Psychological Bulletin
1991, Vol. 110, No. 3, 379–391

0033-2909/91/$3.00

Reinforcement in Applied Settings: Figuring Out Ahead of Time What Will Work

William Timberlake and Valeri A. Farmer-Dougan
Indiana University

This article reviews the practical value of conceptual attempts to specify the circumstances of reinforcement ahead of time. Improvements are traced from the transituational-reinforcer approach of Meehl (1950), through the probability-differential model of Premack (1959, 1965), to the response deprivation and disequilibrium approach (Timberlake, 1980, 1984; Timberlake & Allison, 1974). The application value of each approach is evaluated on the grounds of simplicity, accuracy, and adaptability. The article shows that the disequilibrium approach accounts for and extends current empirically driven techniques of reinforcement control and examines some of its limitations. The disequilibrium approach clarifies how current knowledge can be used to predict more accurately the circumstances of reinforcement and invites the collaboration of applied and basic research in its further development.

A major contribution of operant analysis in applied settings has been to clarify the control of human behavior by reinforcement contingencies. Drawing on the results of basic laboratory research, practitioners have developed techniques for applying reinforcement contingencies to human affairs. For example, both token economies (Kazdin, 1982; Kazdin & Bootzin, 1972) and behavioral contracting (Kelly & Stokes, 1982; Medland & Stachnik, 1982) emerged from basic research on schedules of reinforcement. The development of incidental teaching (Hart & Risley, 1968, 1975; see also McGee, Krantz, & McClannahan, 1985) was influenced by Terrace's (1963) work on errorless learning.

Despite the success of such techniques, there has persisted a significant, unresolved problem: how to specify ahead of time the circumstances that produce reinforcement. The extent of this problem may be surprising given the clear procedural definition of a reinforcer as a stimulus, which, when presented contingent on a response, increases the rate of that response. However, the inadequacy of this definition is apparent in such common frustrations as reinforcing circumstances that work for one individual but not for another or that work one day but not the next. In the end, practitioners rely on their previous experience plus trial and error to produce reinforcement effects, a "seat-of-the-pants" approach to behavior control (see also Konarski, Johnson, Crowell, & Whitman, 1981).

To improve their ability to predict reinforcement, applied researchers have systematized the search for reinforcing circumstances tailored to individuals. For example, Egel (1981), working with developmentally disabled children, asked each child to rank a set of potential reinforcing stimuli. The stimuli with higher ranks were then used as reinforcers. In related work, Pace, Ivancic, Edwards, Iwata, and Page (1985) measured approach to 16 different stimuli as an index of their usefulness as reinforcers with severely disabled children (see also Dattilo, 1986; Green et al., 1988; Mason, McGee, Farmer-Dougan, & Risley, 1989; Wacker, Berg, Wiggins, Muldoon, & Cavanaugh, 1985).

Another empirical approach to the tailoring of reinforcement circumstances to individuals has been to use contingency schedules to interrupt and control access to the typical flow of events in a situation. Examples of this approach include the good behavior game (Barrish, Saunders, & Wolf, 1969), overcorrection (Carey & Bucher, 1981), and incidental teaching (Hart & Risley, 1968, 1975; McGee et al., 1985). In these cases, an ongoing set of events and responses is observed and then the continuation of this stream is made contingent on changes in a target behavior. For example, that a child regularly plays outside at morning recess is observed, and the continuation of this activity is made dependent on previously completing an arithmetic assignment.

Despite their usefulness, these empirically driven techniques lack the advantages of careful conceptual development. Extensive search procedures require time-consuming and sometimes involved testing for reinforcement effects that can interfere with current and subsequent management of behavior. The generality and interrelation of the different empirically driven techniques remain uncertain, and there is no adequate analysis of when and why they fail (Konarski et al., 1981). In our opinion, these limitations can be surmounted only by an improved conceptual analysis of the circumstances of reinforcement.

A major purpose of this article, therefore, is to review attempts by researchers over the last 40 years to provide an analysis capable of specifying the circumstances of reinforcement ahead of time. We will follow previous authors (Allison, 1981;

Preparation of this manuscript was supported in part by National Institute of Mental Health Grant MH 37892 and National Science Foundation Grant BNS 84-13579.

We thank Jim Dougan, Jack Bates, Rick Viken, and especially Dick McFall for their comments and suggestions.

Correspondence concerning this article should be addressed to William Timberlake, Department of Psychology, Indiana University, Bloomington, Indiana 47405, or to Valeri A. Farmer-Dougan, who is now at the Department of Psychology, Illinois State University, Normal, Illinois 61701.

Konarski et al., 1981; Timberlake, 1980, 1984; Timberlake & Allison, 1974) in recounting the progression from Meehl's (1950) transituational-reinforcer hypothesis, through Premack's (1965) probability-differential model, to the response deprivation and disequilibrium view (Timberlake, 1980, 1984; Timberlake & Allison, 1974).

We do not directly consider in this review several current conceptual approaches, including the matching law (McDowell, 1982) and the behavioral application of economic and optimality principles (Allison, 1981; Jacobsen & Margolin, 1979; Rachlin, Battalio, Kagel, & Green, 1981; Rachlin & Burkhard, 1978; Staddon, 1979). The matching law makes predictions about relative performance once a particular reinforcer is known, but it does not identify the circumstances of reinforcement ahead of time. As to economic and optimality approaches, most of their immediate causal aspects can be treated within the disequilibrium approach (Hanson & Timberlake, 1983).

This review extends previous analyses of the circumstances of reinforcement in several ways. First, we carefully track the changes in basic assumptions that underlie the different approaches. Second, we evaluate how well each approach can be applied to the control of human behavior. We assume that a successful approach should satisfy the following three practical requirements: (a) Identification of reinforcement circumstances should involve a small number of simple, nonintrusive, and widely applicable procedures; these procedures should require no special apparatus and introduce no novel or disruptive stimuli that might modify subsequent behavior in an undesirable fashion. (b) Identification of reinforcement circumstances should be accurate and complete. Not only should the circumstances produce reinforcement, but the critical determinants should be identified to allow subsequent manipulation and tests of their effects. (c) The resultant circumstances of reinforcement should be adaptable to a variety of situations rather than limited to a small number of stimuli, responses, or settings.

Two conclusions emerge from our analysis. First, the probability-differential model of Premack (1965) is clearly preferable to the transituational-reinforcer approach in terms of application potential. Second, compared with the probability-differential model, the disequilibrium approach has clear advantages without adding any obvious disadvantages. This latter conclusion calls into question the common practice among research practitioners of stopping their conceptual analysis of reinforcement with Premack's (1965) probability-differential approach rather than moving on to the disequilibrium view (e.g., Catania, 1984; Kazdin, 1980).

In the remainder of the article we first show how the disequilibrium approach provides a common framework accounting for the effectiveness and facilitating the use of empirically driven techniques of reinforcement control. In the last section, we consider some limitations on and extensions of the disequilibrium approach that suggest the importance of further development involving the collaboration of basic and applied researchers.

The Transituational Solution

Conceptual Analysis

The simplest method for figuring out ahead of time the circumstances of reinforcement is to use circumstances that have worked in the past. Meehl (1950) provided a well-reasoned basis for this approach in his concept of the transituational reinforcer, a general causal stimulus. When a stimulus has been identified as a reinforcer in one situation, it can be applied in other situations with the expectation that it will produce reinforcement there as well. (The same transituational quality is attributed to contingent stimuli producing punishment.)

Meehl's (1950) transituational view contains three important assumptions about reinforcing stimuli and their setting conditions. The first is that reinforcers and punishers form unique, independent sets of transituationally effective stimuli. These sets of stimuli cannot overlap because if the same stimulus can reinforce and punish, it is not perfectly transituational. The second assumption is that the essential function of a contingency schedule is to produce the temporally proximate pairings between response and reinforcer that cause reinforcement. The third assumption is that a deprivation schedule specifying long-term denial of access to a reinforcer is a critical setting condition for the operation of a reinforcer.

None of these assumptions has proved to be correct. Premack (1965) documented that reinforcers are not inevitably transituational in their effect and, furthermore, that the sets of reinforcers and punishers are neither unique nor discrete. For example, in his work on manipulation responses in monkeys, Premack (1963a) showed that access to a given manipulable stimulus would reinforce some responses but not others. In other work, Premack (1963b) showed that access to wheel running and drinking could each serve as a reinforcer for the other if their relative baseline probabilities were reversed appropriately (Premack, 1971; for further examples, see Timberlake, 1980). Applied researchers also have demonstrated that reinforcing stimuli are not transituational (e.g., Konarski, Crowell, & Duggan, 1985; Konarski, Crowell, Johnson, & Whitman, 1982; Konarski, Johnson, Crowell, & Whitman, 1980).

