BEYOND THE MOLAR–MOLECULAR DISTINCTION: WE NEED MULTISCALED ANALYSES

Philip N. Hineline

TEMPLE UNIVERSITY

Dinsmoor's (2001) adherence to molecular analyses may require him to assert that molar and molecular principles are mutually exclusive, but to instead analyze the phenomena of avoidance as inherently multiscaled is to follow a well-established practice in the natural sciences. Besides the issue of scale, two-factor theory, which Dinsmoor advocates, has little to say about some important and longstanding results in experiments that qualify as avoidance.

Key words: avoidance, molar analyses, molecular analyses, scales of process, shock-frequency reduction, short-term postponement, situational transition as reinforcement

---

I learned, in a basic undergraduate course on rhetoric and persuasion, that when an author uses phrases like ''It is frequently assumed . . .'' it is a likely attempt to set up a straw-man version of an opponent's position. Thus, in the opening section of Dinsmoor's (2001) essay we find: ''It is frequently assumed that these two [molar and molecular conceptions] are mutually exclusive and that shock-frequency or shock-density reduction is accepted behavior-analytic doctrine'' (p. 311). In addition to invoking the term ''doctrine'' to label a principle that he finds uncongenial, Dinsmoor mistakenly attributes his own apparent assumption of mutual exclusivity to those of us who hold an alternative position.

Several authors have provided extensive discussions of the molar–molecular issue as it has figured in conflicts between theoretical viewpoints, and of the need for behavior analysts to get beyond it (e.g., Moore, 1983; Morris, Higgins, & Bickel, 1982). My own experiments and writings, which Dinsmoor (2001) selects for extensive criticism as representing the molar position, began with explorations of possible complementarities between relations on disparate scales of behavioral process. That is, during the time when Herrnstein and I were working on the shock-frequency reduction experiments (Herrnstein & Hineline, 1966), I was concurrently conducting experiments in which rats could postpone shocks while shock frequency was held constant, thus showing that molecular relations could also be operative. These experiments were sketched by Herrnstein (1969) in his essay on avoidance, and I subsequently described them in detail (Hineline, 1970). In these, and in studies of positive reinforcement (e.g., Hineline & Sodetz, 1987; Wanchisen, Tatham, & Hineline, 1988) and of appetitive and appetitive–aversive interactions (e.g., Hackenberg & Hineline, 1987; Hineline, 1973), I have focused on ways in which differential short-term and longer term effects can be discerned, attempting to understand behavioral process as functioning simultaneously on multiple time scales.

Although this notion of simultaneous but disparate overlapping time scales has become a commonplace in domains such as classical physics and modern chaos theory, and ecological perception theorists have compellingly demonstrated it with ''temporally nested'' phenomena of visual pattern discrimination (Warren & Shaw, 1985), it seems to be a difficult concept to grasp as applied to behavioral process. Some everyday examples may be helpful: Many of us postpone paying our income tax in the short term while our overall rate of paying it remains at once per year. In contrast, I behave in various ways that reduce my frequency of illness, while not discriminably avoiding any particular bout of cold or flu. The former can be understood in terms bearing some resemblance to Dinsmoor's (2001) preferred kind of account, but a similarly molecular appeal to inferred re-

---

Thanks are due to Claudia Cardinal, Thomas Waltz, and E. Terry Mueller for their suggestions during the preparation of this manuscript.

Correspondence regarding this article should be addressed to the author at the Department of Psychology, Temple University, Philadelphia, Pennsylvania 19122 (E-mail: hineline@astro.ocis.temple.edu).

sponse-produced stimuli for the latter case would be treating them as too free for the asking. An additional example illustrates the fact that a single set of events can be involved in behavioral process at more than one time scale: My old car has a slightly defective carburetor that has taught me to do an intricate moment-to-moment ''dance'' on clutch, brake, and accelerator when stopped on inclines before the engine has warmed up. At the same time, when driving that car I select particular routes that have fewer stop signs, and, on an even more extended time scale, I might arrange my schedule with students and colleagues so as to take the car to a repair shop. Note that the events and contingencies at one scale can affect the process at a different scale without one being reducible to the other. If there were no unproblematic routes to work, the repairs would be arranged with greater urgency. On the other hand, if the only available repair shop were far away, I would be likely to put up with the inconveniences arising from the defective carburetor until additional contingencies, such as the annual inspection requirement, provided additional, conjoint consequences of the visit.

