that occur immediately prior to the increase in frequency of the avoidance response?

We realize that this issue may be uninteresting or even improper from a strongly molar orientation, and it may seem much too mechanistic (in a ''push-pull'' sense) to those who favor contextual or selectivist worldviews. Dinsmoor (2001) does not seem to fall into either of those categories, and his approach to the issue of momentary response evocation would be very interesting to us. In any case, we found his article to be clear and scholarly, and an important contribution to the field of behavior analysis.

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EXPLAINING AVOIDANCE: TWO FACTORS ARE STILL BETTER THAN ONE

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Two-factor theory remains a viable account of avoidance behavior. By emphasizing the interplay of respondent and operant contingencies, two-factor theory encourages the analysis of stimuli that mediate molar consequences and incorporates control by local events as well as events that are temporally remote, improbable, or cumulative.

Key words: avoidance, two-factor theory, single-factor theory, shock-frequency reduction, molar account, molecular account, timeout from avoidance

The challenge posed by avoidance behavior is to account for anticipation of future aversive events without recourse to mentalisms or to hypothetical emotional and physiological processes. Dinsmoor's (2001) scholarly analysis of the animal learning literature demonstrates that after more than a half-century of research, discussion, and theoretical controversy, a consensus remains to be reached. In his article, Dinsmoor reviews and expands the version of the two-factor theory of avoidance that he has espoused over the years (cf. Dinsmoor, 1954, 1977). He presents a convincing case for the value of including Pavlovian as well as operant mechanisms in the account and disposes of what appears to be a common misunderstanding: Acknowledgment of the role of Pavlovian contingencies should not be taken to imply that two-

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factor theory requires the conditioning of a fear drive or the reinforcement of avoidance behavior through the reduction of fear.

Dinsmoor (2001) also points to the experimental analysis of aversive control as a testing ground for molar and molecular accounts of behavior in general. In the case of avoidance, a molar account seems to be needed because responding is maintained in the absence of immediate reinforcement. Much of the theorizing has been prompted by Sidman's schedule (Sidman, 1953), which marked a significant departure from the discrete-trial procedures that were the impetus for traditional versions of two-factor theory. In Sidman's free-operant procedure, responses emitted at any time postpone unsignaled shocks. When avoidance behavior is proficient, the environment after a response seems to be no different from the environment before: Both are free of shocks and responding has no obvious contiguous consequence. Either the molecular consequences are inconspicuous (as posited by two-factor theory) or, by default, the maintenance of behavior must be attributed to molar factors such as a more general correlation between responding and the receipt of shock (single-factor theory).

Dinsmoor (2001) neatly solves the riddle by pointing to an inevitable molecular consequence of the avoidance response: the kinesthetic and tactile stimuli that always accompany the response itself. These events (plus whatever exteroceptive stimuli that may distinguish shock periods from shock-free periods) are at the basis of his comprehensive analysis. The versatility of his approach is particularly impressive in his treatment of findings when a stimulus precedes the shock, results that have been presented as a major embarrassment for two-factor theory (Hineline, 1981). If the signal is aversive, why does the animal delay responding until it appears rather than taking the opportunity to postpone the signal as well as the shock? Dinsmoor's analysis makes the answer obvious: "[Presignal] responses do not produce a change in the exteroceptive stimuli from ones that are positively correlated (warning) to ones that are negatively correlated (safety) with the shock" (p. 325).

An overriding issue in the molar–molecular debate—one not discussed by Dinsmoor (2001)—pertains to the heuristic value of either account. Molar accounts are not to everyone's taste. Whatever their virtues (parsimony, absence of appeals to inferred events), they may have the unintended consequence of undermining the search for the variables that control specific instances of behavior (see Baron & Herpolsheimer, 1999; Baron & Perone, 1998; Perone & Galizio, 1987). The problem is particularly apparent when avoidance is attributed to the shock reduction that accompanies responding. It is hard to distinguish the question ("What reinforces avoidance behavior?") from the answer ("Shocks are reduced."). Of course, shocks *are* reduced, but what else could we mean by avoidance? From this standpoint, the single-factor account is subject to the same criticism that behaviorists have directed toward the use of "expectancy" as an explanatory mechanism. To refer to avoidance as a manifestation of expectant behavior is more a restatement of the behavior in need of explanation than a specification of the variables that control it. These divergent views reflect, no doubt, different conceptions of what constitutes a proper explanation. As Dinsmoor's article attests, they will continue to be debated.