As to the presumed critical role of the temporal contiguity produced by a schedule relating response and reinforcer, Premack (1965) found that temporal contiguity alone was not sufficient to produce reinforcement. Numerous chance pairings of a wheel-running response with the known reinforcer of drinking for a thirsty rat produced no effect in the absence of a contingency schedule. There was also no effect of the pairings of wheel-running and drinking resulting from an explicit contingency schedule that maintained the ratio of wheel-running to drinking shown in a free baseline (a period of time during which the two responses are freely and simultaneously available). On the basis of these results, Premack proposed that a reinforcement schedule to be effective must produce a decrease in contingent responding (here, drinking) relative to its baseline. This argument called attention to the critical importance of a schedule-based disruption of baseline responding, but, as we shall see, inappropriately put the emphasis on after-the-fact, rather than predictive, measures of disruption (Timberlake, 1980).

Finally, there is considerable evidence that the third condition, long-term deprivation of access to a stimulus, is neither necessary nor sufficient for reinforcement to occur. Timberlake (1980) reviewed several studies showing that the role of a stimulus could be changed from reinforcer to nonreinforcer without any change in long-term (extra-session) restriction on its access. All that was required was a change in the terms of the within-session contingency schedule to produce an appropriate disruption of baseline responding.

For example, Timberlake and Wozny (1979) showed that the reinforcement relation between wheel-running and eating in rats could be changed by altering the schedule terms relating the two responses without any change in overall deprivation procedures. A contingency schedule that constrained relative access to food *within* the session increased wheel-running. Conversely, a contingency schedule that constrained relative access to wheel-running increased eating. Konarski et al. (1980, 1982, 1985) showed related results with children in classroom settings and with mentally retarded adults in the laboratory (Konarski, 1987). We review these points at greater length shortly.

Application

At the applied level, some variant of the transituational-reinforcer approach has remained the technique most used by practitioners (see Kazdin, 1980). Even applications using more sophisticated technology, such as extensive individual evaluation techniques or the matching law, depend on discovering reinforcers by trial and error and assuming that these reinforcers will show transituationality.

As noted also by other authors (e.g., Hawkins, 1989; Konarski, 1989; Konarski et al., 1981) the transituational-reinforcer approach has many limitations. First, the assessment technique is intrusive, typically requiring the imposition of several contingency schedules to find a reinforcer. Furthermore, the accuracy with which the concept of transituationality identifies the circumstances of reinforcement leaves much to be desired. For example, a toy that is a reinforcer for one child on a particular day may not be a reinforcer for another child, or even for the same child on a different day.

In addition, though responding may vary greatly with the values of the contingency schedule terms, the transituational analysis provides no guidance in setting these values. For example, should a client be required to say one word or five words before receiving a reward, and how large should the reward be? In practice, the values of schedule terms typically are based on convenience, intuition, past experience, and trial-and-error adjustments for reasonable current effects.

Finally, long-term denial of access to a reinforcing stimulus demands careful preparation and can impose considerable hardship on the subject, with no guarantee that it will be effective. Consider, for example, that long-term denial of teacher approval for a disruptive child may facilitate aggressive responses that the schedule is intended to control. Increasing the length of the denial may only increase disruptive behavior or produce other socially manipulative responses. Moreover, consistent long-term denial may decrease the importance of teacher approval if the child substitutes peer approval. Yet many practitioners believe that without long-term denial there can be no reinforcement.

In short, the transituational view lacks flexibility, resulting in a misleading focus on sets of unique reinforcers and punishers as the critical determinants of reinforcement (Konarski et al., 1981). As a result, the search for reinforcing circumstances has been constrained to assembling a set of general-purpose reinforcers and punishers that hopefully can be used across a variety of situations (e.g., Egel, 1981; Pace et al., 1985).

Frequently such general reinforcers as food or social disapproval are imposed in situations in which they do not typically occur. These out-of-place reinforcers often create an additional source of motivation with accompanying behavioral tendencies that may complicate or interfere with responses of interest (see Epstein, 1985; Gardner & Gardner, 1988). For example, the use of food as a general reinforcer may produce begging responses and disrupt scheduled meals by changing the basic timing and patterning of feeding. Food also may require time-consuming preparation by the practitioner and raise issues of nutritional value (e.g., the use of pieces of candy). In a similar manner, the use of social disapproval as a punisher may introduce social motivation and accompanying attention-getting or attention-rejecting responses. In the extreme, the use of shock or other strong aversive stimuli may produce interfering responses and fear as well as raise important ethical questions.

Premack's Probability-Differential Hypothesis

Conceptual Analysis

The probability-differential analysis of Premack (1959, 1965) stands as a distinct improvement over the transituational view in analyzing the circumstances of reinforcement. According to Premack, a schedule in which a higher probability response is contingent on a lower probability response will produce reinforcement, but a lower probability response contingent on a higher probability response will not. In fact, if the subject is forced to engage in the lower probability response, punishment should result. For example, for many first graders, playing is a response of higher probability than reading. Thus, contingent access to play should increase reading, but forced access to reading following play should punish playing.

Premack's approach marks an important change in the conception of reinforcement. In the traditional view, reinforcement is produced by a stimulus. In Premack's view, reinforcement is related to access to a response. This shift facilitates viewing reinforcement within the context of the subject's unconstrained behavior. The probability of a response is determined by the probability (duration) of that response in a free baseline in which all relevant responses are freely and simultaneously available (but mutually exclusive, i.e., they cannot be performed at the same time).

Because of his emphasis on behavior, Premack frequently is called a response theorist. However, his procedures show clear concern with and explicit control of the stimulus situation. Probabilities of responding in free baseline simply reflect the response-producing qualities of the stimulus situation. Given that these stimulus qualities change little from baseline to contingency session, the underlying response probabilities are presumed to remain the same.

It is worth pointing out that Premack's model generates Meehl's transituational reinforcers as a special case. For example, contingent access to the highest probability response in a set is predicted to (transituationally) reinforce all other responses in the set. In a similar manner, forced performance of the lowest probability response in a set should punish all other responses. Most important, though, Premack's approach predicts outcomes that violate the assumptions of the transituationality approach. For example, under different combinations of baseline and schedule terms, access to the same drinking response can reinforce, punish, or have no effect on the wheel-running it follows (Premack, 1965).

Despite its improvement on the transituational-reinforcer account and its dominance of practitioner-relevant books (Donnellan, LaVigna, Negri-Shoultz, & Fassbender, 1988; Kazdin, 1980; Sulzer-Azeroff & Mayer, 1977), Premack's approach is incomplete and unclear about important variables. First, it fails to specify conceptual rules for setting the values of the contingency schedule. Premack most frequently used a ratio of one to one between amount of instrumental responding required and amount of contingent access produced. Though this procedural detail may seem of practical concern only, it actually is the critical piece missing from a more complete picture of the circumstances of reinforcement. In the context of the disequilibrium approach (Timberlake, 1980), changes in the schedule terms can be used to support or contradict the basic predictions of the probability-differential model. As we shall see, the critical variable is not the probability-differential between responses, but the disruption resulting from the relation of the contingency schedule to the baseline.

Second, Premack (1965) was unclear about the role of the reduction in contingent responding relative to baseline that typically accompanies an increase in instrumental responding. In 1965 he indicated that this reduction was a second circumstance that must be added to the probability-differential condition to get reinforcement, but he provided no further evidence or discussion of how it could be causal. He also failed to consider whether there was a parallel additional circumstance in the case of a reverse probability-differential contingency (punishment), namely, an obtained excess in contingent responding.

In the response deprivation/disequilibrium view, the obtained reduction in responding Premack pointed to is not a cause but a result (it occurs after the change in responding). The obtained deviation from baseline is the resolution of the disequilibrium resulting from the imposition of a schedule conflicting with baseline. The causal variable is thus the initial disequilibrium condition, not the obtained reduction or excess in the contingent response.

Finally, Premack appeared to vacillate about the importance of Meehl's third assumption, the requirement of long-term denial of access as a setting condition for reinforcement. When Premack reversed which response served as a reinforcer by altering its long-term deprivation, the results could be interpreted as support for Meehl's assumption. This invites an interpretation of Premack's probability-differential approach as a form of transituationality that depends on long-term deprivation as a setting condition. We argue in the next section that these ambiguities in Premack's approach resulted from his incomplete development of the disequilibrium view of the circumstances of reinforcement.

