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VARIETIES OF CONTRAST: A REVIEW OF INCENTIVE RELATIVITY *BY CHARLES F. FLAHERTY*

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The phenomenon of contrast has been studied from two quite separate perspectives, one derived from the classic studies of incentive contrast such as Crespi (1942) and the other from the study of behavioral contrast within behavior analysis. This book reviews both of these types of contrast effects and finds both differences and similarities between them. Still at issue is the validity of the interpretation of contrast that assumes that the value of some target level of reward is modified in inverse relation to the level of reward from other sources in the same context. This concept works well for the classic studies of incentive contrast, but is challenged by the emerging importance of anticipatory contrast and the finding in both of the separate research traditions that anticipatory contrast is inversely related to other measures of reinforcement value.

Key words: behavioral contrast, incentive contrast, anticipatory contrast, psychopharmacology of contrast, relative rate of reinforcement

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Rewards and payoffs seldom have their effects determined by their absolute values; instead, they are determined by how those values compare with some set of reference values. A professor who is content with his or her salary may become discontented when a newly hired colleague comes along with a higher salary. Pets who routinely eat pet food may reject that food if they are given access to treats such as fresh meat. A man who is satisfied with his wife until a more attractive female enters the picture may become unhappy with his marriage. More generally, commodities that would be unacceptable to an organism accustomed to a rich reward environment may be readily accepted, and worked for, by an organism with experience in a poor reward environment. For almost 50 years, the task of a sizable chunk of experimental psychology has been to define how such comparisons are determined and to specify more precisely the mechanisms that underlie the comparison process.

Flaherty's book provides an excellent review of the psychological literature from laboratories of animal learning that pertains to these issues. The general label under which this research has been conducted has been the study of contrast. For those in the behavior analysis community, such effects have been studied under the rubric of *behavioral contrast,* beginning with the seminal paper of Reynolds (1961). In his famous paper Reynolds demonstrated that the rate of responding maintained by a constant schedule during one stimulus (e.g., red) was substantially increased by decreases in the reinforcement rate during an alternative component of the schedule (e.g., green). Moreover, Reynolds showed for the first time that this elevation in response rate was due to changes in the relative rate of reinforcement associated with the positive stimulus (S+). Using a variety of techniques, he demonstrated that it was not simply that the response rate during the negative stimulus (S−) had been decreased (or altered in other ways) or that the subject had suffered the frustrative effects of extinction, because these manipulations without changes in the relative rate of reinforcement had little effect. Conversely, changes in the relative rate of reinforcement in the absence of these other manipulations produced major changes in responding. The result was that the concept of relative rate of reinforcement was elevated into a fundamental concept of conditioning, which seemed to be irreducible to more elementary concepts.

Although research on behavioral contrast is voluminous (see Williams, 1983, for the most recent review), it constitutes but a fraction of the research of behavioral psycholo-

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gists on the subject of contrast. Members of the behavior analysis community may be surprised that the first studies of contrast antedated Reynolds' classic study by over 30 years. An example of such early research is Tinklepaugh (1928), done in Edwin Tolman's laboratory as part of Tolman's research program to battle reflexological behaviorism. Monkeys were trained in a delayed response problem in which favorite food items such as pieces of bananas and grapes were placed under the correct choice alternative. Tinklepaugh then observed the effects on the monkey's behavior when, unbeknownst to the monkey, a less preferred food, a piece of lettuce, was substituted. The result was that the lettuce was rejected, even though under other circumstances it would have been readily consumed. Moreover, the monkey became quite agitated, shrieking at the experimenter in apparent anger. A conceptually similar experiment was done in Tolman's laboratory by Elliot (1928) using rats in a complex maze. When a nonpreferred food (sunflower seeds) was substituted for a preferred food (wet mash), performance in the maze abruptly deteriorated, with a substantial increase in both blind alley entries and time to traverse the maze. Perhaps most important, the behavior of the rats with the shift in rewards was substantially worse than that of a group of subjects that were trained on sunflower seeds all along, indicating that the prior experience with the preferred food was essential to producing the disruption.