This last example also serves to highlight another deficiency in Dinsmoor's (2001) characterization of nonmolecular theory—portraying it as synonymous with the principle of shock-frequency reduction. As I have detailed elsewhere (Hineline, 1984a; Hineline & Sodetz, 1987), the ''avoidance problem'' obliged us to attend to the more general question of relations between behavior and remote events, which are also relevant in the domain of positive reinforcement. Notable among these are the phenomena generated by concurrent contingencies, which involve more than just the concatenation of smaller units into larger units via chaining principles. McDowell (1988) has illustrated the pragmatic importance as well as the conceptual coherence of addressing these phenomena in terms of behavioral process on extended scales, as described by the generalized matching law (Baum, 1974; Herrnstein, 1970). Rachlin (1995) has developed behavior-analytic theory of self-control beyond the constraint of momentary choices between short-term and long-term consequences, chararacterizing it instead in terms of extended patterns on differing time scales.

The Logic of Local Versus Extended Relations

Dinsmoor (2001) asserts, ''In molecular terms, shock-frequency-reduction theory runs into a *fatal* logical difficulty'' (p. 318). The logic that he then develops is one predicated upon differing characteristics of numerator and denominator in an expression that integrates events over time. Glossing over the fact that the numerator of an average delay has the same fuzziness as the denominator of a frequency (it is always a combining of temporally separated and often irregularly dispersed events), he asserts that a decrement in frequency is less localizable than a decrement in average delay, and concludes,

> Unless we venture into two-factor theory, shock-frequency reduction does not provide the linkage between individual occurrences of a specified class of behavior and individual deliveries of a reinforcing event found in the standard schedules of positive reinforcement. In the usual sense of the term, then, there is no contingency, there *can* be no contingency, between the response and the putative reinforcer. (pp. 318–319)

This seems to concede—even assert—that from a molecular perspective the notion of temporally extended behavioral process per se is incoherent (presumably this is why he asserts the mutual exclusivity of molecular and molar accounts).

The molecular account characterizes behavioral process as a succession of ''slices of simultaneity'' that accrue in producing rates of occurrence and the like. This is problematic, for the duration of those simultaneities is indeterminate: Should it be the spike of a neural impulse? A burst of impulses? The so-called ''span of immediate memory'' (which risks being an artifact of measurement procedures)? Or, should we stay at the level of behavior, and make it the duration of a response? If the latter, the issue becomes problematic, for it is well established that operants can have widely varying durations. I have argued elsewhere (Hineline, 1995) that just as in analytic geometry the point is a fiction, with extended relations such as lines, planes, and solids constituting geometry's ''real'' phemonena, so, too, the privileged ''temporal locus'' is a fiction, with behavioral or psychological ''reality'' being extended in time.

Furthermore, even the concept of safety, which Dinsmoor (2001) embraces, is inherently a molar concept, for safety is meaningful only in a context of surrounding danger. As he says on page 312, ''The mere absence of shock does not qualify as a possible reinforcer, because that condition is ubiquitous.''

Dinsmoor (2001) attempts to make a virtue of the inability of a molecular account to encompass extended process as such, by conflating *contingency* with *contiguity*. First, he converts the description of a convention of positive reinforcement schedules (''the reinforcer always follows immediately upon some individual occurrence,'' p. 318) into an assertion of logical necessity. To be sure, immediacy of contingent delivery of reinforcers is a potent variable, especially in the shaping of new topographies or other highly variable situations. However, Baum (1973) has outlined how this follows from analyses in terms of contingency relations not viewed as dependent on a relative contiguity principle. Furthermore, for several decades now, contingency has been distinguished from contiguity within learning theory. Given the major role given to Pavlovian processes in two-factor avoidance theory, it is odd that Dinsmoor rejects this more extended conception of contingency, which, ever since Rescorla's (1967) delineation of the issue, has been a commonplace within contemporary Pavlovian theory. Even the operant factor of two-factor theory needs to reflect contingency as distinct from contiguity, as illustrated in an experiment by Hammond (1980), albeit on positive reinforcement. Hammond scheduled reinforcer deliveries second-by-second with one probability if a response occurred within a given second, and a second, independent, probability if the response did not occur within that second. Holding the first probability (the likelihood of a response producing a reinforcer) constant, Hammond found that changes in the likelihood of reinforcers in the absence of responding strongly affected the rates of responding. That is, contingency is best understood as a combination of two probabilities (probability given a response in relation to the probability given no response), a concept that intrinsically extends behavioral process beyond the confines of the moment in which the response occurs.