Application

Premack's probability-differential hypothesis has provided a popular and successful conceptual framework for applied investigations that routinely is covered in textbooks (e.g., Donnellan et al., 1988; Kazdin, 1980; Sulzer-Azeroff & Mayer, 1977). For example, Lattal (1969) required 10- to 12-year-old boys attending a summer camp to brush their teeth (a lower probability response) to gain access to swimming (the higher probability response). Implementing the contingency greatly increased the amount of toothbrushing. Hopkins, Schutte, and Garton (1971) made access to the playroom contingent on the rate or quality of printing and writing for first- and second-grade children, greatly increasing whichever response produced access.

The popularity of Premack's approach is due to several desirable characteristics. First, the procedures for identification of potential reinforcers and punishers are clear, yet relatively nondisruptive. A free baseline can be used to assess the probabilities of both the instrumental and contingent responses when both are freely available. It is worth noting that practitioners often use inferred baselines rather than actually measuring the responses in free baseline situations (Konarski et al., 1981), an issue we address in a later section.

Second, Premack's procedure for identifying reinforcement circumstances is more accurate that the transituational approach. The relative probabilities of the instrumental and contingent (reward) responses in a given situation are obviously more important than whether a response served as a reinforcer in another situation. Third, the conditions under which reinforcement or punishment can occur are no longer limited to a particular set of stimuli or responses. Reinforcers and punishers are not necessarily stimuli imposed from outside the situation. Instead, probability-based reinforcers often can be chosen from the responses available within a given situation.

Despite its marked improvement over the transituational approach, application of Premack's approach has several limitations (see also Konarski et al., 1981). First, Premack argued that the probability of each response must be measured in duration (rather than frequency) so that response probabilities can be compared readily. Measuring the duration of a discrete response, such as a lever press or the refusal to cooperate, is awkward and often inconvenient. Translating repetitive acts into durations becomes even more problematic when trying to specify the precise terms of a schedule because the duration measure does not deal with rate changes under constraint. Perhaps most important, there is no guarantee that time is a suitable metric for the relative ranking of response probabilities.

A second limitation on Premack's approach in applied settings is that the set of reinforcers is still constrained in that a reinforcer must always be of higher probability than the instrumental response, and the reverse must be true for a punisher. A third objection is that there is no conceptual basis for establishing the terms of the contingency, simply, the practice of using a one-to-one ratio of instrumental requirement to contingent payoff.

A last drawback concerns the potentially time-consuming nature and cost of the free baseline used to establish response probabilities. For example, a stable baseline requires keeping constant the factors affecting response attractiveness over a period long enough to stabilize responding. Furthermore, the baseline is good only for the set of circumstances under which it was measured. As noted earlier, practitioners frequently estimate the higher probability response only on the basis of intuition or casual observation (e.g., Donnellan et al., 1988, pp. 22–23; Hopkins et al., 1971; Lattal, 1969). Though obviously potentially successful, such a procedure must be considered a weaker substitute for a measured baseline. If intuitions and guesses were sufficient to predict behavior, we would have no need for further research.

Response Deprivation and the Disequilibrium Approach

Conceptual Analysis

The disequilibrium approach is an extension and generalization of the concept of response deprivation (Timberlake & Allison, 1974). The latter concept was generated by a reanalysis and extension of research by Premack (1965; see Eisenberger, Karpman, & Trattner, 1967; Timberlake, 1971, 1980; Timberlake & Allison, 1974). The response deprivation approach is basically a simple system view in which reinforcement results from the adaptation of motivational processes underlying free baseline responding to the performance constraints imposed by a contingency schedule. Thus, the primary role of the schedule changes from a means of presenting a reinforcing agent to a means of constraining the ongoing expression of motivational processes.

Several similar quantitative models accompanied (Timberlake, 1971) or followed (Allison, 1976) formulation of the response deprivation view. These models made more explicit the relation among asymptotic instrumental and contingent responding and their baselines. For our purposes, though, the important conceptual advance occurred in the development of molar equilibrium theory (Timberlake, 1980) and the behavior regulation model (Hanson & Timberlake, 1983; Timberlake, 1984). Molar equilibrium theory emphasizes that the free baseline can be thought of as an equilibrium state that is disrupted by the imposition of a contingency schedule that conflicts with baseline response relations. Both reinforcement and punishment result from the tendency to reduce this disequilibrium condition by changing instrumental responding (see Heth & Warren, 1978).

The behavior regulation model (Timberlake, 1984) further clarifies a systems view of reinforcement. The model explicitly extends the conditions that produce disequilibrium to include the disruption of local patterns of responding (begun in Allison & Timberlake, 1975) and calls attention to differences in the sensitivity of particular responses to directions and types of deviation from baseline responding. The model also emphasizes that both reinforcement and punishment are outcomes of the schedule-based linkage of separable regulatory tendencies underlying the baseline expression of both instrumental and contingent responding (Hanson & Timberlake, 1983). Though we believe the greater complexity of the behavior regulation model is critical for the further development of the regulatory approach, for our present purposes the simple disequilibrium approach provides a sufficient basis for identifying the circumstances of reinforcement ahead of time.

The disequilibrium approach shares with the probability-differential model (Premack, 1959, 1965) the assessment of the free baseline of instrumental and contingent responding before imposition of the schedule. However, the interpretation and use of this free baseline is different. Most interpreters of Premack (1959, 1965) view the baseline as a stable hierarchy of reinforcement value (e.g., Catania, 1984). In this account a reinforcer will be any response of higher baseline probability than the instrumental response; a punisher will be any response of lower baseline probability than the instrumental response.

In the disequilibrium view the baseline is not a stable hierarchy of reinforcement values but simply an estimate of the relative instigation (motivation) underlying different responses. Reinforcement is not produced by this instigation but by the constraints on its expression produced by the contingency schedule. In other words, reinforcement is the result of the schedule-based disruption of the expression of the motivational processes underlying free baseline responding (Hanson & Timberlake, 1983; Timberlake, 1980, 1984). It follows that the circumstances of reinforcement are not tied to particular baseline response probabilities but can be created or eliminated simply by changing contingency schedule values.

Disequilibrium conditions take two forms: response deficit (originally referred to as response deprivation) and response excess. The response deficit condition occurs if the subject, by maintaining instrumental responding at its baseline level, would fall below baseline level of access to the contingent response. The condition of response excess is the reverse; it occurs if the subject, by maintaining instrumental responding at its baseline level, would increase contingent responding above its baseline (Timberlake, 1980; Timberlake & Allison, 1974). The condition of response deficit is predicted to increase instrumental responding (positive reinforcement), whereas the condition of excess is predicted to decrease instrumental responding (punishment; Timberlake, 1980).

The disequilibrium approach improves on Premack's probability-differential model by specifying rules for setting the terms of the schedule. For example, the circumstances for increasing running by rats to obtain access to water occur (under a ratio schedule) when the ratio between the running requirement and the drinking access specified by the schedule is greater than the ratio between the baseline levels of running and drinking, i.e.,

$$I/C > O_i/O_c,$$

where I is the scheduled amount of instrumental responding to obtain C amount of the contingent response, and O_i and O_c are the operant levels of instrumental and contingent behaviors during an unconstrained baseline. In a similar manner, the circumstances for decreasing running in the same situation occur when the ratio of the running requirement to the forced drinking access is less than the baseline ratio of running to drinking, i.e.,

$$I/C < O_i/O_c.$$

These disequilibrium conditions place no limitations on the units for measuring responding as long as the schedule term for each particular response is measured in the same units as its baseline. Neither is there any restriction of disequilibria conditions to ratio schedules. In general, a contingency schedule for increasing the instrumental response requires that the subject, in performing the instrumental response at its baseline, be unable to attain the baseline of the contingent response. A schedule for decreasing the instrumental response requires that the subject, in performing the contingent response at its baseline, be unable to attain the baseline of the instrumental response. These conditions can be satisfied by any schedule that appropriately constrains relative access to the contingent response. For a simple graphical presentation of these issues, see Timberlake (1980, 1984).

It is worth noting that the disequilibrium approach generates the predictions of the probability-differential model as a special case (Konarski et al., 1981; Timberlake, 1980). If the baseline ratio of instrumental to contingent responding is less than a value of one (the contingent response has the higher probability), then use of the schedule ratio of one to one that typifies probability-differential research will produce a relative deficit in the contingent response and predict an increase in instrumental responding ($I/C > O_i/O_c$). If the baseline ratio of instrumental to contingent responding is greater than one (the contingent response has a lower probability), then the schedule ratio of one to one typically used by Premack will produce a relative excess in the contingent response and predict a decrease in instrumental responding ($I/C < O_i/O_c$). Thus, the results of probability-differential experiments can be attributed to the procedures satisfying the requirements of a disequilibrium condition. For the relation of other Premack predictions to the disequilibrium approach, see Timberlake (1980).