The most well known of the early studies of contrast is that by Crespi (1942), both for its clear demonstration of positive and negative contrast and because it had a major impact on Hullian learning theory. Rats were trained in a straight alley for one trial each day. Running speed was shown to be higher for animals shifted from a small reward to a large reward than it was for animals trained with the large reward throughout. Similarly, running speed was slower for animals shifted from a large reward to a small reward than it was for animals trained with the small reward throughout. The former of these came to be called an *elation effect*; the latter came to be called a *depression effect*. In both cases the change in running speed after the shift in reward value was rapid, with adjustments in the first few trials after the shift.

The procedures used in these early studies of contrast were obviously quite different from that of Reynolds (1961). Moreover, research modeled after these early classic studies continued at a high level during the 20-year period prior to Reynolds' study and still persists today. Remarkably, however, little contact has occurred between the experimental literature derived from Crespi and the burgeoning corpus of research on contrast in operant procedures. This separation has been in part caused by the division of animal learning into an associative learning camp and a Skinnerian or behavior analysis camp. As discussed elsewhere (Williams, 1987), each of these two approaches has often ignored the other, or worse, has expressed its disdain for the alternative approach. With respect to the study of contrast, these two separate approaches have coexisted for almost 30 years, but with only the most minimal intellectual contact.

Flaherty's book provides a systematic review of all of the major data regarding the different types of contrast, and by so doing provides a framework by which the empirical phenomena uncovered with these different procedures can be interrelated. Much of the work that is reviewed was initially reported by the author himself, and one cannot help but be impressed by the systematically thorough nature of his research program. But Flaherty's goal is more ambitious, in that he is concerned with what features the different contrast procedures have in common. A central issue is whether there is one general mechanism that determines all types of contrast, or whether the different varieties of contrast rely on an assortment of different mechanisms. For example, is the concept of relative value the underlying basis of all forms of contrast?

A necessary starting point for attempting to answer such questions is some kind of taxonomy of the diverse contrast procedures. The various chapter headings reveal how Flaherty has categorized this large and confusing literature. After a brief but outstanding historical chapter, the next three chapters (the largest section of the book) deal with *successive contrast,* the procedure in which the amount of reward is either increased or decreased from values used earlier in training, analogous to the early study of Crespi (1942). Several important distinctions seem to be forced by the data, including that between positive and negative contrast and that between contrast using an instrumental response and contrast using a consummatory response. With respect to the former distinction, successive negative contrast is a highly robust phenomenon that occurs in almost all contrast paradigms. The major exception to this generalization is that there appear to be comparative differences, in that animals of some species (fish, turtles, toads) do not show successive negative contrast, just as they have not shown more rapid extinction after acquisition training with larger rewards (Bitterman, 1975). Similarly, very young rats also do not show successive negative contrast and reward magnitude effects on the rate of extinction. Such results have been interpreted as showing that negative contrast depends on an ''expectation'' of a specific reward, which in turn requires a cognitive apparatus that simple vertebrates or very young animals do not have.

Compared to the generally robust occurrence of successive negative contrast, successive positive contrast has been a much less reliable phenomenon. Despite Crespi's (1942) early positive results, other early studies often failed to find any evidence for successive positive contrast, while at the same time showing negative contrast in a clear fashion. We now know that procedural modifications (the use of delay of reinforcement, the use of longer alleys) do allow successive positive contrast to occur, presumably because they reduce the role of ceiling effects on running speed. Nevertheless, the asymmetry between positive and negative successive contrast remains an important empirical distinction.

