they sometimes did, 56 that they never did, and 3 were unsure. This increase in the number of subjects reporting that they did not think about UCS in extinction as compared with acquisition is significant at the .01 level (χ^2 1df = 9.224), but cannot be attributed to changes in the informed subgroups alone. Groups with the thermal stimulator removed showed an increase from 10 to 18 in subjects reporting not thinking about UCS before the tone in extinction as compared with acquisition. Groups given instructions that UCS would no longer be presented, but without the stimulator removed, showed an increase from acquisition to extinction in subjects reporting not thinking about UCS after the tone of from 7 to 17. The proportion of these informed two groups combined reporting thinking about UCS after the tone in extinction is greater than in the remaining groups ($\chi^2 = 6.95$, df=1, $p < .01$), whereas in acquisition there was no such difference ($\chi^2 = 1.705$, df=1, $p > .20$). This suggests that one effect of instruction is to reduce the tendency for the CS to evoke UCS related cognitions. That this is a direct effect of instruction,rather than a corollary of abolished responding is indicated by the fact that the CRF100 instructed groups include a larger proportion of subjects reporting not thinking about UCS in extinction than other instructed groups (14 out of 20 as compared with 21 out of 40), despite the fact that these groups show a high level of maintained responding. Table 11 shows the numbers of subjects who reported thinking about UCS in the CS-UCS interval in the above groups.

Q4: Subjects were asked to report their expectancy of UCS in extinction. In addition to the powerful instructional effects on reported expectancy reported in previous sections, it is interesting to note that 4 subjects reported expecting a non thermal UCS in extinction (usually shock) despite the fact that no electrodes were attached. This ubiquitous tendency for subjects to expect painful stimulation in psychological experiments has been commented on before (section 1.3.3.): this result underlines the need for a response measure not sensitive to such expectations.

Most subjects reported either a decreasing expectancy of UCS in extinction (N=44), or an unchanged expectancy over extinction trials (N=82, but these were mostly those with an initially low or zero expectancy of UCS). It is interesting to note that of the four subjects reporting an increasing expectancy of reinforcement over extinction trials, two were from partially reinforced groups and a third was from a group given instructions that UCS would now be presented on a PRF schedule. No subject in groups with the stimulator removed reported any expectation of UCS in extinction.

Q5: When asked whether they noticed feeling warm (cold) in the interval between the tone and UCS presentation, a minority of subjects reported noticing feeling warm or cold following the tone in extinction. As Table 12 shows, there was a non significant trend ($\chi^2 = 3.6$, 3df, $p > .20$) for the CRF groups to show a higher proportion of subjects reporting such sensations, followed by PRF and no acquisition groups in that order. 4 subjects were unsure whether they felt warm/cold; these were excluded from the table and χ^2 analysis.

Q6: Almost all subjects reported being comfortable and neither too warm nor too cold in the experimental room (N=119), 5 subjects reported feeling too warm and 4 reported feeling too cold; 2 reported being uncomfortable for other (unspecified) reasons. These results indicate that the room temperature selected was comfortably neutral for Hobart at the time of year that subjects were run.

Q7: The majority of subjects conditioned with a warm UCS (53) described the thermal stimulus as pleasant, 9 described it as neutral and only 3 as unpleasant. In contrast only 6 subjects conditioned with a cold UCS described it as pleasant; 25 described it as neutral and 34 as unpleasant.

Q8: A majority of subjects reported not attempting to influence responding (117). Included in this total are 10 subjects who reported trying to breathe regularly (as instructed), 1 who reported that he tried to keep still throughout the experiment (as instructed), and 4 who reported that they tried to relax throughout the experiment. 3 subjects reported that they avoided thinking about the experiment, 2 reported that they 'tried to respond' and 5 that they tried not to respond (but were unable to describe any strategy for doing so). 2 subjects reported that they concentrated on the thermal stimulator, and 1 subject reported that she 'tried to transfer her response to her left earlobe' (but gave no strategy for doing so). Owing to the very small number of subjects reporting any attempt to manipulate responding and the fact that these subjects were spread evenly across groups it was not possible to determine the effectiveness or otherwise of these attempts at manipulating responding.

Questionnaire responses are tabulated in appendix E.

TABLE 11: Number of subjects reporting thinking about UCS and not thinking about UCS in the CS-UCS interval following each of the five expectancy manipulation procedures in extinction.

	informed unpairing (stimulator off)	informed unpairing (stimulator on)	non-informed	instructed PRF	instructed CRF
Thought about UCS	12	13	20	23	6
Did not think about UCS	18	17	10	7	4

TABLE 12: Number of subjects reporting feeling warm (cold) in the CS-UCS interval in extinction following each of the four acquisition procedures.

	CRF25	CRF100	PRF	No Acquisition
felt warm (cold)	16	18	10	6
did not feel warm (cold)	21	21	20	14

3.7 SUMMARY OF RESULTS

An interaction between expectancy manipulation and conditioning procedure was obtained, with CRF100 groups being entirely unaffected by expectancy manipulations, and PRF and CRF25 groups showing considerable expectancy manipulation effects on responding in extinction. In these latter groups, expectancy manipulation was found to be sufficient to abolish conditioned responding completely without extinction trials. However, it was not possible to generate conditioned-like responding through instruction alone in the two no acquisition groups, nor was it possible to significantly enhance responding in CRF acquisition groups by instruction that PRF procedures would ensue at the onset of extinction. This latter effect may be due to an apparent weakness of instructions in manipulating expectancy, since fewer subjects in PRF instructed groups reported expecting UCS presentation throughout extinction than in PRF conditioned uninstructed groups. Further, although instruction alone led to a significant reduction in responding in extinction, this reduction was not as great as that obtained by instruction paired with removal of the thermal stimulator.

Expectancy manipulation procedures led to consistent effects on reported expectancies in all acquisition groups, including the CRF100 groups whose vasomotor responding was not affected by expectancy manipulations. This finding supports the interpretation that responding may sometimes be independent of cognitive expectancy. In the case of the CRF100 groups, it appears that overlearning trials had the effect of making the response automatic and not subject to cognitive control. In the case of the no acquisition groups, it would appear that cognitive expectation of UCS presentation following CS was insufficient to generate conditioned-like responding. Consequences of these findings for learning theories, and for their application in the behaviour therapies, are discussed in the following sections.

Referring to the hypotheses outlined in section 2.1, four were supported, two were tentatively supported (but marginally non significant), and one was rejected. (No directional hypotheses were made for CRF100 groups.)

Hypothesis 1 was supported. It was found that responding in CRF25 and PRF conditioned groups given unpairing instructions and with the thermal stimulator removed was abolished from the first extinction trial.

Hypothesis 2 was rejected. Responding was not generated by instruction alone in either of the two no acquisition groups.

Hypothesis 3 was tentatively supported. Although responding in extinction was greater in CRF25 and PRF informed unpairing (stimulator on) than in CRF25 and PRF informed unpairing (stimulator off) groups, this difference failed to reach significance.

Hypothesis 4 was supported. Significantly less responding was obtained in CRF25 and PRF informed unpairing (stimulator on) groups than in CRF25 and PRF noninformed groups.

Hypothesis 5 was tentatively supported. Although there was a trend for greater resistance to extinction following PRF instructions than in noninformed CRF25 groups, this trend was non significant.

Hypothesis 6 was supported. Fewest subjects reported expecting UCS in extinction in informed unpairing (stimulator off) groups; next fewest in informed unpairing (stimulator on) groups; and most in noninformed groups.

Hypothesis 7 was supported. More subjects in PRF instructed groups reported expecting UCS throughout extinction than in noninformed groups, and more subjects in PRF than in CRF conditioned groups reported expecting UCS throughout extinction.

GENERAL DISCUSSION

4.1 IMPLICATIONS OF THE RESEARCH FOR LEARNING THEORIES

The most fundamental conclusion to be reached from the results of the present research is that cognitive concepts such as expectancy are necessary, but are not sufficient to account for all of the results obtained. Consideration of expectancy is necessary to account for the major effects of expectancy manipulation on responding in CRF25 and PRF acquisition groups. As has been argued previously, the complete abolition of responding obtained in these groups consequent on unpairing instruction and removal of the thermal stimulator at the onset of extinction can only be accounted for in terms of information presented to the subject. It cannot be explained in terms of a failure to generalise responding to the changed stimulus complex resulting from removal of the thermal stimulator. On the other hand, cognitive explanations cannot account for the failure of similar expectancy manipulation procedures to modify responding in extinction following CRF100 acquisition procedures, or to generate responding in the no acquisition groups. Accordingly, neither expectancy theory nor conditioning theory alone is able to deal with all of the results. Proponents of each, however, might attempt to accommodate the various results as follows.

It could be argued, as is implied above, that expectancy theory is in general supported by the results of this research. The failure of instruction alone to generate significant responding is open to a number of interpretations (argued in section 3.3), and only in the case of heavily overlearned responding (which could be argued to be a somewhat rare and artificial case) is there any other problem for expectancy theory. Bolles (1972), for example, singles out much practised responding as a possible exception to the expectancy based theory that he proposes. However, it is not clear that the resistance to instructional control following CRF100 acquisition obtained in the present study is either rare or artificial. While it is true that only a few experimental situations have yielded results contrary to expectancy theory, it may be that these situations are of considerable importance.

Seligman (1970), for example, charges that the intentionally neutral stimuli used in conditioning experiments may yield results that are not typical of learning in more natural settings. Breland and Breland (1961), for example, have shown that certain stimulus-stimulus and stimulus-response links, which presumably have adaptive significance, are very much more readily learned than others.

Interestingly, the use of a fear relevant stimulus as a CS in GSR-Shock conditioning appears to lead to important effects on the conditionability of a response and its susceptibility to instructional control. Ohman, Eriksson, and Olofsson (1975) found that skin conductance responses could be conditioned in a single trial by pairing a fear relevant CS with shock in a differential conditioning paradigm (CS+ and CS- were slides of snakes and spiders), while responses to neutral stimuli could not be so readily conditioned. Responses to fear relevant stimuli are also more persistent in extinction (Ohman, Fredrikson, Hugdahl & Rimmo, 1976), and appear to be less susceptible to instructional control (Hugdahl & Ohman, 1977). These results may be predicted from Breland and Breland's position, in that fear relevant stimuli might be expected to condition relatively easily to a fear relevant UCS such as shock.

It may be that a major proportion of the learned associations made in real life are of this "prepared" nature, and it may also be that responses of clinical importance, such as phobias, result from such "prepared" associations (Seligman, 1971). It could even be argued that the results obtained by overlearning in this study may be obtainable in much fewer trials if stimuli links for which the subject is biologically prepared are conditioned: perhaps only a single conditioning trial could be adequate to produce responding similar to that obtained after many trials using neutral stimuli (Ohman, Erkisson & Olofsson, 1975). Accordingly, while expectancy theory may account for a great proportion of the experimental literature, it is possible that it does not account for a great part of the everyday behaviour that learning theories set out to explain. It may be that the rare and artificial case will turn out to be the experimental pairing of neutral stimuli of no adaptive significance.

Proponents of conditioning theory could argue that conditioning was simply not obtained in groups other than the CRF100 groups, and that the effects obtained in other groups have no relevance to conditioning principles. This sort of argument is reflected in the conclusion by Hugdahl and Ohman (1980) that skin conductance responses to neutral stimuli may be expectancy rather than conditioning based, owing to the lack of an ISI effect on responding in extinction. However, to accept this argument is to accept a considerable limitation in the range of applicability of conditioning theories. If it is the case that conditioning theories apply only to highly practised responding, to responding established with a traumatic UCS, or to responding conditioned to a fear relevant CS, then it must be accepted that the great majority of the experimental literature has no relevance to conditioning theory, for there are few studies that satisfy the above requirements. Further, since very few of the studies used by Hull and subsequent conditioning theorists on which to base their hypotheses have used such procedures, it would have to be accepted that considerable revision of these conditioning theories would be required. In fact, very little is known about these specialised situations.

These issues, which are of great importance to our understanding of behaviour cannot be resolved on the present evidence. While it is clear that neither of these two competing approaches provides a complete explanation for the results of this thesis, it has yet to be shown whether either of these approaches provides a sound basis for development as a general learning theory.

The expectancy based conditioning theories of Gray (1975), Bindra (1974) and Smith (1974), despite their use of the term 'expectancy', are unable to deal convincingly with instructional effects on responding obtained in CRF25 and PRF conditioned groups. In each case, expectancy is seen as a relatively simple intervening variable, having direct consequences for behaviour and learned as a result of experience with the environment. As was argued earlier, however, expectancy manipulation procedures had their effects through their meaning to the subject, rather than simply through generalisation effects or conditioning effects. While some theorists (e.g., Smith, 1974) may be able to find ways of reconciling these effects with their theories, this would be due to their lack of specificity rather than to any explanatory power they may possess. Since neither expectancy nor conditioning based theories alone appear to be unequivocally supported by the results of the present research, it may be asked whether two factor or two process theories can deal with the results. A number of two factor theories are clearly not consistent with the results obtained.

Dawson and Furedy's (1976) necessary-gate hypothesis cannot cope easily with the immediate extinction consequent on instruction obtained in CRF25 and PRF acquisition groups (since awareness of extinction contingencies is held to be insufficient for extinction of responding). However, this approach does predict the failure to demonstrate production of responding through instruction alone in the two no acquisition groups, and the failure to show immediate extinction in the CRF100 groups (again since awareness of contingencies is held to be insufficient for conditioning or extinction alone). Evidence for the gate - but - not - analogue part of their hypothesis is less clear. Although there was little relationship between reported expectancy and responding in extinction within groups, as predicted by this hypothesis, there was evidence for graded effects of UCS expectancy on responding between groups; for example, between those informed of extinction and with the thermal stimulator removed, and those informed and without the thermal stimulator removed. While it could be argued that awareness of extinction contingencies had simply not reached the "gate" threshold in some subjects, this is not supported by the failure to find a difference in responding in extinction between those with and those without maintained espectation of UCS presentation, or the lack of a significant subjects effect in the informed unpairing groups. In total, this approach is consistent with only some of the results obtained, and contributes little to our understanding of the obtained interaction between conditioning procedure and the effect of expectancy manipulation on responding.

Similarly, Mowrer's two factor theory, which proposes a union of operant and classical conditioning procedures, is not able to deal with the effects of expectancy manipulation on PRF and CRF25 groups, nor does it predict the obtained interaction between acquisition procedure and expectancy manipulation.

Mandel and Bridger's (1973) distinction between learning with and without perception of contingency relationships is also unable to deal with the complete abolition of responding following the strong manipulation of expectancy in CRF25 and PRF informed unpairing (stimulator off) groups. Their model clearly predicts some residual counter expectancy responding. Furthermore, in common with almost all theories theirs is unable to explain the differential effects of expectancy manipulation on CRF100 and other groups. Although subjects informed of contingencies and contingency changes behaved differently from those not instructed in PRF and CRF25 groups, this was not the case for CRF100 groups. Even the demonstration of instructional effects on responding in extinction need not support Mandel and Bridger's assertion that different behavioural laws apply to subjects informed of contingencies and those not so informed. Instead, it may be argued that the behavioural laws describing acquisition and initial performance of responding need to include concepts relating to expectancy, or awareness of contingencies, while laws describing highly practised responding (and possibly other forms of responding that may be resistant to instructional control) need not.

Support for Mandel and Bridger's distinction between responding in subjects informed of contingencies and those not informed must come from a demonstration that different behavioural laws are required to account for responding in these two groups. The present study provides little such support. Responding in CRF25 and PRF conditioned groups appeared to conform reasonably closely with expectancy theory predictions. Although responding in CRF100 groups was not consistent with expectancy theory predictions, this suggests a difference in process between CRF100 and other conditioning procedures rather than a difference between informed and noninformed subjects. However, the apparently greater sensitivity of reported expectancy over vasomotor responding to instructional effects is consistent with their argument for a difference in the relative efficacy of the first and second signalling systems in modifying responding. It may be that verbal reporting of expectancy was more easily modified by instructions than was conditioned responding. In the former case, both verbal report and instructions relate to the second signalling system, while in the latter case a second signalling system stimulus (instruction) is used to modify a conditioned response established under the second signalling system.

Razran's (1955) distinction between relational learning and conditioning proper provides an interesting basis for the possible explanation of results. This theory does not predict the obtained distinction between highly practicised and less practised responding, and does not argue for complete instructional control of responding established through relational learning (section 1.2.1). However, his suggestion that two learning processes may operate, with one being active and cognitively based, the other passive and contiguity based, and with the former dominant over the latter, does provide the basis for a possible explanation of the results obtained.

As Razran argues, relational learning is a more powerful means of problem solving, and would be used early in conditioning when appropriate responses to the conditioning situation are still being developed. As discussed in section 1.3.3.(e), there is evidence that cognitive activity later in conditioning 'drops out', and responding is dealt with on a less cognitive, more automatic basis (which would have the effect of freeing higher cognitive activity for other purposes). This more primitive mechanism would be argued by Razran to be less capable of dealing with symbolic reasoning (as is presumably required for responding to complex instructions), and therefore less likely to be influenced by the expectancy manipulation procedures employed in this research.

Only two difficulties remain. The first is that extinction was complete in CRF25 and PRF groups informed that UCS would no longer be presented and with the thermal stimulator removed at the onset of extinction. Relational learning is an evolutionary higher form of learning than simple conditioning, and is argued to be dominant. However, Razran does argue that the two processes work together, and that perception of contingency relationships alone is insufficient to account for acquisition or extinction of responding. While this is consistent with the failure of the two no acquisition groups to show significant responding following contingency instructions, it is inconsistent with the obtained abolition of responding consequent on instruction in PRF and CRF25 groups.