The disequilibrium approach, though, goes further than Premack's probability-differential hypothesis in removing restrictions on reinforcers and punishers. Responses, no matter what their probability, have no absolute or pairwise value as reinforcers. Any directional reinforcement value must begin with the disequilibrium condition resulting from the degree of conflict between baseline responding and the requirements of the schedule.

Thus, a lower probability response, such as a child working arithmetic problems, can reinforce a higher probability response, such as coloring (Konarski et al., 1980). Alternatively, a higher probability response of coloring can fail to reinforce a lower probability response of working arithmetic problems (see also Allison & Timberlake, 1974; Eisenberger et al., 1967; Konarski, 1985; Timberlake, 1980). Furthermore, the reinforcement relation between responses, such as two manipulation responses in humans, or wheel-running and drinking in rats, can be reversed simply by changing the terms of the schedule (Heth & Warren, 1978; Podsakoff, 1980; Timberlake & Allison, 1974; Timberlake & Wozny, 1979).

These diverse but predictable effects of schedule changes also provide evidence against Meehl's second assumption that the primary function of schedules is to produce temporal contiguity between response and reinforcer. Whatever the importance of temporal contiguity, a critical feature of the contingency schedule is to disrupt baseline response relations, producing a condition of disequilibrium.

Finally, the critical importance of the schedule-based disruption of baseline responding allows disequilibrium theory to reject Meehl's last assumption—the importance of long-term denial of access to a commodity. There is little question that long-term denial of access typically increases baseline response levels, but this is not a reinforcement effect. The critical circumstance for reinforcement is a disequilibrium condition created *within* the contingency session (Timberlake, 1984). Whether or not there is long-term denial of access, the occurrence of reinforcement always depends on the disruption of within-session baselines by the constraints of a schedule. This point remains confused in some textbooks, which continue to treat response deprivation as an overall deprivation condition rather than as a within-session disequilibrium condition (e.g., Atkinson, Atkinson, Smith, & Bem, 1990).

In short, to specify ahead of time what circumstances will produce reinforcement, a reformulation of our assumptions is required. There are not unique classes of reinforcers or punishers, sets of stimuli, or responses that have transituational reinforcement effects. Neither are there unique combinations of baseline response probabilities that produce reinforcement. Nor is the production of contiguity between a response and a reinforcer sufficient to produce reinforcement. Finally, long-term deprivation of access to the contingent response is neither necessary nor sufficient to produce reinforcement. Instead, reinforcement is predicted to occur if the response relations imposed by a contingency schedule disrupt the response relations shown in a free baseline under comparable circumstances.

Application

At an applied level, the disequilibrium approach shares the desirable practical characteristics of the probability-differential model while clearing up several of its ambiguities and decreasing its limitations. The procedures for identifying the circumstances of reinforcement are specific, relatively nondisruptive, and are more accurate than those of both the transituational view and the probability-differential view. Many different responses can be involved in the reinforcement of another, provided appropriate schedules are specified.

For example, in a study of grade-school children referred to previously, Konarski et al. (1980) assessed a free baseline of coloring and working simple arithmetic problems. Coloring occurred at a much higher rate than working arithmetic problems. Konarski et al. (1980) then applied a schedule that specified a condition of relative deficit for the opportunity to do arithmetic. The children increased the higher probability coloring response to gain access to the arithmetic problems.

In a related study of special education students, Konarski et al. (1985) assessed the free baseline of working arithmetic problems and writing. When a subsequent schedule specified a condition of relative deficit in the higher probability response, the children increased performance of the lower probability response providing access to it. Most important, when the schedule specified a relative deficit of the lower probability response, the children increased the higher probability response leading to it. These results of reinforcement reversal by schedule changes alone and the production of reinforcement effects with a low probability contingent response are not derivable from Premack (1965) or Meehl (1950) but are readily predicted by the disequilibrium approach.

Second, the circumstances under which reinforcement and punishment may occur in the disequilibrium approach are even more flexible than in the case of the probability-differential model. Both of the just previous examples show that reinforcement circumstances are not limited to the use of a particular set of stimuli or responses. Instead, access to a response can produce reinforcement, no effect, or punishment, depending on the relation between the contingency schedule and baseline responding. Remember also that in the disequilibrium approach, the units of response measurement are irrelevant so long as the units for a particular response remain the same in baseline and contingency.

Third, some investigators (e.g., Foltin et al., 1990), though using the disequilibrium approach to specify the terms of the schedule, still attribute their results to a probability-differential between the instrumental and contingent responses (the Premack principle). This is a confusion of description with causation. By focusing attention on a noncritical variable, namely, the baseline probability differential in responding, researchers create confusion and make it difficult for practitioners to understand the technology available.

Some investigators appear to believe that the original probability-differential view has been modified subsequently in ways that deal with disequilibrium effects (Dunham, 1977; Premack, 1971). Thus, they continue to view the probability differential relation as the fundamental causal variable. However, as has been pointed out in several places (e.g., Gawley, Timberlake, & Lucas, 1986; Timberlake, 1980, 1984; Timberlake & Allison, 1974), revisions of the probability-differential approach either make incorrect predictions or are essentially identical to the disequilibrium approach and thus generate predictions not compatible with prior views of probability differential. At the least, continued reference to the probability-differential relation as the critical causal variable confusingly recalls Premack's primary probability-differential approach (Premack, 1959, 1965) and thus diverts attention from the further development of the apparently more fundamental disequilibrium relations.

In sum, relative to the probability-differential model, the disequilibrium approach is both more specific and less limited in its application. Rewards are not restricted to higher probability responses, units of measurement are not limited to duration, and long-term denial of access is not required. In addition, rules for the specification of schedule terms are provided.

A Disequilibrium Analysis of Empirical Reinforcement Techniques

As noted in the introduction, several empirical procedures have been developed that effectively tailor reinforcement circumstances to the individual (behavioral contracting, the good behavior game, incidental teaching, and overcorrection). These procedures, though often very useful, lack a clear conceptual basis that integrates their results and focuses on the critical causal circumstances. In this section we show that the disequilibrium approach provides a common conceptual framework that can account for and suggest improvements in the effectiveness of these procedures.

Behavioral Contracting and the Good Behavior Game

Behavioral contracting (most often used with individual clients) and the good behavior game (most frequently used with groups) have common contingency-based procedures that can be viewed as a direct implementation of the disequilibrium model. A direction of change in a targeted response is selected, and access to a constrained response is made contingent on increasing or withholding the target response. For example, under a behavioral contract, a child, in order to see a movie, might be required to do 2 hours of homework. In a good behavior game, a fifth-grade teacher might make an early recess for the entire class contingent on no talking out-of-turn in the previous period.

In both cases, the effectiveness of the schedule should depend on ensuring that the schedule constraints conflict with the typical (baseline) response distributions. Neither long-term denial of the contingent response nor the relative probability of the responses involved is critical. The key is to determine the typical responding for individuals (or groups) and to impose a contingency schedule that disrupts it appropriately.

Several studies support this interpretation. In a well-controlled experiment on behavioral contracting, Dougher (1983) specifically tested the conditions of response deprivation (response deficit) and response satiation (response excess) of coffee drinking as controllers of inappropriate behavior by hospitalized adult schizophrenics. Rates of obscene responses were decreased and rates of appropriate responses were increased by requiring either a decrease or an increase of responding to maintain baseline coffee drinking. Dougher pointed out that the techniques of satiation and deprivation were relatively nonintrusive, yet they led to powerful and predictable control of behavior.

MacDonald, Gallimore, and MacDonald (1970) used adult mediators to control access to reinforcing activities for high school truants. No explicit baseline rates of responses were obtained; rather, agreements were made between the mediators and the high school students about what preferred activities were to be provided, contingent on school attendance. The schedule imposed by the mediators specified relatively more school attendance than access to the preferred response, a distribution of responding probably the reverse of their baselines. As a result of the program, attendance at school greatly increased.

Finally, Barrish et al. (1969) used the good behavior game to change out-of-seat behavior and talking-out behavior in a fourth-grade class. Following baseline, the class was divided into two teams, and a group consequence was imposed for the fewest inappropriate behaviors. The team with the fewest examples of the target behavior was allowed to line up first for lunch and do special projects. Rather than directly constraining the baseline rates of individuals, Barrish et al. (1969) changed individual behavior by imposing relative constraints on the group baseline.

All of these studies support the disequilibrium view by showing that the probability of a target response can be changed by constraining the occurrence of a contingent response relative to its typical or inferred level. It is worth noting that few applied studies measure the baseline of unconstrained responding, especially a baseline including free access to the contingent response. Instead, informal observations or interviews with subjects are often used to indicate the general importance of the responses. Recognizing the relevance of the disequilibrium analysis may encourage measurement of free baseline with likely increases in predictive accuracy and control.