Overlying the distinction between negative and positive contrast is contrast in instrumental behavior versus contrast in consummatory behavior, typically that of licking some type of solution. Given that the vigor of the consummatory behavior should provide an index of its effectiveness as a reinforcer, one might expect the functional dynamics of the two types of behavior to be parallel. In fact, however, they empirically appear to dissociate in several interesting ways. A notable example is the effect of the level of food deprivation: Contrast with respect to instrumental behavior is enhanced by greater deprivation, whereas contrast in consummatory behavior appears to be independent of deprivation level. A second example is the effect of reduction in sucrose concentration. Whereas a robust negative contrast effect occurs in terms of the rate of consummatory licking, no contrast occurs in runway performance (although it does with other kinds of food). Such dissociations suggest that the motivational dynamics of the two types of behavior may be substantially different.

In addition to reviewing the behavioral data regarding the procedural parameters that determine the magnitude of contrast effects, Flaherty also provides a review (chapter 3) of how successive contrast is affected both by pharmacological manipulations and by a variety of physiological interventions, including various types of lesions. This literature reveals an extraordinarily complex array of effects that defy any simple description. Perhaps the most important finding from a theoretical perspective (chapter 4 is exclusively devoted to the theory of successive contrast) is that anxiolytic drugs such as Valium do not decrease the size of the successive negative contrast effect on the 1st day after the reward shift, but do decrease it on the 2nd day and thereafter. This finding leads Flaherty to argue that successive negative contrast is a two-stage process, the first being a search for the missing high-valued reward and the second being adjustment to the frustration when the missing reward is not found. If correct, such an interpretation may have important implications for the temporal dynamics of contrast in a variety of different procedures.

The second type of contrast described by Flaherty is simultaneous contrast. This is a somewhat misleading label in that the comparison involved is not between two rewards simultaneously present but rather is between two stimuli that alternate successively, each correlated with a different level of reward. In control conditions, both stimuli are correlated with the same level of reward. A second category of simultaneous contrast occurs with consummatory behavior, where the different reward levels are presented several times within a session without differential cues (except of course for the differential tastes of the rewards themselves). As with successive contrast, once again the properties of contrast vary as a function of whether consummatory or instrumental behavior is examined. Whereas consummatory behavior reveals robust negative and positive contrast, negative contrast but not positive contrast is typically found with instrumental behavior. As with successive positive contrast, however, procedural variations such as using delay of reinforcement have been shown to produce simultaneous positive contrast under some conditions. But these parallels between successive and simultaneous contrast do not hold generally, because simultaneous contrast seems to be unaffected by drugs that reduce successive contrast. Similarly, the comparative and ontogenetic differences noted above for successive negative contrast do not apply to simultaneous contrast.

Simultaneous contrast, typically studied in runway situations, is conceptually the same procedure as behavioral contrast studied with multiple schedules. One might expect, therefore, that the functional dynamics of the two procedures should be similar. However, the asymmetry between positive and negative contrast in simultaneous contrast does not hold for behavioral contrast, where both positive and negative contrast are easily obtained. Of some importance, therefore, is the identification of the critical variables that produce the different pattern of results for the two procedures. The most likely explanation appears to be the temporal separation of the different components of the schedule. In the typical simultaneous contrast procedure, substantial intertrial intervals (ITIs) intervene between presentations of the S− and S+, whereas in typical behavioral contrast procedures, the two components of the schedule are temporally contiguous. Support for this interpretation comes from studies in which ITIs have been inserted in behavioral contrast procedures (Mackintosh, Little, & Lord, 1972), where contrast did not occur with long ITIs, primarily because the ITI appeared to increase the response rate in the unchanged target component on its own.

A significant complication in evaluating the relation between simultaneous and behavioral contrast is that behavioral contrast itself appears to be an amalgam of at least two different effects. On the one hand are the molar effects of relative rate of reinforcement, which may themselves be best understood as a form of anticipatory contrast (see discussion below); the second type of effect appears to depend upon the arousing effects created by the transition from the S− to S+, which some (e.g., Malone, 1976) have interpreted as being analogous to what Pavlov termed induction. Flaherty provides an excellent review of the various pieces of evidence supporting an important role for such "emotionality effects" on behavioral contrast, including the effects of drugs, the correlation with stress hormones, and the effects of brain lesions. However, he concludes that such effects do not typically account for a large portion of the usual behavioral contrast effect; rather, they determine what has come to be called *local contrast,* which is an effect distinct from molar behavioral contrast. The analysis is complicated by the role of discrimination difficulty, in that use of highly similar stimuli for the S+ and S− tends to increase the amount of local contrast and thus also increases the portion of the molar contrast effect that is due to local contrast. When dissimilar stimuli are used, on the other hand, local contrast plays only a small role, especially after performance has stabilized.