Further, since responding is so readily abolished by instruction in these groups, it is difficult to account for the lack of instructional effects on responding in CRF100 groups. It cannot be easily argued that this failure to manipulate responding by instruction is due to the dropping out of cognitive processes alone, since it would then be expected that cognitive processes would be reinstated by instruction at the onset of extinction. Instead it must be argued that responding in CRF100 groups became, for some reason, less accessible to cognitive control. There is no suggestion in Razran's theory of a process by which a more primitive form of behaviour control may become dominant over a higher form, except where external conditions are such that use of the higher form of learning is precluded. There is no reason in this research to expect that external conditions were in any way inconsistent with the operation of Razran's postulated higher forms of learning. Although informational input may have been degraded owing to a decreasing attention paid to experimental stimuli over conditioning trials, allowing for the possibility that lower forms of learning or performance direction may have been operating, the stimulus changes at the onset of extinction should have been sufficient to redirect attention and reinstate the operation of the supposedly dominant higher forms of learning.

Accordingly, although the suggestion of two conditioning processes may be appropriate, the manner in which Razran's two processes operate is inconsistent with the obtained results. Although models specifically proposed to account for expectancy effects in conditioning are unable to account for the present results, the majority of results are consistent with a model proposed by Shiffrin and Schneider (1977), who propose a distinction between automatic and controlled processes to account for a series of experiments involving information processing and reaction times.

Controlled processes involve a temporary sequence of memory nodes in a short term store under the constant control of the subject. Owing to channel capacity limits, only one such sequence at a time can ordinarily be dealt with, and so this process is used in novel and variable situations only, where its flexibility and ease of generation and abolition are an advantage. Automatic processes are very much less demanding of channel capacity, and are set up to deal with repetitive environmental events. They have their basis in a long term memory store established as a result of repetitive controlled processing, and require an appreciable amount of training to develop. Automatic processes need not be available to consciousness, they do not require the subject's attention, and they may as a result be very difficult to suppress or alter. Both automatic and controlled processes may include detection of and discrimination between stimuli, and initiation of a response.

If this model were applied to classical conditioning, it would predict that early in training controlled processes would be employed. Responding would therefore require the subject's attention to expermental stimuli, and would be under the subject's cognitive control. This prediction is consistent with the finding that responding in CRF25 and PRF conditioned groups could be modified by instruction at the onset of extinction. However, with continued repetition of experimental trials the model predicts that responding will come under the control of automatic processes, and not be available to cognitive control by the subject. This prediction is consistent with the finding that CRF100 groups showed no expectancy manipulation effects on responding in extinction.

This model makes no specific predictions concerning the number of trials required to establish automatic processes. It may be, as was argued earlier, that this depends on a number of parameters including the nature of the CS and UCS (which, in the Shiffrin & Schneider model, would be important in directing attention to the stimuli, which in turn determines whether they are represented in short term store, and therefore whether they may pass into long term store to establish an automatic process). In addition, this model does not specifically predict the failure of the two no acquisition groups to generate significant responding consequent on instruction alone. As was argued in section 3.3.3, this may be attributed to the necessity for subjects to acquire control over vasomotor responding. Such an explanation is again consistent with the skill learning literature, which suggests that initial learning may involve isolation of, and development of control over, the required response (e.g., Kimble & Perlmuter, 1970).

As has been argued earlier, the adoption of a two process model based on a distinction between relatively unpractised and much practised behaviour has considerable consequences for learning theories. If two processes such as the two discussed above are operating in classical conditioning, then there is no reason to expect any familiar relationship between the behavioural laws that apply to responding under the control of one process, and the laws that apply to responding under the control of the other process. As has been suggested before, it may be that expectancy theory accounts for 'controlled processes', and that a theory along more Hullian lines would be most appropriate to account for 'automatic processes'. However, it would be unreasonable to expect present conditioning theories to account well for automatic processes. This is because they are based on research that makes no distinction between controlled and automatic processes. Too little is known at this stage about the distinction between the two processes to argue confidently that certain procedures will necessarily lead to one or the other process. However, it may be that a great many of the standard procedures previously used to investigate laws of learning relate more to controlled than automatic processes. This is because relatively few studies have investigated highly practised responding, and evidence has been found for instructional effects on responding following the majority of conditioning procedures (Brewer, 1974). Any understanding of automatic processes must therefore come from a specific investigation of automatic responding rather than from an examination of the existing conditioning literature.

4.2 CONSEQUENCES OF THE PRESENT RESEARCH FOR BEHAVIOUR THERAPY

The results of the present research have considerable relevance for the behaviour therapies. This relevance is directly tied to the finding in the present study that expectancy of reinforcement is a major factor in extinction of classically conditioned responding. It can therefore no longer be assumed that maintained responding in extinction will be obtained simply as a consequence of classical conditioning procedures, or that procedures which lead to greater resistance to extinction in some experimental settings will necessarily lead to longer extinction in clinical use. While these assumptions would have been reasonable ones if behaviour followed the automatic and non cognitive laws of Hull or Skinner, consideration of expectancy as a determinant of responding leads to importantly different predictions. If, for example, the effectiveness of partial reinforcement or avoidance conditioning procedures are due to the difficulty of discriminating extinction contingencies, then it would not be predicted that they would be appropriate in those clinical settings where subjects can readily discriminate extinction contingencies regardless of acquisiton procedures.

For example, in classical aversive and avoidance conditioning programmes, punishment is paired with a previously positive stimulus. In many cases it is then assumed that the resulting inhibitory or avoidance response will be maintained following therapy, at least for the time that it takes for learning and reinforcement of competing, socially appropriate behaviour in the natural environment. UCS presentation apparatus is typically removed after treatment, and there is no reason to expect clinical patients under these cirumcstances to have any greater difficulty in discriminating extinction than was the case in the informed unpairing (stimulator off) groups in the present study. Indeed, expectancy theory would predict in general that classical conditioning programmes depending on maintained counter expectancy responding in extinction should be ineffective; a prediction supported in the present study by the abolition of responding consequent on instructions obtained in CRF25 and PRF informed unpairing (stimulator off) groups.

The apparent efficacy of many such programmes in no way conflicts with this prediction. Although a great many studies have demonstrated maintained therapeutic change following classical conditioning based acquisition procedures in subjects with no expectation of reinforcement following treatment (e.g., Marks & Gelder, 1967; Blake, 1966), it may be that these successes are due to non specific factors such as expectancy rather than to maintained conditioned responding (Russel, 1974; Lick & Bootzin, 1975).

It has been demonstrated that manipulation of demand characteristics may be as powerful in modifying approach behaviour towards a feared UCS in phobic patients as legitimate behaviour therapy techniques (Smith, Diener & Beaman, 1974; Lick & Bootzin, 1970), and several studies have produced therapeutic change as great as that brought about by conditioning procedures in expectancy control groups (Marcia, Rubin & Efran, 1969; McReynolds, Barnes, Brooks & Rehagen, 1973; Lick, 1975; Tori & Worrel, 1973). This is despite the fact that expectancy control groups tend to generate less expectancy of treatment success than legitimate treatments (Borkovec & Nau, 1972).

Still stronger evidence for the influence of expectancy in determining treatment success is the finding that subjects led to believe that treatment will be ineffective show no treatment effect (Tori &

Worrel, 1973). Although specific treatment efficacy has been demonstrated for some programmes, notably those based on operant principles in which contingencies are manipulated in the natural environment (e.g. Ayllon & Azrin, 1965), it has yet to be demonstrated that treatment efficacy in classical conditioning based programmes which depend on maintained counter expectancy responding after treatment is due to specific conditioning effects.

The present research does not suggest that such responding could not be obtained. The more appropriate suggestion is that the use of procedures such as overlearning, and possibly the use of emotionally meaningful or biologically prepared responses, may lead to maintained conditioned responding in subjects with no expectation of continued UCS presentation. At present these procedures are very seldom used. Therapists are more likely to use partial reinforcement or avoidance procedures (which minimise the number of reinforced trials) rather than overlearning procedures. Interestingly, Baum (1968) found that overtraining trials led to increased resistance to extinction in an analogue study of response prevention (flooding) only if the subject made frequent errors (which led to UCS presentation). Animals making fewer errors (and therefore reinforced less frequently) actually showed reducing resistance to extinction over trials.

Therapists are also more likely to attempt to extinguish an emotionally meaningful or biologically prepared response such as fear of snakes by counterconditioning a neutral or positive response to the feared stimulus than they are to take advantage of potentially more readily conditioned biologically prepared responses in conditioning socially appropriate behaviour. One possible exception to this rule is the therapeutic pairing of alcohol ingestion with sickness in the treatment of alcoholics (e.g., Voegtlin, 1942; Lemere & Voegtlin, 1950). Unfortunately, this procedure has not enjoyed particularly great success (Quinn, 1967; Rachman & Teasdale, 1969; Davidson, 1974).

Whether the maintained counter expectancy responding obtained in the present study has any clinical value has yet to be demonstrated. It may be that successful therapeutic procedures can be developed based on such counter expectancy responding. If so, it may be that classical conditioning principles will be of great relevance in the future of the behaviour therapies.

APPENDIX A : ACQUISITION DATA

A.1 Proportion of on to off target responding over the final two blocks of five acquisition trials in CRF25 conditioned groups.

		Informed unpairing (stimulator off)		Informed unpairing (stimulator on)		Non-informed		Instructed PRF	
		Trial Block 1	2	Trial Block 1	2	Trial Block 1	2	Trial Block 1	2
Warm UCS subgroup	S1	0	.6	.5	.6	1	.5	.33	.4
	S2	.6	0	0	.6	.75	.5	1	.4
	S3	.6	.8	.2	.8	.67	.4	.67	.6
	S4	1	.25	.5	.8	.4	.5	.5	.75
	S5	1	.75	.4	.5	.6	.8	.8	.4
Cold UCS subgroup	S1	.5	.6	1	.2	1	.8	1	.67
	S2	1	.6	.8	.6	.33	.67	1	1
	S3	1	.8	.75	.25	.75	.8	1	.4
	S4	1	1	1	.8	.25	.75	.8	.2
	S5	.5	1	1	.2	.8	1	.6	.8

A.2 Proportion of on to off target responding over the final two blocks of five acquisition trials in CRF100 conditioned groups.

		Informed unpairing (stimulator off)		Informed unpairing (stimulator on)		Non-informed		Instructed PRF	
		Trial Block 1	2	Trial Block 1	2	Trial Block 1	2	Trial Block 1	2
Warm UCS subgroup	S1	0	.6	0	.5	.33	.8	.5	0
	S2	.75	.75	1	.5	.75	.75	.6	.2
	S3	.5	0	.5	.8	.5	.75	1	.75
	S4	.6	.8	.6	.6	.6	.2	.6	.8
	S5	.6	.75	.33	.8	.67	1	.8	.5
Cold UCS subgroup	S1	.75	.8	.4	.8	1	.6	.75	.8
	S2	.4	1	0	1	.8	.6	1	.8
	S3	0	1	1	.67	.6	.75	.8	.33
	S4	1	1	1	1	.75	.8	.67	.33
	S5	1	1	.75	.33	1	.8	.6	.8

A.3 Proportion of on to off target responding over the final two blocks of five acquisition trials in PRF conditioned groups.

		Informed unpairing (stimulator off) Trial Block 1	2	Informed unpairing (stimulator on) Trial Block 1	2	Non-informed Trial Block 1	2
Warm UCS subgroup	S1	.4	0	.8	.6	1	.67
	S2	.75	.8	.25	.67	.75	.5
	S3	.75	.8	.25	.6	.2	.5
	S4	.5	.75	.5	.5	.8	.75
	S5	.5	.75	.75	.4	.75	1
Cold UCS subgroup	S1	.5	.8	.75	.75	1	.4
	S2	.67	.8	.25	1	.4	.75
	S3	.33	.67	1	.8	.6	.75
	S4	1	.75	.4	.8	.75	.67
	S5	.8	.75	.75	.6	.6	1

A.4 Proportion of on to off target responding over the final seven unreinforced trials in PRF conditioned groups.

		Informed unpairing (stimulator off) 1	Informed unpairing (stimulator on) 2	Non-informed 3
Warm UCS subgroup	S1	1	.57	.6
	S2	0	.43	.8
	S3	.6	.86	.83
	S4	.83	.5	.4
	S5	.6	.67	.75
Cold UCS subgroup	S1	.67	.67	.5
	S2	.67	.5	.57
	S3	.83	.5	.86
	S4	.71	.5	.5
	S5	.4	.71	.8

B.1. Proportion of on-target to on+off-target responding over the four extinction trial blocks in the 13 experimental groups.

GROUP 1: CRF25 informed unpairing (stimulator off)

Trial Block

		1	2	3	4
Warm UCS subgroup	S1	0	.5	.8	.4
	S2	.6	.6	.4	0
	S3	.75	.5	.5	0
	S4	.6	.67	.4	.25
	S5	0	.4	.4	.25
Cold UCS subgroup	S1	.8	.4	.4	.8
	S2	.4	.4	.6	.5
	S3	1	0	.75	1
	S4	.6	.25	.33	.8
	S5	.5	.6	.6	.8

GROUP 2: CRF25 informed unpairing (stimulator on)

Trial Block

		1	2	2	4
Warm UCS subgroup	S1	.8	.5	.25	.67
	S2	.6	.4	.4	.25
	S3	.4	.2	.4	.6
	S4	.5	.6	.75	.6
	S5	.4	.5	.5	.5
Cold UCS subgroup	S1	.75	1	.6	.6
	S2	.5	.2	.8	.8
	S3	.75	.5	.25	.4
	S4	.5	.33	.75	.5
	S5	.75	.6	.5	.6

GROUP 3: CRF25 noninformed

		Trial Block			
		1	2	3	4
Warm UCS subgroup	S1	.5	.33	.6	.2
	S2	.6	.2	.25	.5
	S3	.75	.4	.33	.75
	S4	1	.5	.25	.25
	S5	.5	1	.2	.25
Cold UCS subgroup	S1	.75	.33	.6	.5
	S2	.6	.6	.8	.75
	S3	.67	.8	.8	.67
	S4	.75	.6	.6	.5
	S5	1	.8	.6	.6

GROUP 4: CRF25 instructed PRF

		Trial Block			
		1	2	2	4
Warm UCS subgroup	S1	.4	.4	.75	1
	S2	0	.5	.4	.33
	S3	.2	.4	.6	.6
	S4	.8	1	.67	0
	S5	.75	.25	.4	.4
Cold UCS subgroup	S1	.4	.6	.6	.5
	S2	1	.4	.75	1
	S3	.75	.67	.75	.75
	S4	1	1	.8	.8
	S5	.6	.75	.5	.8

GROUP 5: PRF informed unpairing (stimulator off)

Trial Block

		1	2	3	4
Warm UCS subgroup	S1	.33	.75	.67	.33
	S2	0	.6	.2	.2
	S3	.8	.2	.4	.4
	S4	.6	.5	.8	0
	S5	.67	.5	.6	.5
Cold UCS subgroup	S1	.5	.5	.5	.8
	S2	.2	.5	.8	.8
	S3	.25	1	.5	.8
	S4	.4	.4	.2	.5
	S5	.4	.6	.4	0

GROUP 6: PRF informed unpairing (stimulator on)

Trial Block

		1	2	2	4
Warm UCS subgroup	S1	.6	.6	.75	.2
	S2	.2	0	.8	0
	S3	.67	.33	.5	.5
	S4	.8	.6	.4	.8
	S5	.5	.33	.67	.25
Cold UCS subgroup	S1	.75	.4	.8	1
	S2	.2	.67	.33	1
	S3	1	.2	.5	.33
	S4	1	.75	1	.6
	S5	.25	.5	.8	.4

GROUP 7: PRF noninformed

		Trial Block 1	2	3	4
Warm UCS subgroup	S1	1	1	1	.67
	S2	.5	.25	.8	.75
	S3	.4	.6	.5	.75
	S4	.6	.6	.75	.5
	S5	.5	.33	.4	.8
Cold UCS subgroup	S1	.8	1	.6	.8
	S2	.6	.25	.5	.67
	S3	1	.75	.8	.4
	S4	.5	1	1	1
	S5	1	1	1	.6

GROUP 8: CRF100 informed unpairing (stimulator off)

		Trial Block 1	2	2	4
Warm UCS subgroup	S1	1	.6	.75	.75
	S2	.8	.33	.25	.5
	S3	.75	.8	.75	.6
	S4	.6	.2	.6	1
	S5	.5	.5	.5	.75
Cold UCS subgroup	S1	.6	.8	.5	.25
	S2	1	.6	.8	.6
	S3	.75	.67	.4	.8
	S4	.4	.6	.33	.67
	S5	.5	.6	.8	.5

GROUP 9: CRF100 informed unpairing (stimulator on)

TRial Block

		1	2	3	4
Warm UCS subgroup	S1	1	.4	.6	.4
	S2	.8	.5	.6	.75
	S3	.67	1	1	1
	S4	.4	.6	.5	1
	S5	1	.67	.4	.5
Cold UCS subgroup	S1	.4	.75	.6	.25
	S2	1	.67	.67	.5
	S3	.8	.8	.4	.8
	S4	.6	.8	1	1
	S5	.5	.6	.8	.5

GROUP 10: CRF100 noninformed extinction

Trial Block

		1	2	2	4
Warm UCS subgroup	S1	.8	.2	.75	.67
	S2	.5	1	.33	.5
	S3	.75	.6	.6	1
	S4	.4	.8	.4	0
	S5	1	.5	.6	.2
Cold UCS subgroup	S1	1	.6	.4	.6
	S2	.6	.6	.25	1
	S3	1	.8	1	1
	S4	.6	.6	.5	.33
	S5	.8	.75	.67	.75

GROUP 11: CRF 100 instructed PRF

		Trial Block 1	2	3	4
Warm UCS subgroup	S1	1	.6	0	.2
	S2	.8	.6	1	.5
	S3	1	.33	.5	.4
	S4	.6	.5	.4	.5
	S5	.4	.8	.67	0
Cold UCS subgroup	S1	.75	.67	.25	1
	S2	1	.6	.4	.8
	S3	.75	.6	.67	.6
	S4	.75	.75	1	.8
	S5	.8	1	.25	.2

GROUP 12: No Acquisition instructed PRF

		Trial Block 1	2	3	4
Warm UCS subgroup	S1	0	0	.75	1
	S2	.5	.2	.8	.4
	S3	.5	.2	.6	.8
	S4	.6	.5	1	.4
	S5	.6	.33	0	0
Cold UCS subgroup	S1	.6	.4	.8	.75
	S2	0	0	.5	.5
	S3	.4	.25	.5	.33
	S4	.4	.6	.4	.75
	S5	.8	.4	.8	.5

GROUP 13: No Acquisition instructed CRF

Trial Block

		1	2	3	4
Warm UCS subgroup	S1	.67	.4	.5	.5
	S2	.4	.4	.4	.2
	S3	.25	.5	.5	.2
	S4	.25	.6	0	.4
	S5	.2	.75	.25	.8
Cold UCS subgroup	S1	.6	1	.8	1
	S2	1	.33	1	1
	S3	.6	.6	.67	.75
	S4	.8	.8	1	.5
	S5	.67	1	.5	.25

B.2 Mean responding in the warm and cold subgroups of the 13 groups over the four blocks of 5 extinction trials (Arcsin Transformed).