Even if one is willing to take the molar account on its own terms, questions remain about the shock-rate differences that are so vital to the explanation. As Dinsmoor (2001) points out, the rates cannot be assigned a specific locus in time because frequency is always declining except for the points when shocks are delivered. Another area of imprecision pertains to the rates in the animal's history that are being used as the standard of comparison. Are they the rates that accompanied the previous shock–shock intervals (Anger, 1963), the rates for the last session, or the rates from several weeks ago? The shock–shock intervals of the warm-up period for the same session might seem a likely candidate. However, researchers have reported persistent avoidance even when shocks during the warm-up period are infrequent. For example, signaled shock successfully eliminates the warm-up without impairing subsequent avoidance (Ulrich, Holz, & Azrin, 1964).

Dinsmoor (2001) rightly criticizes the single-factor theory by describing the logical and conceptual problem of attempting to specify contingencies between responding and shock-frequency reduction. The avoidance literature points to empirical ones as well. Hineline has suggested that the problematic cases do not put molar theories to rest, but instead raise a new question: ''Rather than trying to establish either the molar or molecular view as correct, the point [is] to discover what determines the scale of process. That is, under what circumstances is behavior sensitive to its more remote consequences, as contrasted with its more immediate ones?'' (Hineline, personal communication, May 1989, as quoted in Pierce & Epling, 1995, p. 250). Hineline has related the differences between molar and molecular scales of analysis to adjustments in the resolution of the observational tools: ''When one looks at the same object through a microscope using various magnifications one will see a variety of configurations, and each of the orderly relationships is real and valid, irrespective of what is observed at other scales of magnification'' (1986, p. 76).

We applaud efforts to arrive at a rapprochement between divergent theoretical views, but it is important to distinguish between causation (suggested in the first quote from Hineline) and correlation (suggested in the second). Orderly relations can be detected on a molar scale, as shown by the successful application of the matching law to describe the relation between avoidance response rates and shock-frequency reduction (e.g., Logue & de Villiers, 1978). But these correlations do not necessarily establish the causal mechanisms at play. We note that research on matching between rates of responding and positive reinforcement—surely one of the most intensively studied phenomena in the experimental analysis of behavior—has been characterized by vigorous debate about whether the matching law describes a causal process operating at a molar scale or an outcome of more molecular processes. In recent years, the balance has tipped in favor of the latter interpretation (e.g., Davison & Baum, 2000). A similar reevaluation of avoidance seems to be overdue.

We do not doubt that there is a range over which events distributed in time can exert an effect on behavior. But there is reason to believe that the range is more limited than that which would be required if shock-frequency reduction is to function as a significant source of reinforcement for avoidance. One line of evidence comes from Herrnstein and Hineline's (1966) classic experiment, widely cited as the paradigm case of shock-frequency reduction. The procedure, which was designed to eliminate all response-contingent events except the change in shock rate, exposed rats to a series of shocks at irregular intervals. A single lever press transferred control from this imposed schedule to an alternate one that arranged shocks at a lower rate. In the conditions that maintained the highest response rates, the imposed intershock intervals averaged 4 s and the alternate intervals averaged 20 s. In other conditions, responding was maintained by imposed-to-alternate shifts of 6.7 s to 10 s, 6.7 s to 20 s, and 10 s to 20 s. At what point on Hineline's ''scale of process'' should such consequences be placed? The effective shock differences were encountered in the short term—they averaged intershock intervals of 20 s or less—and thus seem to qualify as more molecular than molar. The shifts in the schedules were contacted in 4 s to 10 s on average, and we expect that most researchers would regard these events as relatively immediate and molecular rather than remote and molar.

Research in our laboratories has assessed the reinforcing function of shock frequencies much lower than those in Herrnstein and Hineline's (1966) experiment (e.g., Baron, DeWaard, & Lipson, 1977; Perone & Galizio, 1987). In a typical application, a rat can respond on one lever to postpone shocks and on a second lever to produce timeout from the avoidance schedule. The timeout suspends the avoidance schedule and any correlated stimuli for a minute or two. Under these circumstances, the opportunity for control by shock-frequency reduction—the transition from time-in to timeout periods—seems to be optimal because discriminative stimuli accompany the reductions, thus providing them a temporal locus.