Although the typical simultaneous contrast and behavioral contrast procedures produce important functional differences, one type of contrast cuts across the two procedures with remarkable parallels between them. This is the phenomenon of *anticipatory contrast,* which is the finding that the critical comparison process involves the current target component and the component that consistently follows. Such an effect violates the usual intuitions, because the natural assumption has been that the critical comparison is between the target component and the component that preceded it (or between the reinforcement rate during target component and the molar reinforcement rate in the alternative components). Nevertheless, the importance of the comparison between reinforcement rates in the target component and those in the following component has been known in operant procedures for a long time, in that it was first demonstrated by Wilton and Gay (1969). The importance of such findings comes from the observation that molar behavioral contrast consists primarily of the anticipatory contrast effect.

An example of the evidence that supports the importance of anticipatory contrast comes from three-component schedules that present subjects with a fixed sequence of components (Williams, 1981; Williams & Wixted, 1986) (e.g., ABCABCABC. . .). The schedules of reinforcement during the A and C components are equal and are held constant, while the reinforcement rate during the B component is varied from high reinforcement rates to extinction. The result of such studies is that robust contrast effects occur during Component A, but only sporadic contrast occurs during Component C. Some subjects do show some contrast during Component C that varies widely from condition to condition, but others show no contrast in component C whatsoever. The inference, therefore, is that the usual behavioral contrast effect with two-component schedules is due primarily to anticipatory contrast.

Behavior analysts who are familiar with the behavioral contrast literature will be cognizant of the array of evidence that supports anticipatory contrast as a major category of behavioral effects. They are likely to be less familiar with the the fact that contemporaneous with the studies of anticipatory contrast in operant procedures, the same general phenomenon was independently discovered using the consummatory licking procedure described above for the study of successive and simultaneous contrast. The basic procedure has been to present rats with a target solution (e.g., 0.15% saccharin) for a fixed time period, which then is withdrawn and is replaced by a different following solution (e.g., 32% sucrose), which typically has higher palatability than the initial target solution. In control conditions, the target solution is not followed by a second solution, or is followed by a solution identical to the target solution (e.g., 0.15% saccharin followed by 0.15% saccharin). The general finding is that the rate of licking the target solution is substantially higher for the control conditions than it is for the target solution followed by the preferred reward. The greater the disparity in value between the target solution and following solution, the greater the suppression of licking of the target solution. Also, the greater the temporal separation between the target solution and the following solution, the smaller the degree of suppression of the target-component licking response.

The parallel between anticipatory contrast studied with the consummatory licking procedure and behavioral contrast procedures is provocative. Because the two procedures differ along a number of dimensions (the type of subject, use of different values of reward vs. rate of reward, the temporal parameters necessary to produce the effect, etc.), it is difficult to make a direct comparison between them. Flaherty does make a considerable effort to provide such a comparison by reviewing the various parameters that determine both. Unfortunately, much more parametric work has been done with the consummatory licking procedure than with anticipatory behavioral contrast, so the comparison at this point remains at a qualitative level. Nevertheless, Flaherty's review of his own work on anticipatory consummatory contrast clearly shows that it has properties quite different from the other forms of contrast that are described above. Consummatory anticipatory contrast appears to be unaffected by the pharmacological and physiological manipulations that have been shown to affect successive negative contrast, a functional separation that suggests that the two forms of contrast are fundamentally different in kind. Unfortunately, there has not been sufficient research employing similar manipulations with respect to behavioral contrast to determine whether anticipatory behavioral contrast can be functionally isolated from other components of the molar contrast effect. One possibility suggested by Flaherty is that local contrast may be affected by drugs such as Valium, whereas anticipatory contrast is unaffected. Such a finding would suggest that the emotionality effects that putatively underlie local contrast have a great deal in common with successive negative contrast, whereas anticipatory contrast is a separate type of contrast effect that is functionally similar for the two types of procedures.