			EXTINCTION TRIAL BLOCKS 1-5	6-10	11-15	16-20
NO ACQUISITION	Instructed CRF	Warm UCS	.63088	.81762	.55582	.70091
		Cold UCS	1.08179	1.14935	1.19860	1.09956
	Instructed PRF	Warm UCS	.66859	.46493	.92224	.80948
		Cold UCS	.67253	.55582	.89396	.85543
CRF 25 ACQUISITION	informed unpairing (stimulator off)	Warm UCS	.56387	.82009	.78934	.34638
		Cold UCS	1.00683	.55582	.82320	1.13553
	informed unpairing (stimulator on)	Warm UCS	.82961	.72105	.74513	.80800
		Cold UCS	.94248	.86357	.86988	.86988
	noninformed	Warm UCS	1.01497	.82330	.60177	.66869
		Cold UCS	1.10203	.91968	.97451	.89259
	Instructed PRF	Warm UCS	.66054	.84985	.85231	.75071
		Cold UCS	1.15192	1.02953	.97460	1.12354

CRF 100 ACQUISITION	Informed unpairing (stimulator off)	Warm UCS	1.07932	.77084	.85789	1.06733
		Cold UCS	.99484	.94485	.85927	.85222
	informed unpairing (stimulator on)	Warm UCS	1.17846	.97717	.96261	1.13178
		Cold UCS	1.00683	1.02129	1.04152	.95447
	non-informed	Warm UCS	1.03905	.96261	.82320	.75574
		Cold UCS	1.20418	.96252	.90467	1.13736
	instructed PRF	Warm UCS	1.16391	.85533	.79995	.54383
		Cold UCS	1.16391	1.06980	.85231	1.02696
PRF 100 ACQUISITION	informed unpairing (stimulator off)	Warm UCS	.71280	.79354	.82009	.50914
		Cold UCS	.62842	.94248	.76526	.82137
	informed unpairing (stimulator on)	Warm UCS	.84023	.59921	.91666	.57596
		Cold UCS	1.03521	.78796	1.03649	1.06487
	non-informed	Warm UCS	.94248	.89570	1.03905	.98916
		Cold UCS	1.18404	1.25664	1.18404	1.04152

B.3 Mean responding in warm and cold UCS subgroups combined in the 13 experimental groups over the four extinction trial blocks.

		TRIAL BLOCKS 1-5	6-10	11-15	16-20
NO ACQUISITION	informed CRF	.85634	.98349	.87721	.90023
	informed PRF	.67056	.51037	.90810	.83245
CRF 25 ACQUISITION	Informed extinction (stim. off)	.78535	.68796	.80627	.74096
	informed extinction (stim. on)	.88605	.79231	.80751	.83894
	non-informed	1.05850	.87149	.78814	.78064
	informed PRF	.90623	.93969	.91346	.93712
PRF ACQUISITION	Informed extinction (stim. off)	.67061	.86801	.79268	.66525
	informed extinction (stim. on)	.93772	.69359	.97658	.82041
	non-informed	1.06326	1.07617	1.11155	1.01534
CRF 100 ACQUISITION	informed extinction (stim. off)	1.03708	.85784	.85858	.95977
	informed extinction (stim. on)	1.09265	.99923	1.00207	1.04312
	non-informed	1.12162	.96256	.86394	.94655
	informed PRF	1.16391	.96256	.82613	.78540

APPENDIX C : ANOVA Summary Tables

ANOVA tables are listed in order of appearance in the text.

C.1 Comparison of responding in Acquisition in the II conditioned groups.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(Groups)	0.534706732	10	0.0534706732	0.4465	0.919148
	TESTED AGAINST S				
B(UCS temperature)	1.859885656	1	1.8598856557	15.5291	0.000163
	TESTED AGAINST S				
C (Trials)	0.186900711	1	0.1869007111	1.5871	0.211075
	TESTED AGAINST CS				
A B	0.584253274	10	0.0584253274	0.4878	0.893815
	TESTED AGAINST S				
A C	1.114074426	10	0.1114074426	0.9460	0.495905
	TESTED AGAINST CS				
B C	0.002057982	1	0.00205579820	0.0175	0.895132
	TESTED AGAINST CS				
A B C	2.397444439	10	0.2397444439	2.0358	0.038739
	TESTED AGAINST CS				
S(Subjects)	10.539579984	88	0.1197679544	1.0170	0.468547
	TESTED AGAINST CS				
C S	10.363221398	88	0.1177638795		
TOTAL	27.582124601	219	0.1259457744		

C.2 Comparison of warm and cold UCS subgroups of CRF conditioned groups for responding in the interstimulus interval of acquisition trials.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(groups)	1.50001653	7	0.214288076	0.7162	0.658534
	TESTED AGAINST S				
B(UCS temperature)	6.44784060	1	6.447840595	21.5490	0.000018
	TESTED AGAINST S				
C(Trials)	0.01887598	1	0.018875978	0.1161	0.734365
	TESTED AGAINST CS				
A B	2.11415192	7	0.302021703	1.0094	0.433195
	TESTED AGAINST S				
A C	2.80701961	7	0.401002802	2.4675	0.026332
	TESTED AGAINST CS				
B C	0.26366796	1	0.263667960	1.6224	0.207359
	TESTED AGAINST CS				
A B C	1.12216813	7	0.160309733	0.9864	0.449095
	TESTED AGAINST CS				
S(Subjects)	19.14988582	64	0.299216966	1.8412	0.007896
	TESTED AGAINST CS				
C S	10.40088413	64	0.162513814		
TOTAL	43.82451067	159	0.275625853		

C.3. Comparison of responding in CRF25, CRF100 and PRF noninformed and informed unpairing (stimulator on) groups over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
Z(conditioning procedure)	0.773811218	2	0.3869056092	3.2768	0.046346
	TESTED AGAINST S				
A(expectancy manipulation)	1.551046220	1	1.5510462204	13.1364	0.000698
	TESTED AGAINST S				
B(UCS temperature)	1.209457194	1	1.2094571944	10.2433	0.002434
	TESTED AGAINST S				
C(trials)	0.374807166	3	0.1249357220	1.3255	0.269108
	TESTED AGAINST CS				
Z A	0.791334625	2	0.3956673124	3.3510	0.043420
	TESTED AGAINST S				
Z B	0.255235122	2	0.1276175609	1.0808	0.347424
	TESTED AGAINST S				
Z C	0.714202211	6	0.1190337019	1.2609	0.279137
	TESTED AGAINST CS				
A B	0.105969554	1	0.1059695539	0.8975	0.348200
	TESTED AGAINST S				
A C	0.190458284	3	0.0634860947	0.6725	0.570239
	TESTED AGAINST CS				
B C	0.280542213	3	0.0935140710	0.9906	0.399129
	TESTED AGAINST CS				
Z A B	0.157636972	2	0.0788184861	0.6675	0.517665
	TESTED AGAINST S				
Z A C	0.218442317	6	0.0364070529	0.3857	0.887276
	TESTED AGAINST CS				
Z B C	0.751932361	6	0.1253220602	1.3275	0.248580
	TESTED AGAINST CS				
A B C	0.161589531	3	0.0538631770	0.5706	0.635263
	TESTED AGAINST CS				
Z A B C	1.330872652	6	0.2218121086	2.3497	0.033998
	TESTED AGAINST CS				
S(Subjects)	5.667489697	48	0.1180727020	1.2508	0.157939
	TESTED AGAINST CS				
C S	13.593800764	144	0.0944013942		
TOTAL	28.128628103	239	0.1176930046		

C.4. Comparison of PRF informed unpairing (stimulator off) and noninformed groups over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(groups)	2.015372712	1	2.0153727121	11.1144	0.004208
	TESTED AGAINST S				
B(UCS temperature)	0.393262888	1	0.3932628884	2.1688	0.160237
	TESTED AGAINST S				
C(trials)	0.246262787	3	0.0821542625	0.8669	0.464785
	TESTED AGAINST CS				
A B	0.071374164	1	0.0713741638	0.3936	0.539255
	TESTED AGAINST S				
A C	0.093335629	3	0.0311118764	0.3283	0.804897
	TESTED AGAINST CS				
B C	0.138898886	3	0.0462996286	0.4885	0.691865
	TESTED AGAINST CS				
A B C	0.251939289	3	0.0839797631	0.8861	0.455042
	TESTED AGAINST CS				
S(Subjects)	2.901265841	16	0.1813291151	1.9133	0.042635
	TESTED AGAINST CS				
C S	4.549009879	48	0.0947710391		
TOTAL	10.660922076	79	0.1349483807		

C.5. Comparison of CRF25 informed unpairing (stimulator off) and noninformed groups over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(groups)	0.285881912	1	0.2858819120	6.3707	0.022556
	TESTED AGAINST S				
B(UCS temperature)	0.992080551	1	0.9920805507	22.1077	0.000240
	TESTED AGAINST S				
C(trials)	0.318638515	3	0.1062128383	1.1463	0.340002
	TESTED AGAINST CS				
A B	0.015350818	1	0.0153508176	0.3421	0.566788
	TESTED AGAINST S				
A C	0.265111495	3	0.0883704982	0.9537	0.422223
	TESTED AGAINST CS				
B C	0.883756790	3	0.2945855966	3.1793	0.032243
	TESTED AGAINST CS				
A B C	0.848490308	3	0.2828301026	3.0525	0.037293
	TESTED AGAINST CS				
S(Subjects)	0.717996702	16	0.0448747939	0.4843	0.943024
	TESTED AGAINST CS				
C S	4.447492963	48	0.0926561034		
TOTAL	8.774800053	79	0.1110734184		

C.6. Comparison of CRF100 informed unpairing (stimulator off) and noninformed groups over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(groups)	0.041126221	1	.04112622106	0.3213	0.578715
	TESTED AGAINST S				
B(UCS temperature)	0.079348877	1	.07934887718	0.6198	0.442612
	TESTED AGAINST S				
C(Trials)	0.523908075	3	.17463602499	1.8234	0.155494
	TESTED AGAINST CS				
A B	0.176881545	1	.17688154460	1.3817	0.257002
	TESTED AGAINST S				
A C	0.050453477	3	.01681782581	0.1756	0.912405
	TESTED AGAINST CS				
B C	0.009818899	3	.00327296628	0.0342	0.991418
	TESTED AGAINST CS				
A B C	0.392032586	3	.13067752861	1.3644	0.264911
	TESTED AGAINST CS				
S(Subjects)	2.048227154	16	.12801419711	1.3366	0.215025
	TESTED AGAINST CS				
C S	4.597297922	48	.09577704004		
TOTAL	7.919094756	79	.10024170577		

C.7. Comparison of warm and cold UCS subgroup of the CRF25 informed unpairing (stimulator off) group over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
B(UCS temperature)	0.627122522	1	0.6271225218	12.9540	0.006991
	TESTED AGAINST S				
C (Trials)	0.082418591	3	0.0274728636	0.2470	0.862642
	TESTED AGAINST CS				
B C	1.597738718	3	0.5325795728	4.7883	0.009396
	TESTED AGAINST CS				
S(Subjects)	0.387291737	8	0.0484114671	0.4353	0.887996
	TESTED AGAINST CS				
C S	2.669409017	24	0.1112253757		
TOTAL	5.363980585	39	0.1375379637		

C.8. Comparison of warm and cold UCS subgroups of the PRF informed unpairing (stimulator off) group over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
B(UCS temperature)	0.064781038	1	.06478103829	0.5872	0.465515
	TESTED AGAINST S				
C(Trials)	0.292292408	3	.09743080254	0.9691	0.423532
	TESTED AGAINST CS				
B C	0.259706453	3	.08656881768	0.8610	0.474728
	TESTED AGAINST CS				
S(Subjects)	0.882590531	8	.11032381635	1.0973	0.398828
	TESTED AGAINST CS				
C S	2.412988214	24	.10054117558		
TOTAL	3.912358644	39	.10031688830		

C.9. Comparison of responding in the two no acquisition groups over the four test trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(groups)	0.605136518	1	0.6051365177	4.1055	0.059752
	TESTED AGAINST S				
B(UCS temperature)	1.171963846	1	1.1719638464	7.9511	0.012328
	TESTED AGAINST S				
C(Trials)	0.318712183	3	0.1062373944	0.8390	0.479197
	TESTED AGAINST CS				
A B	0.915439367	1	0.9154393668	6.2107	0.024052
	TESTED AGAINST S				
A C	0.714347853	3	0.2381159511	1.8805	0.145466
	TESTED AGAINST CS				
B C	0.028997748	3	0.0096659160	0.0763	0.972467
	TESTED AGAINST CS				
A B C	0.125173531	3	0.0417245103	0.3295	0.804012
	TESTED AGAINST CS				
S(Subjects)	2.358342237	16	0.1473970148	1.1641	0.329328
	TESTED AGAINST CS				
C S	6.077937526	48	0.1266236985		
TOTAL	12.316060810	79	0.1558995039		

C.10. Comparison of CRF25, PRF and CRF100 informed unpairing (stimulator on) and noninformed groups over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
Z(conditioning procedure)	0.971677263	2	0.4858386338	3.4587	0.039513
	TESTED AGAINST S				
A(expectancy manipulation	0.246779583	1	0.2467795629	1.7568	0.191293
	TESTED AGAINST S				
B(UCS temperature)	1.216960245	1	1.2159602446	8.6565	0.005006
	TESTED AGAINST S				
C(trials)	0.625947586	3	0.2089325120	2.1561	0.095811
	TESTED AGAINST CS				
Z A	0.742353169	2	0.3711765847	2.6424	0.081525
	TESTED AGAINST S				
Z B	0.305192765	2	0.1525963825	1.0863	0.345598
	TESTED AGAINST S				
Z C	0.412800988	6	0.0688001646	0.7093	0.642211
	TESTED AGAINST CS				
A B	0.104055934	1	0.1040559337	0.7403	0.393689
	TESTED AGAINST S				
A C	0.236100182	3	0.0787000541	0.8120	0.489214
	TESTED AGAINST CS				
B C	0.036177106	3	0.0120590352	0.1244	0.945550
	TESTED AGAINST CS				
Z A B	0.171182993	2	0.0855914963	0.6093	0.547864
	TESTED AGAINST S				
Z A C	0.216360362	6	0.0363933937	0.3755	0.893655
	TESTED AGAINST CS				
Z B C	0.132028147	6	0.0220046911	0.2270	0.967393
	TESTED AGAINST CS				
A B C	0.017371497	3	0.0057004991	0.0597	0.980793
	TESTED AGAINST CS				
Z A B C	0.534063620	6	0.1036773033	1.0903	0.371049
	TESTED AGAINST CS				
S	6.742429202	48	0.1404672750	1.4492	0.048963
	TESTED AGAINST CS				
C S	13.957493014	144	0.0969270348		
TOTAL	26.770973769	239	0.1120124425		

C.11. Comparison of responding in CRF100 noninformed and informed unpairing (stimulator on) groups over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(Group)	0.073444764	1	.07344476399	0.4443	0.514562
	TESTED AGAINST S				
B(UCS temperature)	0.050550422	1	.05044042220	0.3058	0.587921
	TESTED AGAINST S				
C(Trials)	0.325886675	3	.10862889166	0.8973	0.449455
	TESTED AGAINST CS				
A B	0.227937489	1	.22793748909	1.3788	0.257483
	TESTED AGAINST S				
A C	0.079502851	3	.02650095050	0.2189	0.882799
	TESTED AGAINST CS				
B C	0.036253071	3	.01208435711	0.0998	0.959723
	TESTED AGAINST CS				
A B C	0.306786364	3	.10226212122	0.8447	0.476197
	TESTED AGAINST CS				
S(Subjects	2.644999981	16	.16531249882	1.3656	0.199430
	TESTED AGAINST CS				
C S	5.810733257	48	.12105694285		
TOTAL	9.556094875	79	.12096322626		