There are several other potential benefits of the disequilibrium analysis. For example, it should facilitate the setting of schedule values designed to produce the desired direction of reinforcement. The disequilibrium interpretation should also encourage the use of unorthodox and nondisruptive contingent responses in changing a target response. For example, in Konarski's work (e.g., Konarski et al., 1980, 1982, 1985), the use of academic behavior as a contingent response instead of access to, for example, leisure time (e.g., Barrish et al., 1969; MacDonald et al., 1970) retains the focus on academics instead of distracting the student with access to potentially disruptive leisure responses. It might be argued that a disadvantage of using academic behavior as a contingent response is its likely reduction below baseline under the schedule requirement. However, the existing evidence is that this reduction is likely to be small, and using an external reinforcer to control classroom behavior often produces much greater competition with academic responses.

Incidental Teaching

Incidental teaching is a recently rediscovered technique used primarily to teach language and other social responses to autistic and retarded individuals (Hart & Risley, 1968, 1975; McGee, Krantz, Mason, & McClannahan, 1983; McGee et al., 1985). The basic procedure involves waiting for the subject to approach or signal a desire for a particular stimulus and then making the continuation of the subject's engagement with that stimulus contingent on increasing a target response, such as saying "please." For example, if a subject initiates responding toward a book, the practitioner (a) removes or prevents access to the book (thus constraining ongoing baseline responding) and (b) requires the subject to produce the target response (such as naming the color of the book or requesting it politely) to continue interaction with the book.

From the disequilibrium view, the incidental teaching procedure should be particularly effective because it clearly constrains access to a current, ongoing response by the immediate imposition of a schedule requirement. The resultant disequilibrium condition is clear and difficult for the subject to avoid. The results of several studies support the relative effectiveness of incidental teaching. McGee et al. (1985) compared traditional contingency procedures with incidental teaching in helping three language-delayed, autistic children to use prepositions to describe the location of preferred edibles and toys. In both procedures, access to the items was contingent on correct use of a preposition. For all 3 subjects, the incidental teaching procedure was more effective in increasing their use of prepositions, and this effect persisted outside the test situation during free play.

In a similar study, McGee et al. (1983) taught two severely language-delayed, autistic youths to label four sets of objects typically used in school lunch preparation. Access to the desired item (e.g., a knife or mayonnaise) was contingent on its verbal identification. The percentage of correct, unprompted object identifications increased markedly when the incidental teaching package was introduced.

From the viewpoint of the disequilibrium approach, the incidental teaching procedure has many advantages. The practitioner uses responses present in the ongoing flow of behavior, making the assessment of a local baseline of responding automatic, nonintrusive, and highly similar in terms of the conditions underlying baseline and the schedule application. Moreover, practically speaking, because the probability of responding is so high, a wide range of response requirements will constrain the local baseline of responding.

In addition to providing reasons for the effectiveness of incidental teaching, the disequilibrium framework suggests several potential conceptual and practical advances. Assessing a separate free baseline of overall interactions might show more clearly the performance characteristics of the responses involved and allow separation of the effect of teacher intervention from the baseline tendency to interact with the object independent of the teacher's presentation. This latter analysis should be important in predicting generalization of effects.

Considering an overall free baseline might also suggest limits on the appropriate duration and timing of an incidental teaching session as well as on the size of the instrumental requirement and contingent payoff and on the frequency with which individual presentations of access should take place. For example, if interaction with a particular set of toys was clearly limited in duration or rarely occurred during a particular time frame (e.g., following a child's nap), setting of the session and schedule terms should take into account these baseline characteristics. Sessions would not be scheduled closely following a nap, and during a session the child should be allowed only a short period of interaction per toy access.

Overcorrection: A Disequilibrium Analysis of Punishment

Overcorrection is used in many applied settings as an effective technique for eliminating unwanted behavior. In overcorrection, the circumstances in which the unwanted behavior occurred are reinstated, and the subject is required to repetitively perform a response that serves to prevent the undesired outcome. When the required response involves task-completion behavior, the procedure is termed positive practice. For example, if a child drops a glass, he or she must practice carrying the glass appropriately. In practice, the overcorrection technique may also include restitutional activities such as sweeping up broken glass.

In disequilibrium terms, the heart of overcorrection consists of imposing a punishment schedule in which occurrence of the response targeted for reduction is followed by requiring the subject to perform that response or another at a level well above its baseline. The resultant type of disequilibrium (response excess) should produce a decrease in the target response. When the contingent (overpracticed) response directly interferes with reoccurrence of the undesired outcome, there should be an added effect of competition for expression in decreasing the unwanted response. For example, each time a young girl slams the door when entering the house, she is required to close the door quietly 10 times in succession. Eventually closing the door quietly should come to compete effectively with slamming.

Several studies support a disequilibrium interpretation of overcorrection. Rolider and Van Houten (1985) required mentally retarded children who engaged in poking or self-injurious behavior to suppress movement for a fixed time. No baseline of movement suppression was measured, but we assume it was low. As would be expected from the disequilibrium analysis, when a requirement of movement suppression was made contingent on inappropriate responding, the level of unwanted self-injurious behavior greatly decreased. Requiring the patients to repeat the movement suppression response well above its baseline served to decrease responses on which it was made contingent.

Carey and Bucher (1981) used related and unrelated contingent practice in an attempt to decrease food-related accidents and inappropriate puzzle responses by mentally retarded subjects. In the related-practice condition, food accidents were followed by food-practice responses, and inappropriate puzzle responses were followed by appropriate puzzle responses. In the unrelated practice conditions the contingent responses were reversed. The target responses decreased in all cases, but when the practiced response was related to the inappropriate instrumental response, the contingency was more effective in reducing the unwanted response.

As was the case for the other empirical procedures, conceptualizing the overcorrection procedure in a disequilibrium framework has several potential advantages. Knowledge of baseline levels of both the instrumental and contingent responses should increase the accuracy of setting the schedule terms and may suggest limits on the duration of the practice period. An important part of overcorrection may be a practice effect that differentiates the response and its stimulus control more effectively but, still, the causal context for the practice is the condition of response excess. For the subject to perform the contingent response at its typical (baseline) level, the unwanted behavior must be decreased.

Note that from a disequilibrium view, overcorrection is conceptually similar to more traditional punishment contingencies, such as delivery of a negative stimulus or withdrawal of a positive stimulus. Requiring a subject to engage in door closing to excess produces a punishing stimulus condition at least somewhat similar to that produced by verbal sanctions ("you are bad") or withdrawing privileges. A potential advantage of the overcorrection procedure, though, is that its focus is exclusively on the undesired response. In the more traditional punishment procedures, the distraction produced by imposing punishment stimuli unrelated to the circumstances may produce unwanted side effects interfering with the desired result. Finally, results such as those of Carey and Bucher (1981) showing an effect of relevant practice indicate the importance of adding some concept of behavioral organization to the disequilibrium approach.

Limitations on and Extensions of the Disequilibrium Approach

The basic and applied research cited in this article provide strong evidence that the disequilibrium model is more accurate and useful than either the transituational-reinforcer hypothesis or the probability-differential hypothesis. That considerable data support these last two hypotheses is not strong evidence for their continued use. These same data support the disequilibrium model. Most important, considerable data are predicted only by the disequilibrium model, explicitly contradicting the predictions of the transituational-reinforcer and probability-differential hypotheses.

This is certainly not to argue, though, that the disequilibrium approach is without flaw. As with any theoretical conception, the disequilibrium approach has awkward points, limitations, and inaccuracies. Put bluntly, there are times it predicts reinforcement and there is none, and times it predicts no reinforcement and changes in responding occur. Most of its shortcomings, though, appear related to needed further development in the precise modeling of the motivational and organizational determinants of responding. As a result, there is considerable opportunity for collaboration between basic and applied researchers to produce further conceptual and empirical advances.

A point of some importance is how best to measure a baseline. Baselines serve multiple functions, including providing information about the organization and levels of free responding, improving the accuracy of setting schedules, and acquainting the subject with the response possibilities in the situation. In short, stable baselines appear to be the most accurate and effective way of assessing the motivational control of behavior in a particular situation. Applying a schedule in the same circumstances as a stable baseline is measured will allow much more accurate prediction of results because the basic instigation of responding remains the same from baseline to contingency.

As noted earlier, however, establishing stable baselines can be very time-consuming. Thus, to the extent that a practitioner is concerned largely with the direction rather than the precise amount of the reinforcement effect, estimates of baselines from questionnaires or observation may be adequate (Bernstein, 1986; Bernstein & Michael, 1990). Furthermore, to the extent that the practitioner is interested in momentary effects (such as in incidental teaching), an ongoing "instantaneous" assessment of baseline may be adequate.