Perhaps the most important recent development in the study of contrast, to which Flaherty gives considerable attention, has been the attempt to test the hypothesis that contrast occurs because the target component is devalued whenever it is followed by a higher valued reward. As noted above, early work on behavioral contrast invoked the concept of relative rate of reinforcement as a primitive variable, with the underlying assumption being that contrast reflected an enhancement of the value of the unchanged schedule of reinforcement due to its being embedded in a lean context of reinforcement or a decrease in value when it is embedded in a rich context of reinforcement. However, a paradox arises when the idea of relative value is extended to the multicomponent schedules described above that were used by Williams (1981) and Williams and Wixted (1986). The problem is that the Pavlovian contingencies implicit in the procedure should produce the opposite effect of the contrast effect that is observed. That is to say, Component A predicts that a higher rate of reinforcement is impending in Component B, which presumably means that the value of Component B will be associated with Component A because of the Pavlovian contingency. One might therefore expect that Component A would possess higher relative value than Component C, which has no such Pavlovian contingency. Nevin (1992b) has explicitly made such a prediction, in that his measure of resistance to change, which generally has been shown to be highly correlated with measures of relative value, is assumed to be determined solely by Pavlovian contingencies. The question that arises is what therefore does the contrast effect in Component A reflect. The hypothesis that contrast is due to relative value implies that the schedule of reinforcement in A is less valued than that in C (when a rich schedule is available in Component B) because of their differences in the surrounding context of reinforcement. But the relative value idea requires that the values of A versus C are opposite to their Pavlovian signaling properties with respect to Component B. Either of two resolutions of this puzzle are possible. It could be that the Pavlovian signaling properties of a stimulus play no important role in determining the value of a discriminative stimulus in a free-operant procedure. Alternatively, the contrast effect seen in Component A does not reflect a greater value of Component A than for Component C, thus implying that contrast with respect to response rate occurs for reasons other than relative value.

In order to separate these alternative possibilities, Williams (1991, 1992) trained pigeons on a four-component multiple schedule in which two target components (A and B) had identical schedules, but with one (A) followed by a rich schedule (X) and the other (B) followed by extinction (Y). The usual anticipatory contrast effect occurred, in that response rate was higher in Target Component B than in Target Component A. In order to then evaluate how the contrast effect was related to the value of the different components of the schedule, probe preference tests were presented in which the stimuli from the two target components were presented as choice alternatives. Although response rate during the baseline was higher in Component B, when choice between A and B was allowed, preference was in favor of Stimulus A, which predicted the higher following rate of reinforcement. The dissociation between response rate and preference that was observed in these studies strongly suggests that anticipatory contrast is not due to an enhancement of the value of the stimulus associated with the increase in response rate. Thus, the relative value hypothesis seems to be an unlikely interpretation of anticipatory contrast and perhaps of other forms of contrast as well.

In addition to his review of anticipatory contrast in operant procedures, Flaherty provides an extensive review of his own attempts to test what he calls the devaluation hypothesis of anticipatory consummatory contrast. In general, the results are similar to those obtained with the free-operant procedures. Rats trained with two different target solutions, cued by different spout cues, exhibited anticipatory contrast during the acquisition phase of the study, with lower rates to the spout cue that signaled the more highly valued following solution. They then were given a preference test between the different spout cues, with the result that the spout cue followed by the higher valued solution was preferred. Thus, the dissociation of response rate and preference seems to hold for both the consummatory and behavioral contrast versions of anticipatory contrast, strongly suggesting that despite their ostensible differences the same fundamental processes are involved.