C.12. Comparison of responding in CRF25 and PRF noninformed and informed unpairing (stimulator on) group over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
Z(conditioning procedure)	0.474190750	1	0.4741907504	3.7033	0.063235
	TESTED AGAINST S				
A(expectancy manipulation)	0.640074059	1	0.6400740590	4.9988	0.032466
	TESTED AGAINST S				
B(UCS temperature)	1.419795142	1	1.4197951416	11.0883	0.002198
	TESTED AGAINST S				
C(Trials)	0.428862002	3	0.1429540006	1.6845	0.175455
	TESTED AGAINST CS				
Z A	0.275613909	1	0.2756139093	2.1525	0.152100
	TESTED AGAINST S				
Z B	0.050807446	1	0.508074458	0.3968	0.533222
	TESTED AGAINST S				
Z C	0.284999847	3	0.0949999490	1.1195	0.345138
	TESTED AGAINST CS				
A B	0.003304178	1	0.0033041779	0.0258	0.873388
	TESTED AGAINST S				
A C	0.195067988	3	0.0650226626	0.7662	0.515725
	TESTED AGAINST CS				
B C	0.012759934	3	0.0042533114	0.0501	0.985079
	TESTED AGAINST CS				
Z A B	0.043997259	1	0.0439972592	0.3436	0.561866
	TESTED AGAINST S				
Z A C	0.179889685	3	0.0599632283	0.7066	0.550381
	TESTED AGAINST CS				
Z B C	0.119192247	3	0.0397307489	0.4682	0.705163
	TESTED AGAINST CS				
A B C	0.100628805	3	0.0335429350	0.3953	0.756692
	TESTED AGAINST CS				
Z A B C	0.244020148	3	0.0813400494	0.9585	0.415671
	TESTED AGAINST CS				
S(Subjects)	4.097429221	32	0.1280446632	1.5089	0.065156
	TESTED AGAINST CS				
C S	8.146759757	96	0.0848620808		
TOTAL	16.717392377	159	0.1051408326		

C.13. Comparison of CRF100 informed unpairing (stimulator on) and informed unpairing (stimulator off) groups over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(Groups)	0.224489238	1	.22448923831	1.9737	0.179173
	TESTED AGAINST S				
B(UCS temperature)	0.038313625	1	.03831362545	0.3369	0.569737
	TESTED AGAINST S				
C(Trials)	0.255426619	3	.08514220623	0.9741	0.412763
	TESTED AGAINST CS				
A B	0.003232504	1	.00323250432	0.0284	0.868238
	TESTED AGAINST S				
A C	0.028568492	3	.00952283051	0.1089	0.954466
	TESTED AGAINST CS				
B C	0.303714534	3	.10123817800	1.1582	0.335426
	TESTED AGAINST CS				
A B C	0.036650045	3	.01221668156	0.1398	0.935705
	TESTED AGAINST CS				
S(Subjects)	1.819847076	16	.11374044226	1.3013	0.235371
	TESTED AGAINST CS				
C S	4.195535276	48	.08740698491		
TOTAL	6.905777409	79	.08741490391		

C.14. Comparison of respondingin CRF25 and PRF informed unpairing (stimulator on) and informed unpairing (stimulator off) groups over the four extinction trial blocks

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
Z(conditioning procedure)	0.003950701	1	0.0039507015	0.0419	0.839125
TESTED AGAINST S					
A(expectancy manipulation)	0.338566723	1	0.3385667232	3.5899	0.067198
TESTED AGAINST S					
B(UCS temperature)	1.188646657	1	1.1886466568	12.6036	0.001216
TESTED AGAINST S					
C(Trials)	0.206781390	3	0.0689271299	0.7104	0.548145
TESTED AGAINST CS					
Z A	0.010154805	1	0.0101548051	0.1077	0.744945
TESTED AGAINST S					
Z B	0.002612701	1	0.0026127011	0.0277	0.868856
TESTED AGAINST S					
Z C	0.105159014	3	0.0350530048	0.3613	0.781114
TESTED AGAINST CS					
A B	0.001920092	1	0.0019200924	0.0204	0.887433
TESTED AGAINST S					
A C	0.257794827	3	0.0859316092	0.8856	0.451513
TESTED AGAINST CS					
B C	0.855345823	3	0.2851152742	2.9384	0.037117
TESTED AGAINST CS					
Z A B	0.236463274	1.	0.2364632738	2.5073	0.123155
TESTED AG INST S					
Z A C	0.344957860	3	0.1149859534	1.1850	0.319609
TESTED AG INST CS					
Z B C	0.260239524	3	0.0867465079	0.8940	0.447256
TESTED AGAINST CS					
A B C	0.357888078	3	0.1192960261	1.2295	0.303303
TESTED AGAINST CS					
Z A B C	0.594932780	3	0.1983109267	2.0438	0.112875
TESTED AGAINST CS					
S(Subjects)	3.017931214	32	0.0943103504	0.9720	0.519790
TESTED AGAINST CS					
C S	9.315051377	96	0.0970317852		
TOTAL	17.098396841	159	0.1075370871		

C.15. Comparison of responding in extinction between those reporting and those not reporting maintained expectancy of UCS in CRF25 and PRF informed unpairing (stimulator on) groups.

ANALYSIS OF VARIANCE

	SS.	DF	MS	F
Reported expectancy	.0733001364	1	.0556633334	1.33119686
within subjects error	.807458334	16	.0504661459	
between subjects error	.88101334	16		

C.16. Comparison of responding in CRF25 and CRF100 instructed PRF and noninformed groups over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
Z(conditioning procedure)	0.119579494 TESTED AGAINST S	1	0.1195794943	1.0551	0.312026
A(expectancy manipulation)	0.001054218 TESTED AGAINST S	1	0.0010542178	0.0093	0.923766
B(UCS temperature)	1.726740645 TESTED AGAINST S	1	1.7267406453	15.2365	0.000459
C(Trials)	1.154034651 TESTED AGAINST CS	3	0.3846785503	3.1187	0.029642
Z A	0.078499097 TESTED AGAINST S	1	0.0784990971	0.6927	0.411428
Z B	0.050437204 TESTED AGAINST S	1	0.0504372035	0.4450	0.509478
Z C	0.170990451 TESTED AGAINST CS	3	0.0569968171	0.4621	0.709410
A B	0.040316148 TESTED AGAINST S	1.	0.0403161483	0.3557	0.555076
A C	0.060012928 TESTED AGAINST CS	3	0.0200043093	0.1622	0.921557
B C	0.341240284 TESTED AGAINST CS	3	0.1170834284	0.9492	0.420089
Z A B	0.010912894 TESTED AGAINST S	1	0.0109128937	0.0963	0.758336
Z A C	0.346521513 TESTED AGAINST CS	3	0.1155071708	0.9365	0.426247
Z B C	0.184136447 TESTED AGAINST CS	3	0.0617121124	0.5003	0.682950
A B C	0.138944975 TESTED AGAINST CS	3	0.0463149916	0.3755	0.770871
Z A B C	0.234550318 TESTED AGAINST CS	3	0.0781834392	0.6339	0.594966
S(Subjects)	3.626541983 TESTED AGAINST CS	32	0.1133294370	0.9188	0.595511
C S	11.841171397	96	0.1233455354		
TOTAL	20.136695538	159	0.1266458839		

C.17. Comparison of responding in CRF100 instructed PRF and noninformed groups over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(Groups)	0.030679672	1	0.0306796719	0.2398	0.631025
	TESTED AGAINST S				
B(UCS temperature)	0.593475439	1	0.5934754389	4.6380	0.046866
	TESTED AGAINST S				
C(Trials)	1.106518257	3	0.3688394190	2.5524	0.066466
	TESTED AGAINST CS				
A B	0.004639158	1	0.0046391583	0.0363	0.851385
	TESTED AGAINST S				
A C	0.115259591	3	0.0384198636	0.2659	0.849655
	TESTED AGAINST CS				
B C	0.455189150	3	0.1517297165	1.0500	0.379116
	TESTED AGAINST CS				
A B C	0.100934930	3	0.0336449765	0.2328	0.873062
	TESTED AGAINST CS				
S(Subjects)	2.047355213	16	0.1279597008	0.8855	0.588543
	TESTED AGAINST CS				
C S	6.936290279	48	0.1445060475		
TOTAL	11.390341687	79	0.1441815403		

C.18. Comparison of responding in CRF25 instructed PRF and noninformed groups over the four extinction trial blocks

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(Groups)	0.048873643	1	0.0488736431	0.4952	0.491741
	TESTED AGAINST S				
B(UCS temperature)	1.183702410	1	1.1837024099	11.9930	0.003204
	TESTED AGAINST S				
C(Trials)	0.218507845	3	0.0728359484	0.7128	0.549162
	TESTED AGAINST CS				
A B	0.046589884	1	0.0465898837	0.4720	0.501888
	TESTED AGAINST S				
A C	0.291274850	3	0.0970916166	0.9502	0.423913
	TESTED AGAINST CS				
B C	0.081197473	3	0.0270658243	0.2649	0.850367
	TESTED AGAINST CS				
A B C	0.272560363	3	0.0908534543	0.8891	0.453553
	TESTED AGAINST CS				
S(Subjects)	1.579186771	16	0.0986991732	0.9659	0.506228
	TESTED AGAINST CS				
C S	4.904881118	48	0.1021850233		
TOTAL	8.626774356	79	0.1091996754		

C.19. Comparison of responding in CRF25 instructed PRF and noninformed groups over the final two extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(Groups)	0.1107628963 TESTED AGAINST S	1	.11076289631	4.1467	0.058618
B(UCS temperature)	0.3084255896 TESTED AGAINST S	1	.30842558959	11.5468	0.003675
A B	0.0045599681 TESTED AGAINST S	1	.00455996808	0.1707	0.684962
S(Subjects)	0.4273762213	16	.02671101383		
TOTAL	0.8511246753	19	.04479603554		

C.20. Comparison of responding in the four CRF100 group over the four extinction trial blocks.

ANALYSIS OF VARIANCE

	SS	DF	MS	F	P
A(Groups)	0.284782676 TESTED AGAINST S	3	0.0949275587	0.7855	0.510870
B(UCS temperature)	0.165102637 TESTED AGAINST S	1	0.1651026369	1.3662	0.251103
C(Trials)	1.063020854 TESTED AGAINST CS	3	0.3543402846	3.0558	0.032061
A B	0.474558090 TESTED AGAINST S	3	0.1581860300	1.3089	0.288511
A C	0.442752104 TESTED AGAINST CS	9	0.0491946782	0.4243	0.919189
B C	0.125063453 TESTED AGAINST CS	3	0.0416878177	0.3595	0.728368
A B C	0.771425205 TESTED AGAINST CS	9	0.0857139116	0.7392	0.672121
S(Subjects)	3.867202289 TESTED AGAINST CS	32	0.1208500715	1.0422	0.424152
C S	11.131825554	96	0.1159565162		
TOTAL	18.325732862	159	0.1152561815		

APPENDIX D : QUESTIONNAIRE PROTOCOL

Question 1: What were you thinking about during the experiment?

Question 2: Did you think about the warm temperature (in the case of warm UCS subgroups, or "cold temperature" in the case of cold UCS subgroups) in the interval after the tone and before the temperature changed on trials before I came in and said "... (extinction instructions appropriate to group). (This question was not asked of no acquisition groups.)

Question 3: Did you think about the warm temperature (in the case of warm UCS subgroups, or "cold temperature" in the case of cold UCS subgroups) in the interval after the tone and before the temperature changed on trials after I came in and said "... (extinction instructions appropriate to group).

Question 4: Did you have any expectation at all that the temperature change might come after the tone after I said "... (extinction instructions appropriate to group). Did you expect anything else to happen instead? Did you believe the instructions? What probablity of reinforcement following the tone did you expect at the beginning of extinction? Did this expectation increase or decrease? When? What probability of reinforcement did you expect at the end of extinction?

Question 5: Did you notice feeling warm (in the case of warm UCS subjects, or "cold" in the case of cold UCS subjects) following the tone on trials after I came in and said "... (extinction instructions appropriate to group)?

Question 6: Were you comfortable during the experiment?

Question 7: Would you rate the warm temperature (in the case of warm UCS subjects, or "cold temperature" in the case of cold subjects) as pleasant, unpleasant, or neutral?

Question 8: Did you try to influence your responding to the tone? If so, how?

APPENDIX E: FREQUENCY OF QUESTIONNAIRE RESPONSES IN EACH RESPONSE CATEGORY IN THE THIRTEEN EXPERIMENTAL GROUPS.

Question Number	Response Category	Group Number 1	2	3	4	5	6	7	8	9	10	11	12	13
1	Temperature change	0	2	0	1	0	0	1	0	0	1	0	2	3
	CS-UCS timing	0	0	0	0	0	0	1	1	2	1	1	1	2
	Pulse rate	0	0	1	1	1	0	0	0	0	1	1	1	0
	Purpose of experiment	0	1	2	0	1	3	1	0	2	0	0	1	0
	thinking about apparatus	0	0	0	0	0	0	0	0	0	0	0	0	1
	relevance to own study	2	0	0	0	0	0	0	0	0	0	0	0	0
	breathing	1	0	0	2	0	0	0	0	0	0	0	0	0
	avoided thinking about expt.	1	0	1	0	0	0	0	0	0	0	0	0	0
	staying awake	0	0	0	0	0	0	1	0	0	0	0	0	0
	things irrelevant to expt.	6	7	6	6	7	4	7	9	6	7	8	5	6
2	Yes (or usually)	5	8	5	4	2	4	4	3	5	4	5	5	8
	No	5	5	2	3	6	2	2	2	3	3	3	5	2
	sometimes	0	0	2	3	2	4	4	5	2	3	2	3	5
	unsure/startled by CS	1	0	1	0	0	0	0	0	0	0	0	0	0
3	Yes (or usually)	4	5	6	4	2	3	2	2	3	3	6	3	3
	No	5	5	2	3	6	5	5	7	7	3	2	4	2
	sometimes	0	0	2	3	2	2	3	1	0	2	2	3	5
	unsure	1	0	0	0	0	0	0	0	0	2	0	0	0
4a	Any expectation of UCS	0	5	8	9	0	5	8	0	3	10	10	8	10
	expected something else	1	0	0	0	1	0	1	0	1	0	0	0	0
	expected small change	0	0	0	0	0	0	0	0	0	0	0	2	0
	no expectation	9	5	2	1	9	5	1	10	6	0	0	0	0
4b	initially sure UCS would come	0	0	0	0	0	0	8	0	2	0	0	5	0
	expected on 25% of trials	0	0	0	9	0	1	0	0	0	1	8	0	10
	fairly sure	0	3	7	0	0	3	0	0	0	5	1	5	0
	uncertain	0	2	1	0	0	1	1	0	4	2	1	0	0
	certain would not come	10	5	2	1	10	5	1	10	6	0	0	0	0
4c	decreasing over trials	0	2	6	7	0	2	2	0	2	8	4	5	6
	no change	10	8	4	2	10	7	7	10	7	2	6	5	4
	increasing over trials	0	0	1	0	1	1	0	1	0	0	0	0	0
5	Yes	7	2	5	2	3	2	5	5	2	6	5	3	3
	No	3	7	5	6	7	8	5	5	7	4	5	7	7
	unsure	0	1	0	2	0	0	0	0	1	0	0	0	0
6	Yes	7	10	10	9	9	7	10	9	10	10	9	9	10
	No	0	0	0	1	0	1	0	0	0	0	0	0	0
	Too warm	2	0	0	0	0	1	0	1	0	0	0	1	0
	Too cold	1	0	0	0	1	1	0	0	0	0	1	0	0
7	Warm UCS pleasant	4	4	4	3	5	4	4	3	5	5	4	4	4
	Warm UCS unpleasant	1	0	1	0	0	0	0	0	0	0	1	0	0
	Warm UCS neutral	0	1	0	2	0	1	1	2	0	0	0	1	1
	Cold UCS pleasant	0	0	0	0	0	0	0	0	1	1	2	1	1
	Cold UCS unpleasant	2	3	2	3	4	2	5	4	1	2	2	2	2
	Cold UCS neutral	3	2	3	2	1	3	0	1	3	2	1	2	2
8	No	8	7	6	9	7	8	7	8	8	8	8	9	9
	relaxed/kept still	0	0	0	0	1	0	2	0	0	0	1	0	1
	concentrated on finger	0	0	0	1	0	0	0	0	0	1	0	0	0
	careful breathing	1	1	1	0	1	1	0	1	1	1	1	1	0
	other	1	2	3	0	1	1	1	1	1	0	0	0	0

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LEARNING THEORY VERSUS PARADIGMS AS THE BASIS FOR BEHAVIOUR THERAPY

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Summary—Contrary to Wolpe's (1976) assertion, it is argued that behaviour therapy is best defined in terms of learning theory rather than 'principles and paradigms'. The deep controversies between the major learning theories, which Wolpe argues prevent the use of learning theory as the basis for behaviour therapy, are due to our lack of understanding of many of the processes important in therapeutic behaviour change. An understanding of these issues is vital to the development of behaviour therapy, and it is stressed that references to vague concepts, whether these are labelled as principles or theories, are no substitute for closely argued treatment rationales.

Over the past few years there has been something of a debate over the 'real' meaning of the term 'behaviour therapy' (Wolpe, 1976). Wolpe argues that this debate is something of a spurious one; that behaviour therapy is a synthetic construct and as such its definition cannot be improved upon. He goes on to state his version of the definition, and to argue some of the consequences of that definition for the future progress of behaviour therapy. Many of Wolpe's points are well taken, but his insistence on "principles and paradigms" rather than 'learning theory' as the basis for behaviour therapy is very probably mistaken and certainly dangerously liable to be misunderstood—with considerable consequences for behaviour therapy and eventually for behaviour therapists.