A second point is that behavior under a contingency schedule is clearly more complexly determined than allowed for by the simple two-response, regulatory processes emphasized in experimental tests of the disequilibrium approach (see the commentaries following Timberlake, 1984, and Aeschelman & Williams, 1989a). This need for increased complexity has the side-effect of de-emphasizing the importance of current quantitative models of schedule responding (e.g., Allison, 1976, 1981; Hanson & Timberlake, 1983; Mazur, 1975; Rachlin & Burkhard, 1978; Staddon, 1979; Timberlake, 1971, 1984). Although these models have fitted simple data in laboratory settings, in the long run we believe that a more complete conception of how baseline behavior is determined must be developed to generate more complex quantitative models.

A critical practical issue requiring further consideration and development is the sensitivity of subjects to particular disequilibrium conditions and the time frame and complexity of the motivational processes that underlie particular responses. For example, rats may not be as sensitive to deficit conditions in contingent wheel-running as in contingent drinking (Timberlake & Wozny, 1979). These effects have been labeled *resistance to change, substitutability,* or *cost-of-deviation* in general regulatory and economic accounts (Hanson & Timberlake, 1983; Rachlin & Burkhard, 1978; Staddon, 1979).

In terms of time frames, there are some surprising limits on the integration of responding across time. For example, rats do not appear to track local deficits across time intervals much longer than 16 min and so may not regulate responding with respect to baselines in larger temporal windows (Timberlake, Gawley, & Lucas, 1987). These results make potential contact with issues of self-control and economic decision making in humans, issues which show highly time-sensitive effects on decisions among alternatives (e.g., Logue, 1988).

Other research has indicated complex interactions of schedule constraints with particular instrumental and contingent responses. Gawley et al. (1986) and Gawley, Timberlake, & Lucas, (1987) found that slightly disrupting the drinking of rats significantly decreased their baseline intake, whereas forcing rats to markedly alter their pattern and amount of running in order to drink did not affect their free running (see also Tierney, Smith, & Gannon, 1987, and perhaps Allison, Buxton, & Moore, 1987). This is reminiscent of the tendency of Kavanau's (1963) deer mice to work to turn off a wheel that was rotating and turn on a wheel that was locked.

In a similar vein, Timberlake and Peden (1987) showed nonmonotonic functions relating instrumental keypecking in pigeons to the type of schedule and the density of reward. These functions were generally bitonic, with relatively similar peak points when reward density was scaled against baseline intake. Such data may have relevance to giving up when confronted with a schedule for access to preferred circumstances as well as to the paradoxical effect of more frequent reward in increasing disruptive behavior in family therapy situations (Viken & McFall, 1990).

Anecdotal accounts of complexity in the behavior of humans abound, but more controlled investigations are less prevalent. One issue concerns the potential long-term "side effects" of reinforcement schedules. In some cases, a brief exposure to a contingency schedule changes baseline levels of responding. Many researchers (see Dickinson, 1989; Lepper & Greene, 1978) have shown that in some cases the baseline of instrumental responding can be decreased by rewarding that response. At the same time, the baseline of a response also can be increased by previous experience with contingent control (Lepper & Greene, 1978). Carefully defining and differentiating the conditions controlling these effects on baseline responding is clearly critical to the use of reinforcement in applied settings.

There also are specific reactions to constraint in humans (as well as in other animals; e.g., Kavanau, 1963). Bernstein (1986) reported that subjects in 24-hr environments, if allowed to, worked to accumulate unused access to a contingent response. Humans, as clever and recalcitrant a primate as exists, frequently go to great lengths to subvert application of a contingency schedule to their behavior, even a contingency schedule that is self-imposed. Thus, for pragmatic as well as ethical reasons, it seems preferable in most circumstances to obtain a participant's agreement to abide by the terms of the contingency.

Finally, as pointed out by several researchers (Aeschelman & Williams, 1989a; Bernstein & Ebbesen, 1978; Diorio & Konarski, 1989; Rachlin & Burkhard, 1978), the results of a contingency may depend heavily on the other responses present. If there is a free response that readily substitutes for the contingent response, the schedule may not change instrumental responding because the subject engages in the substitute response. For example, requiring a subject to increase sewing to read fiction may simply produce an increase in freely available nonfiction reading.

Contrary to what has been claimed by some investigators (e.g., Fuqua, 1989), such results are neither surprising nor damaging within a disequilibrium approach. These results do, nevertheless, point to the theoretical and practical importance of developing a more complex characterization of the motivational structure of the subject. There remains a critical journey between simple regulatory assumptions applied to two responses in the laboratory and the complex life space of most humans, but the beginning has proved useful, and its further development appears possible (e.g., Winkler & Burkhard, 1990).

For now, we think the simple specification of the conditions of disequilibrium is the most useful starting point in figuring out ahead of time the circumstances of reinforcement in applied settings (Timberlake, 1980, 1984). Further improvements in specifying the circumstances and effects of reinforcement will depend on the development of more complex models of the systems underlying organized behavior and their interaction with external constraints (Timberlake & Lucas, 1989). Both applied and basic research settings appear able to contribute to the development of such models (Aeschelman & Williams, 1989b).

Conclusions

This article traced the transition from the traditional view of reinforcers as transituational causal stimuli through the probability-differential theory of Premack to the disequilibrium approach. This transition involved important changes in basic theoretical assumptions and procedures. The idea that reinforcers and punishers are unique sets of stimuli was rejected, along with the concept of a stable reinforcer hierarchy and the idea that long-term denial of access to a commodity is critical for reinforcement.

In the disequilibrium approach the circumstances of reinforcement and punishment arise out of schedule constraints on the free baseline distribution of responding. Outcomes of reinforcement, punishment, and no effect can be produced within the same response–contingency relation and setting conditions by changing the conflict imposed by the schedule terms. Neither a contingent response of higher overall probability nor long-term deprivation of that response or commodity is necessary or sufficient to produce reinforcement.

In the progression from transituational reinforcers to the disequilibrium approach, the ability to predict reinforcement has become more precise. Each succeeding conception predicted the data used to support the preceding view while adding new, more accurate, predictions. For example, Premack's probability-differential hypothesis predicts transituationality if the reinforcing stimulus controls access to the higher probability response but predicts reversibility of reinforcement if the overall response probabilities are reversed. The disequilibrium approach predicts the same effects as Premack's probability-differential hypothesis when the higher probability response is constrained relative to baseline. However, the disequilibrium approach appropriately contradicts Premack's hypothesis when access to the lower probability response is constrained or when access to the higher probability response is not constrained.

Another advantage of the disequilibrium approach is its relative ease of use in applied settings. Compared with inserting a general reinforcer such as food in a situation, the arranging of contingency schedules relating available responses (a) provides a wider range of rewards and punishers; (b) avoids ethical concerns about long term withholding of "reinforcers" such as food; (c) reduces evoked behaviors such as food begging and aggression that may interfere with the targeted response; and (d) more closely approximates and generalizes to other common conditions.

The disequilibrium approach is not without its limitations and criticisms by both basic and applied researchers (see the commentaries following Aeschelman & Williams, 1989a, and Timberlake, 1984). Some of these criticisms appear to be based on misunderstandings about the conceptual underpinnings of the disequilibrium approach. Other objections, however, are directed at the lack of extended development, including better specification of the determinants of baseline responding, the differential sensitivity to disequilibrium conditions of particular responses and their combinations, and application of a disequilibrium analysis to complex choice situations. Most of these latter objections appear potentially correctable by further development of disequilibrium analyses of the determinants of behavior.

Konarski et al. (1981) raised the objection that insufficient published data exist to evaluate the model across a variety of applied settings, responses, and populations, especially because the approach requires investment in a systematic baseline methodology before it can be applied. However, in several careful analyses of disequilibrium predictions in applied settings, Konarski and his co-workers have provided considerable data to support an improvement in accuracy of prediction and control relative to that provided by previous approaches (e.g., Diorio & Konarski, 1989; Konarski, 1987; Konarski et al., 1980, 1982, 1985). Others have provided similar data (Aeschelman & Williams, 1989a; Dougher, 1983; Holburn & Dougher, 1986).