An important complication in the studies of anticipatory consummatory contrast reviewed by Flaherty is that they depend critically on the stimuli that accompany the initial target solutions. This issue becomes especially important for within-subject designs that present two different initial solutions, which are then presented together in preference tests. Almost all of the early work used different experimental contexts for the different target solutions, and anticipatory contrast was readily obtained. As noted above, anticipatory contrast has also occurred when the differential stimuli were different types of licking spouts. However, the use of different tastes or different odors as predictors of different following solutions does not produce anticipatory contrast. Instead, a conditioned taste-odor preference typically develops, in that the licking rate to the target solution that is followed by the higher valued solution is enhanced. The puzzle is why differences in the nature of the discriminative stimuli should critically determine the nature of the effect.

The importance of stimulus variables has also been demonstrated for anticipatory contrast in operant procedures. Using the four-component multiple schedule described above in which A-X component pairs were interspersed with B-Y component pairs, Williams (1979, 1990) investigated the role of the stimuli that are predictive of the different following components, X and Y. Whereas such cues in the usual procedure were distinctly different (e.g., a line vs. a circle), in some conditions the same stimulus was used for both following schedules. For example, the circle signaled the rich following schedule (X) and also the following schedule of extinction (Y). Here anticipatory contrast was abolished, and in the initial study of Williams (1979) was reversed (higher response rates occurred in Component A than in Component B).

The effect of taste stimuli in the consummatory anticipatory contrast procedure and the effect of nondifferential stimuli for the different following schedules in the operant procedure most likely have a common interpretation. Both manipulations are likely to enhance the Pavlovian association between the initial target component and the higher valued following event. With respect to the use of taste cues, this presumably is due to "preparedness" effects that enhance the association between the target tastes and the subsequent higher valued solution. This Pavlovian conditioning of a taste preference then competes with and overrides whatever anticipatory contrast effect might otherwise occur. The use of differential or nondifferential stimuli in the following components of the four-component operant procedure also produces variations in the degree of the Pavlovian contingency signaled by the stimuli that are correlated with the target components. When differential stimuli are present in the two different following schedules, those stimuli compete with the stimuli in the target components for cueing the reinforcement rates in the following schedules. But when nondifferential stimuli are present in the two different following schedules, such competition for stimulus control does not occur, so that the Pavlovian contingency between Target Component A and Following Component X is enhanced. Consequently, response rate during Component A is higher than in Component B when nondifferential stimuli are employed in the X and Y components but is lower than in Component B when differential stimuli are correlated with the X and Y components. This competition between the enhancement of stimulus value created by the Pavlovian contingency and suppression of operant responding due to the dynamics of anticipatory contrast has the important implication that anticipatory contrast depends on some type of discriminative stimulus function that is different from the Pavlovian signaling properties of the target components for the different following schedules. Unfortunately, how such a discriminative stimulus function should be characterized remains a mystery.

This review has described the highlights of the findings reported by Flaherty because his book is first and foremost a review of a complex experimental literature. Much of this research is entirely behavioral in character, but a substantial fraction will be of interest to neuroscientists who have little background in behavioral psychology. Not only does Flaherty describe the effects of pharmacological and physiological manipulations on the various types of contrast but he also provides an appendix that reviews the psychopharmacology of different animal models of anxiety. Behavioral psychopharmacologists will undoubtedly find this section of the book of interest and will gain a greater appreciation of contrast effects as an additional method for studying the kinds of emotionality effects that are of special interest to pharmaceutical companies.

Given that the present book is primarily a compendium of research findings, what message can we take away? Contrast effects are among the most Byzantine of all behavioral phenomena, but is there some general set of principles that will provide insight into their dynamics? The close parallels between anticipatory contrast in consummatory licking and in operant behavioral contrast strongly suggest that general principles are involved. Whether the same set of principles applies to forms of contrast other than anticipatory contrast is less clear. Flaherty concludes that there are multiple types of comparison processes involved in producing contrast, including the comparison between the target reward and other rewards in the immediate past, the comparison between the target reward and other rewards soon to follow, and the comparison between the target reward and other rewards simultaneously present. The various dissociations that have been described above (e.g., the effects of anxiolytic drugs such as Valium) provide meaningful evidence that the different types of contrast reflect different processes.