According to Wolpe, the issue of whether behaviour therapy is most properly defined in terms of theory or in terms of principles and constructs (as distinct from the issue of whether theory is in any way useful in behaviour therapy), is best determined by examination of "the" definition of behaviour therapy. This is not at all as simple as Wolpe suggests, and the definition we select will depend on the criteria we use in selection.

One possibility would be to take the first use of the term as the source of a definition. Wolpe credits the first use of 'behaviour therapy' to Skinner and Lindsley (1953), but the paper referred to was a set of mimeographed reports that seem never to have been published. Since we have no guarantee that others did not use the term previous to this (as a lecture topic, in a personal communication or whatever), since the paper referred to is not now and never has been generally available, and since I can find no reference to a specific definition of behaviour therapy by these authors there seems no reason to take this paper into account in determining the definition of behaviour therapy.

A second possibility would to be to take the first published use of the term as the source of a definition. Lazarus (1958) seems to be the first to use the term in a publication. Although he gives no formal definition of behaviour therapy in this article, Lazarus does argue that the behaviour therapist should use all the usual psychotherapeutic techniques, but should *in addition* use 'objective techniques designed to inhibit specific neuroses'. This eclectic viewpoint is one of those specifically singled out for the label of "malcontent" by Wolpe, and perhaps its intrinsic imprecision disqualifies it as "the" definition of behaviour therapy. Lazarus' article made little impact at the time (Lazarus himself argues that Eysenck and Wolpe, who popularized the

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term, used it quite independently of previous authors), no formal definition is given, and although he uses his various labels for behaviour therapists apparently interchangeably, only a few of his comments refer specifically to the term behaviour therapy.

The third possibility is to take the first published use of the term that was both clearly defined and widely accepted. There is no doubt that these criteria are fulfilled by Eysenck's (1960) definition of "behaviour therapy" as referring to "a large group of methods of treatment, all of which owe their existence and their theoretical justification to modern learning theory; they thus derive from Pavlov, Watson and Hull, rather than from Freud, Jung and Adler". Four years later Eysenck (1964) abbreviated this to the simple statement that "behaviour therapy may be defined as the attempt to alter human behaviour and emotion in a beneficial manner according to the laws of modern learning theory". There can be no doubt that Eysenck was highly influential in popularizing the term 'behaviour therapy' and the treatments subsumed under it. It was not until his two important books (1960, 1964) that the term came into general usage. Since Eysenck used the term independently of previous authors and since it was his definition that gained wide acceptance at the time it is hard to see why this should not be accepted as "the" definition of behaviour therapy. It seems highly probable that there were several aspects of the behaviour therapy proposed by Eysenck that gained ready acceptance at the time—not the least of these being the claim that procedures are based on a powerful theory. Behaviour therapists were quick to point out the lack of a sound empirically based psychoanalytic theory, and it seems probable that without the stress on learning theory the behaviour therapies would not have become as popular as they are.

Two kinds of criticism have been raised against this conception of behaviour therapy. London (1972) has argued that theory is a hindrance to the development of new therapies, and Wolpe (1976) has argued that since there is no one 'modern learning theory' it is meaningless to define behaviour therapy in terms of such a theory.

Taking London's criticism first, a number of authors, most recently Wolpe (1976), have pointed out the importance of an understanding of the processes involved in treatment for the development of new treatments. Without such an understanding we would be reduced to more or less random trial and error in treatment formulation, which is both tedious and unlikely to lead to any radically new treatments. Quite possibly, however, some effective new treatments or effective variants of existing treatments may be found in this way—for example, Wolpe's carbon dioxide treatment is admitted to be something of a lucky find, and no atheoretical basis is claimed for it. If we are convinced that this treatment is effective there is no reason why it should not be used; but it would be misleading and dangerous to classify this with the behaviour therapies until a behaviouristic rationale has been established.

Without an understanding of the processes believed to be important in carbon dioxide therapy or any other theoretical treatment we have no way of demonstrating specific treatment efficacy. Since non-specific factors such as expectancy are known to be capable of producing powerful treatment effects (Russel, 1974; Marcia *et al.*, 1969; Tori and Worrel, 1973) the only procedure capable of demonstrating specific efficacy is the use of an expectancy control treatment—a treatment which looks to subjects as though it should work as well as the experimental treatment, but which cannot be predicted from the treatment rationale to be effective. This sort of procedure may appear to be divorced from realities of clinical practice, and to some extent it is. The clinician is understandably most interested in selecting treatments that appear to have the greatest chance of leading to an effective treatment outcome for an individual patient, and if a treatment deriving its effectiveness solely from expectancy seems more powerful it would again be understandable if the therapist chose to use it in preference to less powerful treatments. But there is a grave danger in this. As Russel (1974) has shown, that part of a treatment's effectiveness due to expectancy is highly transient, and although new treatments can be expected to be effective for a time solely due to expectancy, unless there is some specific treatment effect we can expect such treatments to be rapidly discredited. Unless atheoretical treatments that may be based on expectancy alone are set apart from the legitimate behaviour therapies, there is a real risk that the behaviour therapies will be discredited along with the atheoretical treatments.

But what of Wolpe's claim that behaviour therapies cannot be based on modern learning theory, since there is no such theory, and his suggestion that treatments should instead be based on principles and paradigms? This is a superficially attractive solution, especially since the distinction between theories, principles, and paradigms is rather vague. Simply by changing the terminology we appear to avoid the very deep conflicts between competing learning theories—it seems more attractive to talk about 'principles', whose truth is supposedly empirically based, than theories, especially when there is no one learning theory that is universally accepted. This viewpoint has been supported by Maher (1972), who suggests that behaviour therapy is based on the empirical observations relating to stimulus response relations such as the 'descriptive propositions setting forth the relationships between hunger, food, bells, and saliva in Pavlov's dogs, and the propositions that describe the response probabilities when a pigeon trained to peck in response to a particular hue is presented with other hues variously removed along the spectrum'. He goes on to suggest that there is general agreement about the validity of many of these propositions; that it is only in the matter of hypothesizing processes that might account for them that disputes arise.

All of this is true enough—very few would dispute the fact that dogs do learn to salivate in response to bells paired with food, or that pigeons continue to peck stimuli other than the one they have been trained to peck. But it must be stressed that we are not interested in salivating dogs or pecking pigeons; behaviour therapy treatments are not infrequently unlike the research on which they are supposedly based, e.g. self-control procedures (Catania, 1975).

Aversion and avoidance programs are among the easiest to relate to experimental situations, yet even here the relationship is not at all close. In the commonly used procedure designed by Feldman and McCulloch the only element of the treatment situation closely similar to the experimental situations is the electric shock administered. Instead of conditioning responses to the target stimulus (e.g. males or females) photographs are used, and instead of utilizing a relevant avoidance response subjects are trained to press a button. Further, subjects undergo a number of sessions between which they would return to the environment that previously maintained their maladaptive behaviour, and perhaps most importantly subjects are well aware between sessions and at the end of the program that treatment contingencies no longer apply. Any of these differences are sufficient to prevent us from using laboratory evidence as direct support for treatment procedures—the fact that a certain response probability was obtained in the laboratory cannot be used to predict a similar probability in the treatment program. This is made still more obvious by the fact that the laboratory relationships are known not to apply in certain circumstances. It is well known that even rats can use a safety signal to make an otherwise punished response when contingencies are not operating (Azrin, 1956; Brethower and Reynolds, 1962), and it seems improbable that humans would be less able to learn a discrimination between conditioning sessions and the intervals between them when contingencies do not operate. There is also considerable evidence that humans aware of contingency changes do not exhibit learning properties found in other subjects. Even the ubiquitous partial reinforcement extinction effect may be abolished in human subjects that are aware of contingencies (Mandel and Bridger, 1965).

In order to predict treatment success for any behaviour therapy we cannot simply refer to what happens in situations that are different; we need to invoke theoretical concepts, consistent with the available evidence, that tell us which similarities and differences are important and which are not. Whether these concepts are labelled as 'principles and paradigms', or whether they constitute part or all of a theory is not the issue. What is important is that treatments be based on closely specified rationales and tied down to concrete evidence. There is just as much risk for the future of behaviour therapy if clinicians speak vaguely of 'learning theory' and 'conditioning' without arguing specific processes as there is if no rationale is given at all.

This need not be seen simply as a warning of doom if treatments are not based on a closely specified rationale. The payoff resulting from understanding process is great. For example, Eysenck's new theory of neurosis (Eysenck, 1977) provides an account of the processes that may be involved in a number of treatments such as systematic desensitization and response prevention. It makes predictions of when these treatments should work, and when they should not—for example, Eysenck's theory predicts that short exposure in response prevention will be harmful, and that longer exposure after a certain point will be beneficial—predictions borne out in clinical practice (Eysenck, 1976). The development of theories such as these and their careful application to treatment programs is vital for the future development of behaviour therapy, and it is only by insisting on a close link between therapy, theory development and research evidence that we can avoid the otherwise inevitable eclipse.

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PARTIAL REINFORCEMENT AND EXTINCTION IN VASOMOTOR CONDITIONING:

A TEST OF COGNITIVE AND TWO FACTOR THEORIES

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ABSTRACT

In order to investigate cognitive versus traditional accounts of responding in extinction, and the discrimination hypothesis for the partial reinforcement effect, 40 human subjects were randomly divided into two groups, and were given thermal vasomotor conditioning procedures using either 25 trials of continuous reinforcement or 100 trials of 25% partial reinforcement. At the onset of extinction half of each group was given traditional noninformed extinction, while the other (informed) half had the thermal stimulator removed. The usual greater resistance to extinction was obtained after partial reinforcement than after continuous reinforcement in the two noninformed groups, while immediate extinction of responding was obtained from the first extinction trial in the two informed groups. These results are consistent both with the discrimination hypothesis for the partial reinforcement extinction effect and with cognitive explanations of responding in extinction. Consequences for the behaviour therapies are discussed.

Descriptors: Expectancy, partial reinforcement, cognition, vasomotor conditioning, extinction, behaviour therapy.

Over the past decade there has been a renewal of interest in the old Tolman-Hull debate over the role of cognition in conditioning and extinction. It has been increasingly accepted that strict Hullian or similarly non-cognitive accounts of conditioning are unable to cope with the findings of a great many experiments involving expectancy manipulation through instruction, and as a result there has been a proliferation of 'two factor' and 'two process' theories, which argue for both Hullian 'conditioning' and cognitive processes in conditioning and extinction. There has also been a renewed interest in strictly cognitive accounts of conditioning processes (Bolles, 1972; Brewer 1974; Jennings, Crosland, Loveless, Murray & George, 1978), and indeed it would appear that the argument has shifted from the issue of whether it is necessary to invoke cognition in explaining behaviour, to one of whether it is necessary to invoke Hullian or similar 'conditioning' concepts.

The studies on which this controversy is based include a number designed to assess the effect of informing subjects of extinction contingencies before the first extinction trial. The onset of extinction in subjects aware of extinction contingencies provides a particularly clear test of cognitive, two factor, and 'conditioning' theories. According to strictly Hullian or similar conditioning accounts such information should have no effect on responding, while according to strictly cognitive accounts responding should be immediately abolished when subjects are aware that the unconditioned stimulus (UCS) will no longer be presented. Two factor theories predict reduction, but not abolition, of responding under these circumstances.

One particularly influential series of experiments was undertaken by Bridger and Mandel (1965; Mandel and Bridger 1967, 1973). These authors have consistently interpreted their results as showing clear evidence of residual GSR responding in subjects informed that UCS would no longer be presented and with shock electrodes removed. In addition, Mandel and Bridger compared the effect of this procedure on subjects whose reinforcement history differed in ISI (Mandel and Bridger,1967) and reinforcement schedule (Bridger and Mandel, 1965). These procedures allow for the testing of two critical hypotheses; first, whether any responding at all is present in subjects with no expectation of reinforcement, and second, whether this residual responding follows traditional behavioural laws as would be predicted by 'conditioning' theories and some two factor theories.

This second issue is as important as the first, from an applied as well as from a theoretical perspective. If there is residual responding contrary to expectancy it is this residue that forms the basis of many theoretical accounts of neurosis (e.g., Eysenck, 1976) and that is invoked in most behaviour therapy rationales. Many therapists adopt procedures from the general conditioning literature (Yates, 1975) and the yet unresolved issue is whether these procedures are appropriate to produce high resistance to extinction in subjects aware of contingencies and contingency changes. It cannot simply be assumed that any residual responding found will follow any particular set of traditional behavioural laws. For example, the two major competing accounts of the partial reinforcement extinction effect (PREE) suggest quite different things for the effect of reinforcement schedule on responding contrary to expectancy. The discrimination hypothesis (Mowrer & Jones, 1945) suggests that high resistance to extinction after partial reinforcement (PRF) is due to the greater difficulty for the subject in determining that UCS will no longer follow the conditioned stimulus (CS) in extinction after PRF than after CRF experience. According to this explanation, the PREE would be abolished if subjects had uniform zero expectation of UCS at the onset of extinction. On the other hand, conditioning accounts of the PREE (Hull, 1952) suggest that the superiority of PRF in leading to resistance to extinction is due to the acquisition of secondary reinforcing value by the unreinforced periods, which serves to maintain responding. This account leads to the prediction that subjects' expectancy of reinforcement is not involved in, and hence is irrelevant to, the PREE. The resolution of this theoretical conflict is therefore relevant not only to theorists, but also to those therapists who use PRF in programmes where resistance to extinction is required in patients who are aware that UCS will no longer follow CS after therapy.

Unfortunately, the results of the Bridger and Mandel (1965) study cannot be used to resolve this conflict. Subsequent research calls into question the conclusion reached by Mandel and Bridger that residual responding is obtained in subjects aware of contingencies at the onset of extinction. Wilson (1968), for example, obtained 'no-trial' extinction of a conditioned GSR in subjects instructed that shock, previously paired with CS+, would now follow CS-. Similarly, Jennings et al.(1978) found no-trial extinction of the pupillary response to shock in subjects informed that shock would no longer be presented at the onset of extinction. This conclusion was based on the fact that responding in a pseudoconditioning control group was as high as in the experimental group from the first extinction trial.

This debate over the issue of the existence and/or nature of residual counter expectancy responding is not easily resolved. Although the residual responding often found at the onset of extinction, even in subjects aware that UCS will no longer be presented, can be explained as being due to imperfect expectancy manipulation (Brewer, 1974), it can also be interpreted as evidence for two factor theories (Dawson & Furedy, 1976; Razran, 1971). Furthermore previous research on the question has suffered from a number of methodological problems that preclude unequivocal interpretation of results, and that must be overcome before the issues addressed by Bridger and Mandel (1965) can be satisfactorily resolved.

The first of these problems concerns the difficulty of manipulating expectancy in any study using shock as the UCS and any electrode pickup measure such as the galvanic skin response (GSR) as CR. Since GSR electrodes must remain on the subject during extinction in order to measure responding, there is always the possibility that subjects will expect shock presentation via GSR electrodes, despite experimenter's instruction that shock will not be presented, and despite the removal of shock electrodes. In fact, Mandel and Bridger had to reject a third of their subjects for admitting to such an expectation. This suspicion that UCS may be presented is, in the circumstances, entirely justified. After all, painful shocks <u>can</u> be administered through GSR electrodes, and deception is now so commonly employed in psychological research that it is not unreasonable that subjects should be suspicious of instructions given by experimenters.

Although subjects in the Mandel and Bridger studies who expressed any degree of disbelief in the instruction that UCS would no longer follow CS were eliminated from the sample, it is quite possible that a more sensitive measure of expectancy might reveal additional subjects who disbelieved the experimenter (Creelman, 1966). Further, subjects may choose, owing to situational demand, not to report any suspicions that they might have had about UCS presentation in extinction (Jennings et al., 1978). This problem of expectancy manipulation and measurement forces us to leave open the question of whether responding in extinction was due to maintained and unreported expectancy of the UCS, or, as is claimed by Mandel and Bridger, to a conditioned response exhibited contrary to the subject's expectancy. Further, since we cannot be certain that expectancy of UCS was zero at the onset of extinction, we cannot be certain that expectancy was equated across groups; and therefore, any group differences could be due either to cognitive or to 'conditioning' factors, invalidating their conclusions concerning the PREE.

To minimize the possibility of any such counter-instructional expectations it is necessary to make the apparatus for delivering the UCS as far as possible dissimilar to, and incompatible with, the apparatus for measuring the conditioned response (CR). The difficulties in quantifying such dissimilarity do nothing to reduce the urgency of the problem.

An additional but frequently related problem found with all unidirectional responses such as the GSR, is that of confounding of the CR with artifact such as the orienting response (OR), which can be distinguished from the CR only with the use of latency and topography criteria. Distinctions made on such bases are fraught with methodological difficulties (Gormezano, 1965), based on contentious theoretical issues (Stern & Walrath, 1977; Grings, 1965), and may result in the rejection of potentially important conditioned components from analysis (Furedy & Poulos, 1977).

Three techniques of experimental control have been commonly used to resolve such problems, but all have major flaws. The simplest is the attempt to habituate the OR through the use of CS adaptation trials. Habituation procedures were once considered to be important in conditioning experiments, due to the implicit expectation that ORs, once habituated, would not be reinstated. It is now accepted, however, that CS habituation before acquisition is ineffective, as the CS, when combined with the UCS, constitutes a novel stimulus which again elicits an OR (Stern & Walrath, 1977).