Finally, as with any attempt to develop applications from a conceptual analysis, experienced practitioners will question whether their educated "seat-of-the-pants" pragmatism developed over years of practice is not just as good as, if not better than, the conceptually grounded disequilibrium approach. One answer is that "seat-of-the-pants" pragmatism works much less well than a clear conceptual approach when practitioners are inexperienced and working under time pressures in unfamiliar situations with unfamiliar responses and subjects. Furthermore, we anticipate that a careful analysis of "seat-of-the-pants" predictions will turn up implicit procedures and assumptions compatible with the disequilibrium analysis. Thus, if a disequilibrium analysis were taught, it could provide a shortcut to the experience that is so costly and time-consuming to obtain. The ideal combination would be a practitioner both familiar with the disequilibrium approach and experienced with the setting, the response repertoire, and the motivational systems of the client.

In summary, the disequilibrium approach more accurately identifies the circumstances of reinforcement ahead of time than previous notions of transituational reinforcers and a probability differential between responses. It is also more flexible in terms of response measurement and the absence of a requirement of long-term deprivation as a setting condition. The disequilibrium approach argues against generally valid reinforcers or probability differentials between responses. Access to a response (and stimulus) regardless of its type or relative probability is inherently neither reinforcing nor punishing. Rather, reinforcing and punishing effects depend on the extent to which a contingency schedule constrains the free distribution of responding, combined with structural and motivational characteristics of the organism. The increased complexity of causality in the disequilibrium approach, instead of limiting the application of behavioral principles to human behavior, seems to us to increase the potential predictability and flexibility of the practice of behavior control in applied settings. In a reciprocal manner, the increased use of the disequilibrium approach in applied settings should compel the development of more complexity in the way behavior is studied in basic research settings.

References

Aeschelman, S. R., & Williams, M. L. (1989a). A test of the response deprivation hypothesis in a multiple-response context. *American Journal on Mental Retardation, 93,* 345–353.

Aeschelman, S. R., & Williams, M. L. (1989b). Rebuilding burned bridges: Analysis returns to applied behavior analysis. *American Journal on Mental Retardation, 93,* 345–353.

Allison, J. (1976). Contrast, induction, facilitation, suppression, and conservation. *Journal of the Experimental Analysis of Behavior, 25,* 185–199.

Allison, J. (1981). Economics and operant conditioning. In P. Harzem & M. D. Zeiler (Eds.), *Advances in analysis of behaviour: Vol. 2. Predictability, correlation and contiguity* (pp. 321–353). Chichester, England: Wiley.

Allison, J., Buxton, A., & Moore, K. E. (1987). Bliss points, stop lines, and performance under schedule constraint. *Journal of Experimental Psychology: Animal Behavior Processes, 13,* 331–340.

Allison, J., & Timberlake, W. (1974). Instrumental and contingent saccharin licking in rats: Response deprivation and reinforcement. *Learning and Motivation, 6,* 122–142.

Allison, J., & Timberlake, W. (1975). Response deprivation and instrumental performance in the controlled-amount paradigm. *Learning and Motivation, 6,* 112–142.

Atkinson, R. L., Atkinson, R. C., Smith, E. E., & Bem, D. J. (1990). *Introduction to psychology.* New York: Harcourt Brace Jovanovich.

Barrish, H. H., Saunders, M., & Wolf, M. M. (1969). Good behavior game: Effects of individual contingencies for group consequences on disruptive behavior in the classroom. *Journal of Applied Behavior Analysis, 2,* 119–124.

Bernstein, D. J. (1986). Correspondence between verbal and observed estimates of reinforcement value. In P. N. Chase & L. W. Parrott (Eds.), *Psychological aspects of language: The West Virginia lectures* (pp. 187–205). Springfield, IL: Charles C Thomas.

Bernstein, D. J., & Ebbesen, E. B. (1978). Reinforcement and substitution in humans: A multiple response analysis. *Journal of the Experimental Analysis of Behavior, 30,* 243–253.

Bernstein, D. J., & Michael, R. L. (1990). The utility of verbal and behavioral assessments of value. *Journal of the Experimental Analysis of Behavior, 54,* 173–184.

Carey, R. G., & Bucher, B. (1981). Identifying the educative and suppressive effects of positive practice and restitutional overcorrection. *Journal of Applied Behavior Analysis, 14,* 71–80.

Catania, A. C. (1984). *Learning.* Englewood Cliffs, NJ: Prentice-Hall.

Dattilo, J. (1986). Computerized assessment of preference for severely handicapped individuals. *Journal of Applied Behavior Analysis, 19,* 445–448.

Dickinson, A. M. (1989). The detrimental effects of extrinsic reinforcement on "intrinsic motivation." *Behavior Analyst, 12,* 1–15.

Diorio, M. S., & Konarski, E. A., Jr. (1989). Effects of a freely available response on the schedule performance of mentally retarded persons. *American Journal on Mental Retardation, 93,* 373–379.

Donnellan, A. M., LaVigna, G. W., Negri-Shoultz, N., & Fassbender, L. L. (1988). *Progress without punishment: Effective approaches for learners with behavior problems.* New York: Teachers College Press.

Dougher, M. J. (1983). Clinical effects of response deprivation and response satiation procedures. *Behavior Therapy, 14,* 286–298.

Dunham, P. (1977). The nature of reinforcing stimuli. In W. K. Honig & J. E. R. Staddon (Eds.), *Handbook of operant behavior* (pp. 98–124). Englewood Cliffs, NJ: Prentice-Hall.

Egel, A. L. (1981). Reinforcer variation: Implications for motivating developmentally disabled children. *Journal of Applied Behavior Analysis, 14,* 345–350.

Eisenberger, R., Karpman, M., & Trattner, J. (1967). What is the sufficient condition for reinforcement in the contingency situation? *Journal of Experimental Psychology, 74,* 342–350.

Epstein, R. (1985). The positive side effects of reinforcement: A commentary on Balsam and Bondy (1983). *Journal of Applied Behavior Analysis, 18,* 73–76.

Foltin, R. W., Fischman, M. W., Brady, J. V., Bernstein, D. J., Capriotti, R. M., Nellis, M. J., & Kelly, T. H. (1990). Motivational effects of smoked marijuana: Behavioral contingencies and low-probability activities. *Journal of the Experimental Analysis of Behavior, 53,* 5–19.

Fuqua, R. W. (1989). Response deprivation: The same wine in a new bottle? *American Journal on Mental Retardation, 93,* 373–379.

Gardner, R. A., & Gardner, B. T. (1988). Feedforward versus feedbackward: An ethological alternative to the law of effect. *Behavioral and Brain Sciences, 11,* 429–446.

Gawley, D., Timberlake, W., & Lucas, G. (1986). Schedule-constraint of average drink-burst length and the regulation of wheel running and drinking in rats. *Journal of Experimental Psychology: Animal Behavior Processes, 12,* 78–94.

Gawley, D., Timberlake, W., & Lucas, G. (1987). System-specific differences in behavior regulation: Overrunning and underdrinking in molar nondepriving schedules. *Journal of Experimental Psychology: Animal Behavior Processes, 13,* 354–365.

Green, C. W., Reid, D. H., White, L. K., Halford, R. C., Brittain, D. P., & Gardner, S. M. (1988). Identifying reinforcers for persons with profound handicaps: Staff opinion versus systematic assessment of preferences. *Journal of Applied Behavior Analysis, 21,* 31–43.

Hanson, S. J., & Timberlake, W. (1983). Regulation during challenge: A general model of learned performance under schedule constraint. *Psychological Review, 90,* 261–282.

Hart, B. M., & Risley, T. R. (1968). Establishing the use of descriptive adjectives in spontaneous speech of disadvantaged preschool children. *Journal of Applied Behavior Analysis, 1,* 109–120.

Hart, B. M., & Risley, T. R. (1975). Incidental teaching of language in the preschool. *Journal of Applied Behavior Analysis, 8,* 411–420.

Hawkins, G. D. (1989). Yes context matters: Behavior analysis is maturing. *American Journal on Mental Retardation, 93,* 357–360.

Heth, C. D., & Warren, A. G. (1978). Response deprivation and response satiation as determinants of human instrumental performance. *Animal Learning and Behavior, 6,* 294–300.

Holburn, C. S., & Dougher, M. J. (1986). Effects of response satiation procedures in the treatment of aerophagia. *American Journal of Mental Deficiency, 91,* 72–77.

Hopkins, B. L., Schutte, R. C., & Garton, K. L. (1971). The effects of access to a playroom on the rate and quality of printing and writing of first and second-grade students. *Journal of Applied Behavior Analysis, 4,* 77–87.

Jacobsen, N. S., & Margolin, G. (1979). *Marital therapy: Strategies based on social learning and behavior exchange principles.* New York: Brunner/Mazel.

Kavanau, J. L. (1963). Compulsory regime and control of environment in animal behavior: I. Wheel-running. *Behavior, 20,* 251–281.