Additional Relations Involved in Avoidance

Dinsmoor's ''ideal control procedure'' (2001, p. 313) is, as he asserts, appropriate for demonstrating the production of conditioned aversive stimuli, and subsequently, negative reinforcement based upon response-produced removal of such stimuli. I agree that sometimes that is an appropriate description of what is transpiring when we speak of avoidance. However, that control procedure does not enable us to understand other relations that are embedded in avoidance procedures—relations that can be equally or even more important. I have discussed these at length (Hineline, 1977, 1981), and have presented them in summary form (Hineline, 1984a), as follows:

> 1) Negative reinforcement is to be understood in terms of transitions between situations as well as by postponement or prevention of events within a situation. In some cases, a continuously present aversive stimulus defines such a situation; in other cases, the situations will be partly defined by additional, delineating stimuli and by operant contingencies that are in effect only during the situation.
> 2) Relative aversiveness of a situation (the degree to which transitions away from it will reinforce behavior) depends only partly upon primary aversive stimuli that occur within the situation. Even when those stimuli do contribute to aversiveness, a relevant feature is their short-term versus longer-term distributions in time.
> 3) Relative aversiveness of a situation depends substantially upon: (a) contingencies (''work requirements'') in that situation, but also (b) contingencies (''work requirements'') in alternative situations.
> 4) Most importantly, the role of the alternative situation(s) depends upon contingencies regarding change of situation (i.e. upon ''what is involved in getting from one situation to the other'').
> 5) All things being equal, performance tends to allow persistence of the situation closer to primary aversive events. (p. 505)

I have explicitly asserted that two-factor theory characterizes *part* of what is happening in situations whereby we speak of avoidance, and have applauded the work by Dinsmoor and Sears (1973) regarding safety signals (Hineline, 1977). It *should* follow that some (Dinsmoor, 2001, overstates it as ''most'') of my interpretations are compatible with two-factor theory. But whether it is predicated solely upon exteroceptive stimuli or whether it includes stimulation intrinsically generated by responses, two-factor theory has little to say about most of the relations described above. Operant contingencies per se are not primary aversive stimuli of a respondent conditioning procedure. Hence, the accompanying stimuli that delineate the situations in which they are operative are better characterized as operant discriminative stimuli or establishing stimuli rather than as Pavlovian conditional stimuli. Thus, one thing Dinsmoor does get correct is a recognition that my main criticisms of two-factor theory concern its incompleteness.

What Counts As Explanation?

I have no problem with Dinsmoor's statement of the goal of scientific theory: ''to discover and describe the common characteristics that link together seemingly unrelated observations'' (p. 324). I would elaborate that by saying all explanations are descriptions, but not all descriptions are acceptable as explanations. The issue, then, is to identify the characteristics of a description (or, more usually, a set of interrelated descriptions) that occasion our accepting them as explanatory or even calling them theory. From a commentary on the nature of behavior-analytic theory, which met with Skinner's (1984) agreement:

> Skinner's behavior analysis is a conceptual fabric in which operations are themselves the very warp and weft. Furthermore, it is a bona fide theory, monistically construed, of ''the 'real' or 'physical' world (or at least the 'one' world).'' Skinner's specification of operations, then, is an attempted characterization of features of the world as they affect behavior. *The theory is an attempt to describe efficiently the effective environment in interactions between behavior and environment.* (Hineline, 1984b, p. 560)

I included the term ''efficiently'' in this statement to acknowledge the importance of parsimony; one includes no more principles than are needed. Dinsmoor (2001) apparently faults my account of avoidance on this ground. Claiming that his approach pulls together a broad range of operant phenomena as unified by the parameters of Pavlovian conditioning, he asserts,

> By contrast, a treatment such as that pursued by Hineline, which simply adds a controlling variable to the list of avoidance parameters each time one is discovered, does not unify the several consequences that have been found empirically to establish and maintain avoidance responding, let alone integrate these relations with other areas within the provenance of a theory of behavior. (p. 325)
> His emphasis has been on the results of unusually complex procedures, which tend to be the most difficult to analyze in an unambiguous fashion. (p. 325)

It appears, then, that Dinsmoor would prefer to dismiss as ''unusually complex'' any procedures whose features do not fit the terms of two-factor theory.