Differential conditioning procedures do not resolve the problem, for only the pairing of CS+ with non-reinforcement is novel in extinction, the CS- always having been associated with non-reinforcement. This procedure would therefore result in more orienting responses being emitted to CS+ than to CS- in extinction, and therefore lead to the possibility of finding a spurious effect. The third commonly employed control procedure, the pseudoconditioning control, is also in principle problematic. Since the control group cannot undergo acquisition procedures identical to those of the experimental groups, there is always the possibility that certain artifacts will be more or less present in the control than in the experimental groups. For example, at the onset of extinction the conditioning group has experienced only the CS-UCS complex, while the pseudoconditioning control has experienced only the CS alone, unpaired with the UCS. Accordingly, the CS alone is novel only in the conditioning group, and this group could therefore be expected to give orienting responses to the CS alone, leading to apparent, entirely spurious, 'conditioned responding', as in the differential conditioning procedure. Further, pseudoconditioning controls must have the UCS scheduled on either a truly random or explicitly unpaired schedule. In the former case, CS will on some trials be paired with UCS, transforming the pseudoconditioning control into a partial reinforcement conditioning group. In the latter, CS signals a safe period in which UCS will not be presented, which could be expected to lead to inhibition of the conditioned response (Prokasy, 1965; Rescorla, 1967). These problems render the pseudoconditioning control group inadequate as a means for correcting for artifact, especially during extinction.

The present study incorporates methodological and procedural innovations designed to overcome both the problem of inadequate manipulation of expectancy, and that of confounding of conditioned responding with generalised artifact such as the OR and pseudoconditioned responses to the CS. The second problem, which is methodologically the more fundamental of the two, is dealt with by the use of the bidirectional vasomotor response. The major advantage of bidirectional responses such as the vasomotor response in isolating conditioned responding from artifact was long ago recognised (e.g., Luria & Vinogradova, 1959), but they have not been frequently used. The one vasomotor study involving expectancy manipulation in extinction (Shean, 1968) conditioned constriction to shock, rather than dilation and constriction to thermal stimuli, and so failed to take advantage of its bidirectional nature.

The digital UCR to warm thermal stimuli is dilation, to cold constriction, and to novel, startling, or noxious stimuli constriction (Sokolov, 1963). The CR to thermal stimuli is in the same direction as the UCR (Bykov, 1959). As in other response systems, ORs may unavoidably be obtained on the first few presentations of the UCS. As has been pointed out, these ORs cannot be eliminated with habituation procedures which, accordingly, are not used in this study. By conditioning one half of each group to dilate to a warm stimulus paired with CS, and the other half to constrict to a cold stimulus paired with CS, a measure of conditioned responding may be obtained by taking the overall frequency of responses in the direction of the conditioned response for the group as a whole. This measure is automatically corrected for artifact. ORs will decrease the apparent frequency of conditioned responding in subjects conditioned to dilate, but increase it in subjects conditioned to constrict, thereby not affecting the group conditioning measure. Similarly, any pseudoconditioned or other generalised responses to the CS will be in the same direction for both warm and cold conditioned subjects, and will therefore not contribute to the overall measure of conditioned responding. It should be stressed that in this design, the warm and cold conditioned subgroups act as controls for one another. Accordingly, neither can be interpreted alone, but the two together provide a powerful means of eliminating generalised artifact from the conditioned response measure. This procedure thus does much to preclude the possibility noted in previous studies that maintained responding in extinction may be attributable to artifact.

In order to take advantage of this important feature of the vasomotor response it is first necessary to devise a scoring procedure equally sensitive to both dilations and constrictions that allows treatment in the same way of the records of subjects conditioned to dilate and those conditioned to constrict. This requirement of equal sensitivity to dilations and constrictions is an unusual one, and results from the need to base conditioned response measures on the difference between responding in subjects conditioned to dilate and those conditioned to constrict. Such a scoring procedure must be able to deal with several peculiarities of the vasomotor system. First, it cannot be assumed that latency and rise times of constrictions and dilations will be the same. Vasoconstriction is an active process, controlled by sympathetic vasoconstrictor fibres. Vasodilation, however, is due entirely to the release of vasoconstrictor tone (Lader, 1967). Accordingly, it is to be expected that latency and rise time will be slower for dilations than for constrictions. Analysis of pilot test data in the present study revealed that while for constrictions the median time for a deflection of .5mm or greater to take place in the appropriate direction was less than 5 seconds, for dilations the median was over 10 seconds, with both constrictions and dilations showing a wide range of latencies within and between subjects. Second, and for the same reason, the magnitude of constrictions is much greater than that of dilations. Analysis of pilot data revealed that this was so both within and between subjects. Even in subjects conditioned to dilate to a warm UCS, the magnitude of trials characterised by constriction (such as an OR) are considerably larger than those characterised by dilation. These considerations preclude the use of the commonly used digital pulse volume measure (Furedy, 1968), since the close time locking of responses required for this measure would not allow treatment of dilations and constrictions in the same way. The other commonly used alternative, maximum blood volume change, (e.g., Zimny & Miller, 1966), would produce meaningful results, but the wide latency criteria that would have to apply to include both dilations and constrictions would reduce this measure to one of maximum deflection within a given trial. As well as the usual problems of reliability associated with taking a single score to represent a group of scores, in this case taking maximum deflection as the score for each trial would result in a bias in favour of the relatively more labile constrictive component of the vasomotor response. For example, on trials with a brief constriction followed by a sustained but relatively small dilation, a measure of maximum change would classify the trial as constrictive even when the mean tendency is dilative. Accordingly, an area under the curve measure is most appropriate, as it takes account of all of the data within a given response period, but does not require close time locking. However, owing to the requirement for equal sensitivity for dilations and constrictions, and to the fact that trials characterised by constriction are larger than those characterised by dilation, the trial scores obtained must be transformed in such a way as to reduce the impact of the size of constrictions on the overall measure of responding. The only available means for doing this while conforming to the requirement that comparisons between warm and cold conditioned subgroups remain meaningful is to reduce the measure for each trial to an ordinal scale of dilation, no response, and constriction.

Expectancy manipulation problems can be minimized with the use of a compact, distinctive, and easily removed thermal stimulator. When this is removed at the onset of extinction, no comparable means for thermal stimulation are available. Although subjects may expect some other consequence of the CS in extinction, this expectation would result in orienting rather than conditioned responding, which would not contribute to overall group performance. Some previous studies such as that of Jennings et al.(1978) have also been able to remove all possibility of UCS presentation in extinction, and may therefore be equally powerful in abolishing expectancy of the unconditioned stimulus. However, none have been able to do this and at the same time eliminate possible artifacts resulting from the use of unidirectional sympathetic response measures which may produce responding due to the generalised expectancy that 'something' may follow CS in extinction.

The present study makes use of these methodological innovations, with respect to both expectancy manipulation and response measurement, to begin the task of addressing again the question of the role of expectancy in conditioning and extinction. Responding in extinction is assessed following two acquisition paradigms, continuous reinforcement (CRF) and partial reinforcement (PRF). The CRF paradigm is used because of its centrality in any accounts of learning. The PRF paradigm is used because of the jointly theoretical and practical importance of an explanation of the Partial Reinforcement Extinction Effect, as reviewed above. In both cases, it is hypothesized that in subjects given instructions and instrumentational procedures designed to abolish expectancy of reinforcement in extinction, responding will drop to zero (or chance level) from the first extinction trial. This hypothesis is thus compatible with the discrimination explanation of the PREE, as advanced both by Mowrer & Jones (1945) and Bridger and Mandel (1965).

METHOD

Subjects

51 undergraduate volunteer subjects were recruited in psychology laboratory classes. They were told before volunteering that the experiment involved conditioning, and that non-painful thermal stimuli would be used. 10 subjects were eliminated for failing to arrive at their first or second experimental session, and one subject was eliminated owing to equipment failure. The remaining 40 subjects were divided into 4 equal groups, and then each group was divided into two sub-groups, each containing two male and three female subjects. Assignment to groups was randomly determined by order of arrival for the first experimental session. All subjects were run in late summer and early autumn, when outside temperature varied approximately between 10^{o} and 25^{o} C.

Apparatus

Subjects sat semi-supine in a reclining armchair in an experimental 3m x 2m room maintained at 23^{o} C (+-1.5 C). Relative humidity was not controlled and varied between 50% and 70%. This room was connected via a plug-board to a similar room housing a Beckman 4 Channel Recorder model R511A. The thermal stimulator was a small copper box (10cm x 10xm) held to the subject's chest just below the sternum by a crepe rubber band, and fed by water from three thermostatically controlled water tanks outside the subject's room via solenoid switching valves and a 3/8" ID plastic pipe. A second pipe from the stimulator to a drain allowed a continuous flow of water through the stimulator. The temperature of the stimulator between UCS presentations was maintained at 29° C (+-2°) for all subjects. This temperature was within the range of temperatures judged subjectively neutral by each subject in pilot testing. The cold UCS was 8° (+-2°), and the warm UCS was 40° C (+-2°). These temperatures were determined by pilot testing as leading to maximal UCRs. UCS was presented by the switching of the appropriate solenoid valves of either the neutral, warm, or cold water tanks. All solenoid valves were audible to subjects at an amplitude of approximately 48 db. Water flow could be interrupted by the experimenter with a manual valve; this operation could be neither heard nor seen by subjects. The time delay between switching the solenoid and temperature change at the stimulator was maintained at 10 seconds and constituted the inter-stimulus interval (ISI). A 52 db tone of 4,500 Hz presented by means of a Sonalert and the concurrent switching of the solenoids constituted the CS. CS and UCS duration were both 30 seconds, and owing to the 10 second ISI there was a 20 second overlap.

Response measures were : Channel 1, Blood volume. A Beckman radial photocell transducer model 215660 was attached to the subject's right index finger. The signal was fed to the pen recorded through a bridge circuit and a general purpose coupler. The bridge circuit was used to correct the individual differences in tissue opacity by adjusting the photocell light source until the photocell resistance measured 150 ohms. For all subjects amplification was set at 5 mv/mm.

Channel 2, Pulse size was measured by amplifying the blood volume signal until the pulse waves were between 3 and 6 cm. A time constant was used to maintain the pen within the limits of its travel.

Channel 3, Respiration. A mercury strain gauge encircled the subject's chest just above the thermal stimulator. The signal was transduced via a Parks Electronics Laboratory plethysmograph model 270.

Channel 4, Surface temperature of the thermal stimulator. A thermal probe was attached with tape to the outside surface of the stimulator, and connected by fine wires to a Digitron digital thermometer.

Procedure

Subjects were assigned randomly to four groups; half of each group was conditioned to dilate to a tone followed by a warm UCS, and the other half was conditioned to constrict to a tone followed by a cold UCS. Experimenter and subject were of the same sex in all cases. Since it was found in pilot testing that subjects were unable to remain reasonably still for more than 50 - 60 minutes without either falling asleep or becoming restless, conditioning and extinction took place over two sessions in the case of the CRF groups and four sessions in the case of the PRF groups.

On arrival for their first session, subjects were informed that they would have to attend for either two or four sessions, and were told whether the stimulus would be warm or cold. The experimenter explained the purpose of transducers and the thermal stimulator while attaching them. Subjects were told that responses given were automatic and therefore that they were not required to do anything beyond relaxing, attending to the tone, and trying not to make any violent movements, coughs, or sneezes in periods when the tone was on. They were informed that there would be a delay of five minutes while they accommodated to room temperature and were told of the expected duration of the session. They were also told that they may find on some trials that the temperature would not follow the tone. During this five minute period neutral temperature water (29^{o} C) was circulated through the stimulator. At the end of the five minutes the first trial was presented by switching on the tone and water solenoid valve for the appropriate tank. Trials were presented at sixty second intervals.

but were withheld for up to a further 30 seconds if there was considerable movement in the blood volume record. This happened on 3.2% of trials in the PRF groups, and on 4% of trials in the CRF groups.

The rationale for informing subjects of the CS-UCS relationship was to retain comparability with the Mandel and Bridger (1967) study. It may be that informing subjects of contingencies will result in less orienting and more rapid acquisition.

Group 1. Acquisition: 25 trials CRF. Extinction: Stimulator on. Fifteen acquisition trials were presented in the first session. On arrival at the second session subjects were treated as before, except that instructions concerning the purpose of pickup transducers were not repeated. There were ten conditioning trials in the 2nd session, after which the experimenter went into the subject room, and informed subjects that there would be a break of 2 minutes before the next trial, and that if they wished they could move about for that time. This two minute break was included to ensure comparability of informed and noninformed groups, and might be expected to result in slightly lower resistance to extinction in the two noninformed groups than would otherwise have been the case. The manual water tap was turned off, preventing circulation of water through the system regardless of the operation of the solenoids. There were 20 presentations of the CS alone (tone plus solenoid) scheduled as before.

At the end of the twenty trials pickup transducers were removed from the subject and a structured post-experimental questionnaire was given to ascertain what the subjects expected would happen during the course of the experiment, particuparly at the onset of extinction.

Group 2. Acquisition : 25 trials CRF. Extinction : Stimulator off. At the onset of extinction the experimenter removed the thermal stimulator and told subjects that UCS would no longer follow CS, and that there would be a number of presentations of the tone alone for the remainder of the session. The experimenter then said that there would be a delay of 2 minutes before the next trial, and that the subjects could move about during that time if they wished. In all other respects group 2 was identical to group 1.

Group 3. Acquisition : 100 trials 25% PRF. Extinction : stimulator on. Subjects attended 4 sessions each of 30 trials, the last comprising 10 conditioning and 20 extinction trials. During conditioning, trials were scheduled on a 25% semi-random PRF schedule. The final conditioning trial before the onset of extinction was reinforced. On trials where UCS did not follow CS, water flow was prevented for the duration of the trial by turning off the manual water tap. In all other respects group 3 was identical to group 1.

Group 4. Acquisition : 100 trials 25% PRF. Extinction : stimulator off. At the onset of extinction group 4 subjects had the thermal stimulator removed and were told that UCS would no longer follow CS and that there would be a number of presentations of the tone alone for the remainder of the session. They were then told that there would be a delay of two minutes before the next trial, and that they could move about during that time if they wished. In all other respects group 4 was identical to group 3.

In summary, groups 1 and 2 had 25 continuously reinforced acquisition trials, while groups 3 and 4 had 100 acquisition trials of which 25 were reinforced. Groups 2 and 4 were given procedures designed to abolish their expectancy of reinforcement before the first extinction trial and groups 1 and 3 were not. In all groups in both acquisition and extinction, the solenoids were switched with the tone on all trials.

Scoring

The final ten conditioning trials and the 20 extinction trials were scored in the following way. A line was drawn horizontally along the blood volume record at the height of the small pulse wave immediately preceding CS onset for all trials. The 30 second CS duration (incorporating a 20 second interval in which UCS was presented on conditioning trials) was divided into six 5 second periods. For each five second period the average deviation of a line drawn through the peaks of the small pulse waves of the blood volume record from the horizontal line was scored to the nearest .5mm. These average deviations were summed across the six intervals for each trial to produce a mean change score. In order to allow for the differences in magnitude of constrictive responses as opposed to dilative responses, these mean change scores were transformed to +, -, or 0 scores. Trials with a positive mean score were assigned a +, those with a negative mean score were assigned a -, and trials with a mean score of 0 were assigned 0. Non parametric data have been used by Baer and Fuhrer (1970) to overcome similar distributional problems in blood volume data. Trials on which major respiratory changes or body movements coincided with changes in the blood volume record were not scored (Brown, 1967). This criterion resulted in the rejection of 3% of trials. On-target responses were defined as dilations in subjects conditioned with a warm UCS and constrictions in subjects conditioned with a cold UCS, and off-target responses were defined as constrictions in subjects conditioned with a warm UCS and dilations in subjects conditioned with a cold UCS. The proportion of on-target responses to the total of on- and off-target responses (excluding 0 responses) given by each subject for each block of five trials were determined. These proportions were then arcsin transformed as Winer (1971) recommends for proportional data, using the formula $X' = 2 \arcsin \sqrt{X}$.

RESULTS

The means for the four groups over each of the four blocks of conditioning trials, and for the final ten conditioning trials, are graphed in Figure 1, which also shows the proportion of on-target to on- and off-target responses for each group on the first extinction trial.

Conditioning

To assess the possibility that systematic differences in subjects' responding between groups may have led to any differences between groups in extinction, an analysis of variance was performed on the four groups for responding over the final ten conditioning trials. No significant differences were found between groups, $\underline{F}$ (3,32) = .27, n.s. Evidence that conditioning has taken place is drawn from the significant responding in extinction found in the two groups given traditional (noninformed) extinction procedures over the first five extinction trials, $\underline{t}$ (19) = 2.6, p (one tailed) < .01. Significantly above chance on-target responding during acquisition was shown in both the CRF warm UCS subgroup, $\underline{t}$ (9) = 2.44, p (one tailed) < .025, and the CRF cold UCS subgroup, $\underline{t}$ (9) = 3.56, p (one tailed) < .005. There was also significantly above chance on-target responding on the 25 reinforced trials in the PRF warm UCS subgroup $\underline{t}$ (9) = 2.67, p (one tailed) < .025, and the PRF cold UCS subgroup, $\underline{t}$ (9) = 22.8, p (one tailed) < .0005. Although there was significantly more on-target responding to the cold UCS than to the warm UCS during acquisition in the PRF group, $\underline{F}$ (1, 72) = 26.65, p < .001, and a marginally non-significant trend in the same direction in the CRF group, $\underline{F}$ (1, 72) = 4.185, p = .0557, this cannot be interpreted as showing greater conditionability of constriction than dilation owing to the intentional confounding of artifact with responding within each subgroup. That is, artifact adds to measured responding in the cold UCS subgroup and subtracts from it in the warm UCS subgroup.