Kazdin, A. L. (1980). *Behavior modification in applied settings.* Homewood, IL: Dorsey Press.

Kazdin, A. E. (1982). The token economy: A decade later. *Journal of Applied Behavior Analysis, 15,* 431–445.

Kazdin, A. L., & Bootzin, R. R. (1972). The token economy: An valuative review. *Journal of Applied Behavior Analysis, 5,* 343–372.

Kelly, M. L., & Stokes, T. F. (1982). Contingency contracting with disadvantaged youths: Improving classroom performance. *Journal of Applied Behavior Analysis, 15,* 447–454.

Konarski, E. A. (1985). The use of response deprivation to increase the academic performance of educationally mentally retarded students. *The Behavior Therapist, 8,* 61.

Konarski, E. A., Jr. (1987). Effects of response deprivation on the instrumental performance of mentally retarded persons. *American Journal of Mental Deficiency, 91,* 537–542.

Konarski, E. A., Jr. (1989). Toward a functional approach to learned performance. *American Journal on Mental Retardation, 93,* 360–362.

Konarski, E. A., Crowell, C. R., & Duggan, L. M. (1985). The use of response deprivation to increase the academic performance of EMR students. *Applied Research in Mental Retardation, 6,* 15–31.

Konarski, E. A., Crowell, C. R., Johnson, M. R., & Whitman, T. L. (1982). Response deprivation, reinforcement and instrumental academic performance in an EMR classroom. *Behavior Therapy, 13,* 94–102.

Konarski, E. A., Johnson, M. R., Crowell, C. R., & Whitman, M. L. (1980). Response deprivation and reinforcement in applied settings: A preliminary analysis. *Journal of Applied Behavior Analysis, 13,* 595–609.

Konarski, E. A., Jr., Johnson, M. R., Crowell, C. R., & Whitman, T. L. (1981). An alternative approach to reinforcement for applied researchers: Response deprivation. *Behavior Therapy, 12,* 653–666.

Lattal, K. A. (1969). Contingency management of toothbrushing behavior in a summer camp for children. *Journal of Applied Behavior Analysis, 2,* 195–198.

Lepper, M. R., & Greene, D. (1978). Divergent approaches to the study of rewards. In M. R. Lepper & D. Greene (Eds.), *The hidden costs of reward: New perspectives on the psychology of human motivation* (pp. 217–244). Englewood Cliffs, NJ: Erlbaum.

Logue, A. W. (1988). Research on self-control: An integrating framework. *Behavioral and Brain Sciences, 11,* 665–679.

MacDonald, W. S., Gallimore, R., & MacDonald, G. (1970). Contingency counseling by school personnel: An economical model of intervention. *Journal of Applied Behavior Analysis, 3,* 175–182.

Mason, S. A., McGee, G. G., Farmer-Dougan, V., & Risley, T. R. (1989). A practical strategy for ongoing reinforcer assessment. *Journal of Applied Behavior Analysis, 22,* 171–179.

Mazur, J. E. (1975). The matching law and quantifications related to Premack's principle. *Journal of Experimental Psychology: Animal Behavior Processes, 104,* 374–386.

McDowell, J. J. (1982). The importance of Herrnstein's mathematical statement of the law of effect for behavioral therapy. *American Psychologist, 37,* 771–779.

McGee, G. G., Krantz, P. J., Mason, D., & McClannahan, L. E. (1983). A modified incidental-teaching procedure for autistic youth: Acquisition and generalization of receptive object labels. *Journal of Applied Behavior Analysis, 16,* 329–338.

McGee, G. G., Krantz, P. J., & McClannahan, L. E. (1985). The facilitative effects of incidental teaching on preposition use by autistic children. *Journal of Applied Behavior Analysis, 18,* 17–31.

Medland, M. B., & Stachnik, T. J. (1982). Good behavior game: A replication and systematic analysis. *Journal of Applied Behavior Analysis, 5,* 45–51.

Meehl, P. E. (1950). On the circularity of the law of effect. *Psychological Bulletin, 45,* 52–75.

Pace, G. M., Ivancic, M. T., Edwards, G. L., Iwata, B. A., & Page, T. J. (1985). Assessment of stimulus preference and reinforcer value with profoundly retarded individuals. *Journal of Applied Behavior Analysis, 18,* 249–256.

Podsakoff, P. M. (1980). *Performance models, microeconomics, and schedule behavior in humans.* Unpublished doctoral dissertation, Indiana University, Bloomington.

Premack, D. (1959). Toward empirical behavioral laws: Instrumental positive reinforcement. *Psychological Review, 66,* 219–233.

Premack, D. (1963a). Rate differential reinforcement in monkey manipulation. *Journal of the Experimental Analysis of Behavior, 6,* 81–89.

Premack, D. (1963b). Prediction of the comparative reinforcement values of running and drinking. *Science, 139,* 1062–1063.

Premack, D. (1965). Reinforcement theory. In D. Levine (Ed.), *Nebraska Symposium on Motivation* (pp. 123–180). Lincoln: University of Nebraska Press.

Premack, D. (1971). Catching up with common sense or two sides of a generalization: Reinforcement and punishment. In R. Glaser (Ed.), *The nature of reinforcement* (pp. 121–150). San Diego, CA: Academic Press.

Rachlin, H. C., Battalio, R., Kagel, J., & Green, L. (1981). Maximization theory in behavioral psychology. *Behavioral and Brain Sciences, 4,* 371–417.

Rachlin, H. C., & Burkhard, B. (1978). The temporal triangle: Response substitution in instrumental conditioning. *Psychological Review, 85,* 22–45.

Rolider, R., & Van Houten, R. (1985). Movement suppression time-out for undesirable behavior in psychotic and severely developmentally delayed children. *Journal of Applied Behavior Analysis, 18,* 275–288.

Staddon, J. E. R. (1979). Operant behavior as adaptation to constraint. *Journal of Experimental Psychology: General, 108,* 48–67.

Sulzer-Azeroff, B., & Mayer, R. (1977). *Applying behavior-analysis procedures with children and adults.* New York: Holt, Rinehart & Winston.

Terrace, H. S. (1963). Discrimination learning with and without "errors." *Journal of the Experimental Analysis of Behavior, 6,* 1–27.

Tierney, K. J., Smith, H. V., & Gannon, K. N. (1987). Some tests of molar models of instrumental performance. *Journal of Experimental Psychology: Animal Behavior Processes, 13,* 341–353.

Timberlake, W. (1971). *Toward a theory of the motivational determinants of positive reinforcement behavior.* Unpublished paper, Indiana University, Bloomington.

Timberlake, W. (1980). A molar equilibrium theory of learned performance. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 14, pp. 1–58). San Diego, CA: Academic Press.

Timberlake, W. (1984). Behavior regulation in learned performance: Some confusions and misapprehensions. *Journal of the Experimental Analysis of Behavior, 41,* 355–375.

Timberlake, W., & Allison, J. (1974). Response deprivation: An empirical approach to instrumental performance. *Psychological Review, 81,* 146–164.

Timberlake, W., Gawley, D. J., & Lucas, G. (1987). Time horizons in rats foraging for food in temporally separated patches. *Journal of Experimental Psychology: Animal Behavior Processes, 13,* 302–309.

Timberlake, W., & Lucas, G. A. (1989). Behavior systems and learning: From misbehavior to general principles. In S. B. Klein & R. R. Mowrer (Eds.), *Contemporary learning theories: Instrumental conditioning theory and the impact of biological constraints on learning* (pp. 237–275). Hillsdale, NJ: Erlbaum.

Timberlake, W., & Peden, B. F. (1987). On the distinction between open and closed economies. *Journal of the Experimental Analysis of Behavior, 48,* 35–60.

Timberlake, W., & Wozny, M. (1979). Reversibility of reinforcement between eating and running by schedule changes: A comparison of models. *Animal Learning and Behavior, 7,* 461–469.

Viken, R., & McFall, R. M. (1990, November). *Paradox lost: Implications of the response deprivation/behavior systems approach for family therapy.* Paper presented at the meetings of the Association for the Advancement of Behavior Therapy, San Francisco.

Wacker, D. P., Berg, W. K., Wiggins, B., Muldoon, M., & Cavanaugh, J. (1985). Evaluation of reinforcer preferences for profoundly handicapped students. *Journal of Applied Behavior Analysis, 18,* 173–178.

Winkler, R. C., & Burkhard, B. (1990). A systems approach to behavior modification through behavioral economics. In L. Green & J. H. Kagel (Eds.), *Advances in behavioral economics* (Vol. 2, pp. 288–315). Norwood, NJ: Ablex.

Received March 20, 1990
Revision received March 11, 1991
Accepted April 17, 1991 ■