The most surprising feature of the contrast literature reviewed by Flaherty is how poorly our notions of contrast derived from the concept of relative value perform as a predictor of the behavior in contrast procedures. The prevailing view of contrast has been that it is a reflection of the ratio of the current reward conditions to its context (e.g., Bloomfield, 1969), which implies that the current reward conditions should be enhanced in value when in a lean context but decreased in value when in a rich context. If this were in fact the case, the dissociation between contrast in response rate and preference described above for both types of anticipatory contrast procedures would not occur. Thus, our intuitions about why contrast occurs seem to be fundamentally misguided.

But what then determines contrast if the concept of relative value is excluded as an hypothesis? No simple answer to thisquestion can be provided, either from Flaherty or from the present reviewer. Clearly the relation between a current reward condition and the following reward conditions is not to be explained by the Pavlovian relation between them. Instead, the Pavlovian relation appears to provide competition for whatever process underlies contrast. What is missing is an understanding of the nature of the discriminative stimulus function whereby the stimulus correlated with the target component is compared with the reinforcement conditions in the following component. If this is not Pavlovian in nature, then what? An answer to this question may provide important insight into the different kinds of stimulus functions that may occur. Without an answer, the phenomenon of contrast will remain a mystery.

It is of course possible that anticipatory contrast is a separate domain of contrast, and that the other types of contrast can be interpreted in terms of how the context of reinforcement modulates the value of the constant reinforcement schedule (e.g., Nevin, 1992a). However, when the relation between anticipatory contrast and the usual simple behavioral contrast effect is considered, the residual amount of contrast after anticipatory contrast is removed is not a robust phenomenon (e.g., Williams & Wixted, 1986). The apparent implication is that behavioral contrast generally is due to anticipatory contrast and that the increase in responding seen in such procedures does not reflect modulations in the value of the unchanged target components by its context of reinforcement.

The dominance of anticipatory contrast as the major component of behavioral contrast highlights the importance of the strong similarity between the functional properties of anticipatory contrast in operant schedules and in consummatory contrast. The dissociation described above for both of the two types of anticipatory contrast procedures between the rate of responding during the target component and the value of that target when presented in preference tests suggests an underlying general process despite the ostensibly major procedural differences involved; in neither procedure does contrast appear to result from a modulation of the value of the target component by the reinforcement conditions that follow. That is to say, even though the subjects may be responding more slowly when the target component is followed by a richer reinforcement condition, this decrease in rate does not mean that the target component is diminished in value. If anything, the target component is enhanced in value when it is followed by the richer schedule. This dissociation between response rate and stimulus value, in both the behavioral contrast and consummatory response procedures, is a major unexpected finding that appears to require a drastic reconceptualization of how contrast operates. As shown by Flaherty's review, such a reconceptualization is still in its infancy. This is not a problem that additional research will easily solve, in that the facts about anticipatory contrast are increasingly clear. What remains unclear are the explanatory constructs that are needed to interpret those facts.

Although anticipatory contrast does not appear to be caused by modulations of the value of the unchanged target component in inverse relation to the richness of the following component, it is undoubtedly premature to dismiss the concept of relative value. Whether there are other types of contrast (e.g., successive negative contrast, local contrast in multiple schedules) that are caused by relative value remains to be resolved. The examples noted in the introduction provide prima facie evidence that the value of a particular reward is indeed relative to the context in which it occurs. The strong intuitive appeal of the concept of relative value thus makes an even greater mystery of the results involving anticipatory contrast. Why then does the pigeon respond at high rates to a stimulus that is followed by extinction but at low rates to a stimulus that has an identical reinforcement schedule but that is followed by a high rate of reinforcement? This remains a perplexing issue.

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