Extinction

Differences between groups were tested by analysis of variance. In addition to the experimental factors of interest, an additional factor of warm and cold UCS was added to the analysis to avoid including variance attributable to artifact (which adds to measured responding in cold UCS subjects and subtracts from it in warm UCS subjects), which would have spuriously inflated the variance. Several 3 way analyses were performed in preference to a single 4 way analysis for two reasons. First, separate three way analyses would have been required in addition to the 4 way analysis in order to demonstrate the effects of interest, rendering all but the interaction of expectancy manipulation and conditioning procedure redundant in the 4 way analysis. Second, examination of means shows that such an interaction would be meaningless, and could seem to support the incorrect conclusion that expectancy had a differential effect on responding between the two conditioning procedures. In fact, expectancy manipulation led to the abolition of responding in both groups, the apparent interaction being due to the significantly higher rate of responding in the PRF noninformed than in the CRF noninformed groups, $\underline{F}\ (1,48) = 5.02$, $p < .05$. Although there was significantly more on-target responding in the cold UCS than the warm UCS subgroups, $\underline{F}\ (1, 48) = 5.31$, $p < .05$, the warm UCS subgroups also showed significantly above chance responding over the first five extinction trials $t\ (9) = 1.87$, p (one tailed) $< .05$. This shows that the responding in the noninformed groups is not due to artifact.

Both the PRF and CRF noninformed groups showed significantly more responding than their informed counterparts; respectively, $\underline{F}\ (1, 48) = 11.11$, $p < .005$, and $\underline{F}\ (1, 48) = 6.37$, $p < .025$. However, the two informed groups did not differ from one another, $\underline{F}\ (1, 48) = .01$, n.s. None of the fluctuations above or below the chance level in these two groups approach significance, nor do they differ from one another on any trial block. There was proportionately more on-target responding in the cold UCS subgroups than the warm UCS subgroups in these two groups, $\underline{F}$ (1, 48) = 6.9, $p < .025$. This is due to artifact such as ORs rather than maintained responding in the cold UCS subgroup, as both warm and cold UCS subgroups show a comparable proportion of constrictions, reflected in the overall below chance responding in these groups in extinction. Rates of responding for the warm and cold subgroups of all four groups averaged over the first ten and the second ten extinction trials are shown in Table 1.

Orthogonal trend analyses performed on each of the four groups revealed only one significant effect, a linear trials effect for the CRF noninformed group, $\underline{F}$ (1, 24) = 5.67, $p < .05$. That is, only the CRF noninformed group shows extinction; neither the PRF noninformed nor the two informed groups show a reduction in responding over trials. In the case of the informed groups, this is because neither shows responding at above chance level, both groups performing at or below chance level from the first extinction trial. In the case of the PRF noninformed group, the lack of a significant trials effect is due to maintained responding over all four blocks of extinction trials.

Questionnaire Data

Analysis of questionnaire data revealed that PRF noninformed subjects were more likely to report expecting UCS throughout the extinction trials than were CRF noninformed subjects, $\chi^2 = 6.36$, $p < .05$. None of the informed subjects reported expecting a thermal UCS in extinction. Only two subjects in the noninformed groups reported zero expectancy of UCS at the onset of extinction, and both performed at a level above the mean for their respective groups. There were insufficient data for this effect to be tested or interpreted.

DISCUSSION

Those groups given traditional extinction procedures showed the expected maintained responding in extinction, with longer extinction after PRF conditioning than after CRF. However, both PRF and CRF conditioned groups with the thermal stimulator removed, and therefore with no maintained expectancy of UCS, showed no residual responding in extinction. This finding clearly supports a cognitive rather than two factor account of extinction, as it shows that awareness of extinction contingencies is a sufficient condition for the abolition of conditioned responding, contrary to all two factor theories. Attempts to account for this 'no-trial' extinction on the basis of a lack of generalisation of the conditioned response to the novel situation in which the thermal stimulator was removed (and therefore in which the conditioned response, although present, was simply not evoked by the novel stimulus complex) can be discounted unless the novelty is couched in cognitive terms. That is to say, it is not the difference between stimuli present during the conditioning and extinction phases as such that led to extinction; it is the meaning to the subject of this stimulus change. This conclusion is based on the interesting study by Jennings et al. (1978) mentioned previously. Although, as was argued earlier, pseudoconditioning control procedures as used in this study cannot be used to justify the conclusion that there was no residual responding in subjects informed that UCS will no longer follow CS, intergroup comparisons on the effect on extinction of various changes in the stimulus array are meaningful. In the Jennings et al. study, these stimulus changes varied from the relatively major intervention of the removal of an arm band used for UCS presentation to the more minor change to the stimulus array involved in the cutting of a wire that fed power to the band. All of these procedures were equally effective in reducing responding, while a meaningless but equally major stimulus change (adjustment to the arm band) had no effect on responding.

The finding of 'no-trial' extinction, while at variance with traditional conceptions of conditioning and the conclusions drawn from many previous experiments, is quite consistent with Brewer's (1974) suggestions that residual responding found in earlier experiments is due to imperfect expectancy manipulation, and that better experimental designs will lead to a demonstration that there is no counter-expectancy residual responding. In this regard it is interesting to note that Bridger and Mandel's (1965) study does completely not support those authors' interpretation that there is maintained responding contrary to cognitive expectancy. Examination of the extinction data for those subjects aware that UCS would no longer be presented reveals that responding to CS+ drops on the first extinction trial to a low level that is maintained throughout the 10 extinction trials. The appearance of maintained responding that extinguishes over trials is due to the fact that responding to CS-, initially lower than to CS+, increases to the same level as CS+ over the second five trials. This increase cannot be due to pseudoconditioning or sensitisation as is argued by Bridger and Mandel, for UCS was not presented in extinction and therefore the greatest responding due to either artifact would be expected on the first extinction trial. It is extremely difficult to account for this phenomenon in terms of any conditioning effect.

Some theorists (e.g., Mandel & Bridger, 1967) have asserted that responding contrary to expectancy may be obtained only with emotionally meaningful stimuli such as electric shock. This assertion will remain untested until procedures for the use of such stimuli are devised that avoid the possible confounding of artifacts with conditioned responses, and that overcome the problems of expectancy manipulation connected with the use of such stimuli. There remains, nevertheless, the possibility that under certain conditions conditioned responding contrary to expectancy may be demonstrable. It has been shown, for example, that the use of a very traumatic UCS (respiratory paralysis) leads to CRs very different from those produced with a milder UCS (Campbell, Sanderson & Laverty, 1964). In this last cited study however, electric shock was classified, along with loud noise, as a mild UCS. It is clear only that the differential effect on response strength of intense, traumatic or emotionally charged UCSs remains a problem for investigation. Existing data and theory are insufficient to warrant any assertions.

The finding that partial reinforcement conditioning procedures are not in themselves sufficient to produce responding resistant to extinction is of considerable practical importance. Many behaviour therapy programmes employ partial reinforcement on the assumption that behaviour change will be maintained longer after this form of conditioning than after continuous reinforcement. It appears, as was suggested by Bridger and Mandel (1965) that long extinction following partial reinforcement may be attributed to the greater difficulty in discriminating between conditioning and extinction contingencies, and therefore in determining that UCS will no longer be presented, rather than to a more resistant conditioned response as such. Accordingly, there is no reason to believe that the use of PRF is appropriate in therapy programmes where long extinction is required at the end of therapy, when subjects are aware that UCS will no longer be presented.

Indeed, the finding of 'no-trial' extinction when subjects are aware that UCS will no longer be presented calls into question the use of classical conditioning procedures in adult human behaviour therapy. It can no longer be assumed that a response classically conditioned to a stimulus will be evoked by that stimulus when subjects are aware that the CS - UCS contingency no longer applies. Since a great many behaviour therapy programmes are based on that assumption, current research on the role of expectancy in the extinction of classically conditioned responses should have far reaching consequences.

			1st 10 TRIALS	2nd 10 TRIALS
CRF	NONINFORMED	WARM	.919	.635
		COLD	.970	.934
	INFORMED	WARM	.692	.568
		COLD	.781	.979
PRF	NONINFORMED	WARM	.919	1.014
		COLD	1.220	1.113
	INFORMED	WARM	.753	.665
		COLD	.785	.793

TABLE 1. Mean proportion of on-target/on- plus off-target responding (arcsin transformed) in the warm and cold subgroups of the 4 experimental groups averaged over the first and second blocks of 10 extinction trials.

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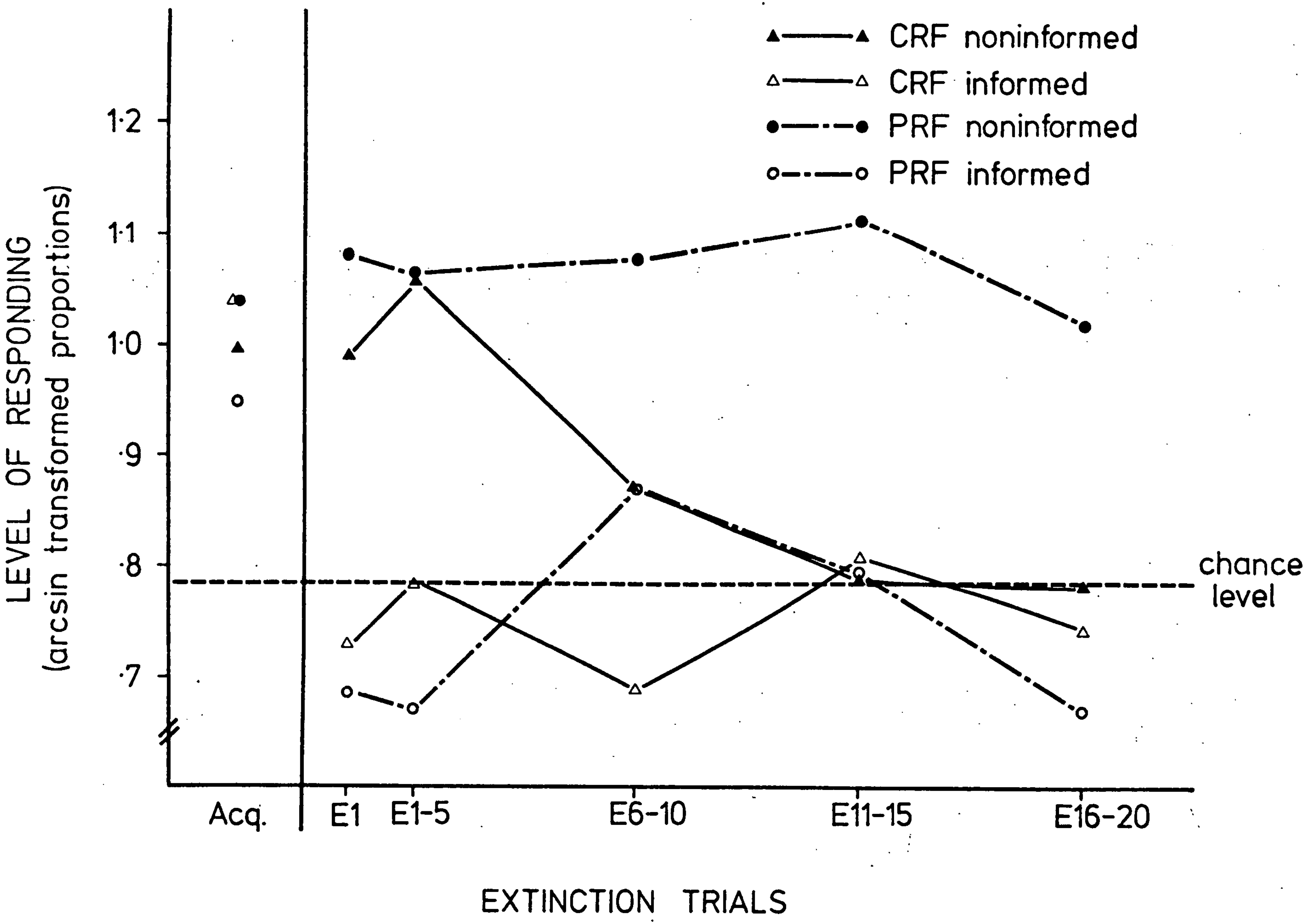
FIGURE 1

Level of responding at the end of acquisition and throughout extinction trials. (Level of responding is measured as the proportion of on-target responses to on- and off-target responses, arcsin transformed. Extinction trials are graphed in blocks of 5. Acquisition level is the mean of the last two blocks of 5 trials. The chance responding line is at the level of the arcsin transformation of .5).



CRF noninformed
CRF informed
PRF noninformed
PRF informed
LEVEL OF RESPONDING
(arcsin transformed proportions)
1·2
1·1
1·0
·9
·8
·7
chance level
Acq.
E1
E1-5
E6-10
E11-15
E16-20
EXTINCTION TRIALS

OVERLEARNING AND INSTRUCTIONAL CONTROL

OF EXTINCTION OF VASOMOTOR RESPONDING.

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ABSTRACT

In a previous study by the authors, immediate extinction of conditioned vasomotor responding was obtained, under conditions of both continuous and partial reinforcement, when the UCS delivery apparatus was removed and subjects were informed that there would be no further UCS presentations. The present study varied the number of continuous reinforcement trials using the same conditioning procedure. 40 human subjects were randomly divided into two groups, given thermal vasomotor conditioning procedures on either 25 or 100 continuous reinforcement trials. At the onset of extinction half of each group was given traditional noninformed extinction procedures, while the other (informed) half had the thermal stimulator removed. Immediate extinction was obtained in informed subjects given 25 conditioning trials. However, there was no significant reduction of responding in informed subjects given 100 conditioning trials. Consequences for behaviour theories and therapies are discussed.

The growing debate over the role of cognition in the conditioning and extinction of autonomic responses should be of great interest to behavior therapists. It has suggested (Bolles, 1972, Brewer, 1974) that the period of maintained responding normally found in extinction may be due to the difficulty for the subject in discriminating the onset of extinction. This suggestion is based on the finding that subjects who are informed of the termination of the CS-UCS contingency at the onset of extinction show a very great (sometimes complete) reduction in responding on the first extinction trial (Brewer, 1974). These findings have direct relevance to therapeutic situations. Many programmes of behavior modification require, for their success, that clients continue to produce the therapeutically conditioned response <u>after</u> treatment has terminated and (at least for a short time) <u>before</u> reinforcement is provided in the natural environment. Such responses by the client thus constitute, in effect, extinction trials. Furthermore, it may often be obvious to clients that the reinforcement contingencies which applied during treatment are no longer in effect once they step into the real world. The gloomy conclusion is that there may be no experimentally based reason to expect therapeutic change, due to conditioning, to be maintained after treatment. Nor is such a conclusion necessarily at odds with clinical experience. In view of the growing evidence that expectancy and demand, both transient effects, may account for much of the treatment efficacy of the behavior therapies (Russel, 1974), the suggestion that current behavioral research does not allow the prediction of treatment success for many behavior therapies should be of great concern.

To a great extent, however, the research which shows complete or nearly complete abolition of responding through instruction appears to be based on the assumption that all conditioning procedure are about equally appropriate for testing the clinically vital issue of whether residual responding remains. Although this assumption would appear to be reasonable according to traditional Hullian conceptions of conditioning, it is becoming increasingly clear that Hullian theory cannot cope with the results of studies involving cognitive manipulation (Brewer, 1974), and may be singularly inappropriate as a theoretical base for such research. A most interesting hypothesis drawn from other conceptions of conditioning and relevant to this debate is that different conditioning procedures may lead to qualitative differences in performance. Although there has been little direct interest in the possibility, a number of theorists have argued since nearly a century ago that cognitive processes come to have less and less influence over the performance of an act with repetition, the response becoming less and less susceptible to cognitive control and more and more automatic after a great many repetitions (James, 1890; Kimble & Perlmuter, 1970; Bindra, 1969; Shiffrin & Schneider, 1977). Bolles (1972) singles out much practiced responding as a possible exception to his expectancy based theory of learning, suggesting that "... perhaps sheer repetition of a response as a consequence of the law of performance suffices to connect it with prevailing stimuli. Certainly there is little *a priori* reason to expect such behavior to be governed by the same laws or to depend on the same neural mechanisms as those involved in the laws of learning, performance, and motivation that have just been proposed". However, research supporting such a change in learning processes over extended conditioning trials is not extensive.

A number of studies have called for introspective reporting of cognitive activity in paired associate learning and motor skill learning tasks; their results suggest that mediational activity is at its greatest in early stages of learning, with reported mediation decreasing over trials (O'Brien, 1921; Barnes & Underwood, 1959, Dean & Martin, 1966). These studies are consistent with the hypothesis that there may be qualitative differences between recently learned and much practiced responding. However, such studies do not provide direct support for the suggestion that the latter is more resistant to informational or instructional control than the former. Two studies have examined this issue directly.

Grings and Lockhard (1963) found no increase in resistance to extinction after instructions that UCS would no longer be presented, in subjects given 36 GSR conditioning trials compared with those given only 9. However, this study may have used too few conditioning trials to demonstrate effects present only in highly practiced responding. The same can be said for the majority of other 'informed unpairing' experiments (ie, ones in which subjects are informed of the onset of extinction trials) which have used between 10 and 20 reinforced trials. The notable exception is a study of eyeblink conditioning to an airpuff UCS by Hartmann and Grant (1962), who used 60 reinforced trials in their CRF conditioned group. This group showed no reduction in responding after unpairing instructions, contrary to the effect found in other groups and in other experiments. This group's performance is thus consistent with the hypothesis that after much practice, responding may not be subject to instructional control.