But the evidence from the timeout-from-avoidance procedure has not supported a molar account of the results. In one experiment (Courtney & Perone, 1992), a variable-interval schedule arranged timeouts, and the parameters of the avoidance schedule were manipulated to afford varying degrees of shock-frequency reduction. Analyses based on the generalized matching law should have indicated strong relations between responding on the timeout lever and the degree of shock-frequency reduction. To the contrary, such relations were weak. Instead, responding on the timeout lever was sensitive to reductions in response effort. Production of the timeout allowed the rat to escape from a contingency that required sustained responding and to enter an alternative situation with no response requirement. The differences in sensitivity to response effort and shock fit well within a molecular account. Response rates during time-in were much higher than shock rates. Consequently, the interruption of responding by a timeout was contacted shortly after its onset, but contact with the interruption of shock depended on an accumulation of several instances of timeout (see Perone & Crawford, 1999, for the argument in detail).

An appealing feature of two-factor theory is the integration of operant and respondent processes. It is easy to forget in the search for response-contingent forms of reinforcement that avoidance procedures—confining the animal in an environment in which painful stimuli are delivered—provide fertile grounds for emotional conditioning. As Hineline (1986) has noted, ''one cannot arrange a procedure for operant conditioning without stimulus-stimulus relationships being embedded therein, and thus the possibility of concomitant Pavlovian conditioning'' (p. 63). Perhaps that is one reason why clinicians have been so accepting of Mowrer's version of two-factor theory (Stampfl, 1987). Their phobic clients come to them with two sorts of complaints: on the one hand, descriptions of the problems that their avoidance behavior has created for them (interference with their job and social life), but on the other, reports of disturbing symptoms that accompany avoidance (variously reported as fear, anxiety, and panic).

Dinsmoor's (2001) analysis, although carefully sidestepping references to emotional processes, does describe the conditioned properties of response feedback as a consequence of Pavlovian inhibitory conditioning. In other words, feedback stimuli become safety signals within the avoidance process because the conditional probability of shock given the occurrence of a response is lower than the conditional probability of shock given the absence of a response. But there is no acknowledgment in Dinsmoor's analysis of the Pavlovian responses that may be induced by aversive stimuli and inhibited by safety signals. We see considerable value in broadening the analysis to include respondent as well as operant forms of behavior, as in applications of the conditioned emotional response procedure developed by Estes and Skinner (1941). Apart from the clinical relevance of a coordinated approach, the findings may shed light on failed efforts to establish and maintain free-operant avoidance in the animal laboratory (cf. Baron, 1991).

In reading Dinsmoor's (2001) article, we were struck by the paucity of current research on avoidance. Although theoretical controversies abound, not much behavior-analytic research on avoidance has been done since the 1970s (the most recent empirical reference on Dinsmoor's list is 1983). The molecular view of avoidance that Dinsmoor elaborates was expressed originally by Schoenfeld (1950) and Dinsmoor (1954), and the molar position was presented a few years later (Herrnstein, 1969; Herrnstein & Hineline, 1966; Sidman, 1962). So if one criterion of a good theory is ''fruitfulness,'' neither view of avoidance appears to measure up very well.

The empirical neglect of avoidance is unfortunate because the research seems especially well suited to advancing our understanding of intractable problems of societal importance. Human behavior is not well controlled by outcomes that are temporally remote, improbable, or cumulative in nature, and this is the source of much of the problematic, self-defeating behavior that can be observed outside the laboratory. Such behavior is endemic, not only on the level of the individual (familiar examples are overeating, alcohol abuse, and compulsive gambling), but also on the broad societal level (as may be seen in environmental pollution, overpopulation, and depletion of natural resources). In avoidance we have a laboratory model for the study of behavior that appears to have adapted to its long-term consequences. The fact is, animals do avoid shock under a wide range of conditions. The question is, how do they do it? Two-factor theory, with its integration of respondent and operant contingencies, prompts a search for stimuli that mediate control by molar outcomes. In addition to clarifying important theoretical issues, such research will help us to understand the operation of mediational stimuli and exploit them in the solution of human ills.

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