Nevertheless, Hartmann and Grant's study does not provide strong support for the hypothesis. The reason is that their study had two weaknesses that are shared by many experiments on the role of expectancy in conditioning and extinction: uncertain expectancy manipulation and susceptibility to artifact. Hartmann and Grant did not assess subjects' expectancies of UCS presentation during extinction. It is very possible, however, that some subjects disbelieved the experimenter's instructions that there would be no further air puffs, especially since the UCS delivery apparatus remained intact throughout extinction. Other studies that have assessed subject expectancies in similar circumstances have found that subjects often disbelieve such unpairing instructions (Creelman, 1966; Mandel & Bridger, 1973). Furthermore, such assessments are probably conservative. The demand characteristics of the experimental environment are more likely to induce subjects to understate their disbelief than to exaggerate it (Jennings, Crosland, Loveless & George, 1978). The problem of generating appropriate subject expectancies can be minimized by removing the UCS delivery apparatus or rendering it clearly inoperative. Even this procedure is ineffective, however, in a widely used experimental preparation, that of conditioning GSR to shock. Mandel and Bridger (1973) found that many subjects admitted to a continued expectancy of shock through the GSR electrodes. Since the shock and the recording electrodes are somewhat similar, and painful shocks can be delivered through GSR electrodes (although usually by accident), the expectancy is hardly unreasonable. Susceptibility to artifact, such as reinstatement of the orienting response during extinction (when the CS without a subsequent UCS constitutes a novel stimulus), is a problem for any conditioning procedure that makes use of unidirectional responses, such as GSR or pupillary contraction. Distinguishing such artifacts from genuine conditioned responses is difficult and sometimes unreliable (for details see Eaglen & Mackenzie, in press).

Eaglen and Mackenzie (in press) tested the effect of unpairing instructions on responding in extinction, in an experimental preparation designed to overcome these difficulties. Artifacts such as orienting responses and reflex responses to the CS were corrected for by use of the bidirectional vasomotor response; such artifacts increase the apparent strength of constriction and decrease the apparent strength of dilation, leaving no net effect. Subject expectancies of no further UCS were maximized by removing the thermal stimulator prior to extinction, as well as instructing subjects appropriately. Under these conditions they found abrupt abolition of conditioned responding from the first extinction trial, in subjects given the unpairing instructions. The effect was as noticeable in subjects given partial reinforcement (PRF) acquisition trials as in those given continuous reinforcement (CRF) trials. Those not given unpairing instructions showed the usual extinction curve (following CRF) and resistance to extinction (following PRF). Thus, the Eaglen and Mackenzie study supported the hypothesis that responding during extinction is under the control of cognitive (expectancy) variables.

Eaglen and Mackenzie did not assess the effect on responding in extinction of varying the number of acquisition trials. Since their study showed a strong and clear effect of unpairing instructions, however, it provides the basis for a strong test of the effect of number of acquisition trials. The present study makes use of the same experimental preparation, varying the number of acquisition trials to test the hypothesis that, under conditions of overlearned practice, responding in extinction is relatively independent of cognitive control.

METHOD

Subjects

42 undergraduate volunteer subjects were recruited in Psychology practical classes. They were told before volunteering that the experiment involved conditioning, and that non painful thermal stimuli would be used. 2 subjects were eliminated for failing to arrive at their first or second experimental session. The remaining 40 subjects were divided into 4 equal groups, and then each group was divided into two subgroups, each containing 2 male and 3 female subjects. Assignment to groups was randomly determined by order of arrival for the first experimental session. Subjects in all groups were run in late summer and early autumn, when outside temperature varied approximately between 10° and 25°C.

Apparatus

Conditioning and extinction took place in an experimental 3m x 2m room maintained at 23°C (+-1.5°C). The thermal UCS was administered by running warm (40°C) or cold (8°C) water through a small thermal stimulator attached to the subject's chest immediately below the sternum. Between presentations of warm or cold temperatures, the stimulator was flushed with neutral temperature water (29°C). A 52db tone of 4,500 Hz and concurrent audible switching of solenoid water valves constituted the CS. CS and UCS duration were both

30 seconds; there was a 10 second ISI (CS onset - UCS onset) and thus a 20 second overlap between CS and UCS. The conditioned response, blood volume, was measured on a Beckman 4 channel recorder in an adjoining room. In addition, pulse size (also taken from the above transducer), respiration (via a chest strain gauge) and surface temperature of the thermal stimulator (via a thermal probe) were recorded. This apparatus is described in detail by Eaglen and Mackenzie (in press).

Procedure

Subjects were assigned randomly to four groups; half of each group was conditioned to dilate to a tone followed by a warm UCS, and the other half was conditioned to constrict to a tone followed by a cold UCS. Experimenter and subject were of the same sex in all cases. Since it was found in pilot testing that subjects were unable to remain reasonably still for more than 50 - 60 minutes without either falling asleep or becoming restless, conditioning and extinction took place over two sessions in the case of the CRF 25 groups and four sessions in the case of the CRF 100 groups.

On arrival for their first session, subjects were informed whether they were required to attend two sessions or four, and were told whether the stimulus would be warm or cold. The experimenter explained the purpose of transducers and the thermal stimulator while attaching them. Subjects were told that responses given were automatic and therefore that they were not required to do anything beyond relaxing, attending to the tone, and trying not to make any violent movements, coughs, or sneezes in periods when the tone was on. They were informed that there would be a delay of five minutes while they accommodated to room temperature and were told of the expected duration of the session. They were also told (to ensure comparability to a previous study) that they might find on some trials that the temperature would not follow the tone. During this five minute period neutral temperature water (29°C) was circulated through the stimulator. At the end of the five minutes the first trial was presented by switching on the tone and water solenoid valve for the appropriate tank. Trials were presented at sixty second intervals, but were withheld for up to a further 30 seconds if there was considerable movement in the blood volume record. This happened on 5.1% of trials in the CRF 100 groups, and on 4% of trials in the CRF 25 groups.

Group 1. Acquisition: 25 trials CRF. Extinction: Stimulator on. Fifteen acquisition trials were presented in the first session. On arrival at the second session subjects were treated as before, except that instructions concerning the purpose of pickup transducers were not repeated. There were ten conditioning trials in the 2nd session, after which the experimenter went into the subject room, and informed subjects that there would be a break of 2 minutes before the next trial, and that if they wished they could move about for that time. This two minute break was included to ensure comparability of informed and noninformed groups, and might be expected to result in slightly lower resistance to extinction in the two noninformed groups than would otherwise have been the case. The manual water tap (not visible to the subjects) was turned off, preventing circulation of water through the system regardless of the operation of the solenoids. There were 20 presentations of the CS alone (tone plus solenoid) scheduled as before.

At the end of the twenty trials pickup transducers were removed from the subject and a structured post experimental questionnaire was given to ascertain what the subjects expected would happen during the course of the experiment, particularly at the onset of extinction.

Group 2. Acquisition: 25 trials CRF. Extinction: Stimulator off. At the onset of extinction the experimenter removed the thermal stimulator and told subjects that UCS would no longer follow CS, and that there would be a number of presentations of the tone alone for the remainder of the session. The experimenter then said that there would be a delay of 2 minutes before the next trial, and that the subjects could move about during that time if they wished. In all other respects group 2 was identical to group 1.

Group 3. Acquisition: 100 trials CRF. Extinction: Stimulator on. Subjects attended 4 sessions each of 30 trials, the last comprising 10 conditioning and 20 extinction trials. In all other respects group 3 was identical to group 1.

Group 4. Acquisition: 100 trials CRF. Extinction: stimulator off. At the onset of extinction the experimenter removed the thermal stimulator and told subjects that UCS would no longer follow CS, and that there would be a number of presentations of the tone alone for the remainder of the session. The experimenter then said that there would be a delay of 2 minutes before the next rial, and that the subjects could move about during that time if they wished. In all other respects group 4 was identical to group 3.

In summary, groups 1 and 2 had 25 acquisition trials, while groups 3 and 4 had 100 acquisition trials. Groups 2 and 4 were given procedures designed to abolish their expectancy of reinforcement before the first extinction trial and groups 1 and 3 were not. In all groups, in both acquisition and extinction, the solenoids and the tone were turned on together to constitute the CS.

Scoring

The final 10 conditioning trials, and the 20 extinction trials, were scored as dilations, constrictions, and 0 responses on the basis of the mean direction of change in the blood volume record over the 30 seconds following CS onset. This scoring procedure was designed to overcome difficulties associated with different magnitude and rise times of dilations and constrictions, and the need to obtain comparable sensitivity to both, as discussed by Eaglen and Mackenzie (in press). On-target responses were defined as dilations in subjects conditioned with a warm UCS, and constrictions in subjects conditioned with a cold UCS; off-target responses were defined as constrictions in subjects conditioned with a warm UCS, and dilations in subjects conditioned with a cold UCS. The proportion of on-target responses to the toal of on- and off-target responses (excluding 0 responses) given by each subject for each block of five trials was determined. These proportions were then arcsin transformed as Winer (1971) recommends for proportional data, using the formula $X' = 2 \arcsin\sqrt{X}$.

RESULTS

The means for the four groups over each of the four blocks of extinction trials, and for the final ten conditioning trials, are graphed in Figure 1.

Conditioning

To assess the possibility that differences between groups in responding during acquisition may have led to any differences between groups in responding during extinction, an analysis of variance was performed on the four groups for responding over the final ten conditioning trials. No significant differences were found between groups, F (3,32) = .07, n.s. The absence of significant differences between groups, and the close similarity in means for responding in acquisition for CRF 25 and CRF 100 groups (illustrated in Figure 1), show that the additional conditioning trials in CRF 100 groups did not lead to a higher rate of conditioned responding; they are evidence, therefore, that these additional trials were overlearning trials. Evidence that conditioning has taken place is drawn from the significant responding in extinction found in the two groups given traditional (noninformed) extinction procedures over the first five extinction trials, t (19) = 5.31, p (one tailed) < .001. Significantly above chance on-target responding during acquisition was shown by all subgroups (CRF 25 warm UCS subgroup, _t_ (9) = 2.44, p (one tailed) < .025; CRF 25 cold UCS subgroup, _t_ (9) = 3.56, p (one tailed) < .005; CRF 100 warm UCS subgroup, _t_ (9) = 2.19 p (one tailed) < .05; and CRF 100 cold UCS subgroup, _t_ (9) = 6.78, p (one tailed) < .001).

Extinction

Differences between groups were tested by analysis of variance. In addition to the experimental factors of interest, an additional factor of warm and cold UCS was added to the analysis to avoid including variance attributable to artifact (which adds to measured responding in cold UCS subjects and subtracts from it in warm UCS subjects), which would have spuriously inflated the variance.

The CRF 25 noninformed group showed significantly more responding than its informed counterpart, _F_ (1,48) = 6.37, p<.025. However, the two CRF 100 groups did not differ from one another,

$\underline{F}$ (1,48) = .321, n.s. While there was no significant difference between CRF 25 and CRF 100 noninformed groups, $\underline{F}$ (1,48) = 1.77, n.s., there was significantly more responding in extinction in the CRF 100 informed group than in the CRF 25 informed group, $\underline{F}$ (1,48) = 9.61, $p<.01$. Rates of responding for the warm and cold subgroups of all four groups averaged over the first ten and second ten extinction trials are shown in Table 1.

Orthogonal trend analyses performed on each of the four groups revealed only one significant effect, a linear trials effect for the CRF 25 noninformed group, $\underline{F}$ (1,24) = 5.67, $p<.05$. That is, only the CRF 25 noninformed group shows extinction; neither the CRF 25 informed nor the two CRF 100 groups show a reduction in responding over trials. In the case of the CRF 25 informed group, this is because it never shows responding at above chance level; responding is at or below chance level from the first extinction trial. In the case of the CRF 100 groups, the lack of a significant trials effect is due to maintained responding over all four blocks of extinction trials.

Overall, there was significantly more on-target responding in the cold UCS subgroups than in the warm UCS subgroups in extinction $\underline{F}$ (1,96) = 9.44, $p<.005$. However, in the three groups that (as predicted) showed maintained on-target responding over the first five extinction trials, the response levels were significantly above chance for both the warm UCS subgroups (t (14) = 2.206, p (one tailed) $<.02$) and the cold UCS subgroups (t (14) = 5.957, p (one tailed) $<.001$).

<u>Questionnaire Data</u>

Number of acquisition trials had no effect on reported expectancy of UCS during extinction, either in informed subjects (none of whom reported any level of UCS expectancy in extinction), or in noninformed subjects (X^2 = 1.0, n.s.). Ninety percent of noninformed subjects, as against zero informed subjects, reported expecting UCS during extinction. The difference is significant ($X^2 = 32.72$, $p<.001$).

DISCUSSION

In the groups with the thermal stimulator attached in extinction the usual longer extinction following 100 than 25 conditioning trials was obtained. The expected reduction in responding consequent on abolishing subject's expectancy of reinforcement (in this case by removal of the thermal stimulator), is found only in subjects conditioned with 25 trials. In this case responding was abolished on the first extinction trial. Although some previous studies report a low level of residual responding in similar circumstances, it can be argued that this is due to inadequate expectancy manipulation and to confounding of the conditioned response with artifact (Brewer, 1974; Eaglen and Mackenzie, 1980). The group that had 100 reinforced trials (of which 75 were overlearning trials) did not, however, show a reduction in resistance to extinction with abolition of expectation of UCS. Neither the initial decline in that group's responding, nor the subsequent rise, are significant. That is, it would appear that non-overlearned-responding can be abolished by expectancy manipulation, a finding in accord with a strictly cognitive explanation of conditioning; overlearned responding by contrast, appears to be entirely unaffected by expectancy manipulation, a finding more consistent with a traditional Hullian view.

This radical difference between the effect of expectancy manipulation on overlearned and non-overlearned responding is consistent with the view that a response becomes less accessible to cognitive control with repetition. It would appear that cognitive expectation of

UCS is not required for the production of a conditioned response after sufficient conditioning trials have elapsed, the process becoming automatic. The results from this experiment cannot be accounted for by strictly cognitive theories (which would argue against the possibility of a conditioned response contrary to subjects' expectancy) or by strictly "conditioning" accounts (which cannot account for the abolition of responding in the CRF 25 group with the stimulator removed). They are also inconsistent with the popular two factor and two process theories which argue either that both cognitive and 'conditioning' factors contribute to responding at all times (Mowrer, 1960) or that one learning process is used in preference to the other except when for some reason it is unavailable (Razran, 1955). Instead, it would appear from these results that conditioning processes supplant cognitive processes given sufficient repetition of the CS-UCS pairing. This seems more consistent with James' (1890) notion of "habit, the great flywheel" maintaining behavioral patters that initially were established with the aid of cognition and subsequently, after sufficient repetition, became independent.

This conclusion is of great importance to our standing of the learning principles that may underlie the behavior therapies. Since few therapeutic programmes involve overlearning, the possibility exists that the learning processes involved in most behavior therapies have more to do with cognitive principles than with traditional classical conditioning principles. This suggestion is consistent with Russel's (1974) assertion that treatment efficacy in the majority of the behavior therapies may be accounted for by expectancy and demand characteristics. At the same time, however, the results of this paper should not be seen as providing support for the view that behavior therapy in principle cannot or should not be derived from the great resource of behavior theory and evidence. It has already been argued that it is vital for the behavior therapies to retain a close link with behavior theory (Eaglen, 1978), and while the result from this study further reinforce the argument that general vague references to behavior theory are inadequate, they also show how closer analysis of existing evidence and appropriate further research may lead to the possibility of maximising the power of treatment programmes. It seems clear that clinical trials of the effect of overlearning on remission rates would be worthwhile, and it is argued that overlearning procedures may turn out to be of value despite their increased cost. It should be noted that partial reinforcement conditioning procedures do not lead to more resistant conditioned responding in informed extinction; subjects conditioned with 100 trials of 25% PRF showed the same immediate extinction of responding after unpairing instructions as did subjects conditioned with 25 trials of CRF (Eaglen & Mackenzie, in press). Accordingly, clinical use of PRF conditioning procedures may serve only to prevent the resistance to extinction that might otherwise have been obtained with the same total number of trials.

The present use of PRF and relatively brief CRF acquisition procedures, in the many therapeutic programmes in which maintained responding is required in subjects aware that UCS will no longer be presented after treatment, allows for the possibility that any treatment success obtained is due more to factors such as expectancy than to conditioning. Clinical investigation of the effectiveness of overlearning procedures on remission rates would therefore seem to be indicated.

			1st 10 TRIALS	2nd 10 TRIALS
CRF 25	NONINFORMED	WARM	.919	.635
		COLD	.970	.934
	INFORMED	WARM	.692	.568
		COLD	.781	.979
CRF 100	NONINFORMED	WARM	1.00	.789
		COLD	1.083	1.021
	INFORMED	WARM	.925	.763
		COLD	.970	.856

TABLE 1. Mean proportion of on-target/on- plus off-target responding (arcsin transformed) in the warm and cold subgroups of the 4 experimental groups averaged over the first and second blocks of 10 extinction trials.

Note: Data were averaged over ten trials rather than five as in the thesis.

FIGURE 1

Level of responding at the end of acquisition and throughout extinction trials. (Level of responding is measured as the proportion of on-target responses to on- and off-target responses, arcsin transformed. Extinction trials are graphed in blocks of 5. Acquisition level is the mean of the last two blocks of 5 trials. The chance responding line is at the level of the arcsin transformation of .5.)

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