Two experiments are especially relevant here. The first is one that does fit the terms of two-factor theory, but Dinsmoor (2001) missed what I consider to be its main point when describing it. Feild and Boren (1963) arranged for rats' responses to postpone shocks by 10-s increments up to a maximum of 110 s. In various phases of their experiment the accumulated shock-free time was correlated with no added stimuli, with a row of 11 lights, with a varying click rate, and with lights and click rates presented together. The fact of responding with the added row of incrementing or decrementing lights or variable click rates, correlated with proximity to shock, is of course not a contradiction of two-factor theory. The telling result, however, occurred when the correlated lights and clicker were presented together. Instead of the 40 to 90 s from shock that they maintained with clicker alone, or the 70 to 110 s that they maintained with the lights alone, the rats stayed only 30 to 50 s from shock when the lights and clicker were combined. If reinforcement, here, were the reduction in conditioned aversive stimuli, the combined stimuli should have resulted in responding that maintained greater rather than lesser distance from shock. If Dinsmoor wants to handle this by emphasizing safety signals, then it seems that safety is increased by superimposing the stimuli correlated with danger, making it even more clear that safety is a molar concept.

Dinsmoor's (2001, pp. 321–322) account of the session-shortening experiment of Mellitz, Hineline, Whitehouse, and Laurence (1983) also is an appeal to molar variables, speculating about a possible correlation between relative rate of responding and session terminations that were separated by at least 2 min from the contingency operative on that relative rate.

Another experiment Dinsmoor (2001) targeted, but missed what I consider to be the main point of, was that by Krasnegor, Brady, and Findley (1971), who described a chain schedule based on negative reinforcement. The mere fact of avoidance in their procedure is indeed consistent with two-factor theory. However, the major result of that experiment was the demonstration that reducing the fixed-ratio size within one component strongly affected the animal's response rate in the alternative component, producing an increased response rate there and changing the animal's relative time allocations to the two components. This summarizing principle is portrayed even more strikingly in an experiment by Sidman and Boren (1957), which Dinsmoor does not cite, that showed two major effects that are not predicted by two-factor theory. In this procedure, rats' responding could prevent a warning stimulus, but once the warning stimulus had been allowed to come on, a separate contingency, of posponing shocks, was in effect. A return to the prewarning situation occurred only if the animal allowed a shock to be delivered. When the two postponement intervals were independently varied, the strongest effect was the effect of changing the contingency in one situation on the rate of responding in the other situation—to the extent that when the prepostponement interval was made long enough, the animal often waited out the warning stimulus and took a shock in the condition in which the shock was followed by a return to the prewarning stimulus.

Dinsmoor (2001, p. 325) briefly enumerates some ancillary relations, ''conditioned reinforcement, chaining, and stimulus control,'' that he claims are consistent with two-factor theory. However, textbook chapters on avoidance that emphasize two-factor theory do not, as a matter of practice, integrate that theory with such principles, but rather place avoidance in its own separate chapter. Furthermore, the additional schedule relations derived from studies of positive reinforcement, particularly those concerning the concurrent contingencies that would be needed to address the Sidman and Boren (1957) experiments, are no less complex than the brief set of principles that I have summarized above for dealing with the situations in which we speak of avoidance.

So, in the words of N. J. Mackintosh, surely an advocate of making maximal use of Pavlovian principles in accounting for operant behavior,

> The issue reduces, in part, to the general question whether contiguity or correlation between events underlies conditioning. Herrnstein's analysis stresses the overall correlation between rate of responding and rate of shock. The alternative is that avoidance responses are reinforced by their more immediate consequences. The dispute is misplaced, for it is impossible to describe a correlation between two events without regard to the temporal relationship between them. Without specifying what is to count as a conjoint occurrence of two events, a correlational analysis can be pushed into absurdity. But it is equally absurd to suppose that immediate consequences of an action are the sole determinants of that action, if only because we have no *a priori* definition of what is to count as ''immediate.'' Undeterred, several experimenters have addressed themselves to some of the issues involved. (1983, p. 153)

Yes, both Dinsmoor and I are undeterred—now if only he wouldn't avoid (sic) a discussion of multiscaled analyses!

REFERENCES

Baum, W. M. (1973). The correlation-based law of effect. *Journal of the Experimental Analysis of Behavior, 20,* 137–153.

Baum, W. M. (1974). On two types of deviation from the matching law: Bias and undermatching. *Journal of the Experimental Analysis of Behavior, 22,* 231–242.

Dinsmoor, J. A. (2001). Stimuli inevitably generated by behavior that avoids electric shock are inherently reinforcing. *Journal of the Experimental Analysis of Behavior, 75,* 311–333.

Dinsmoor, J. A., & Sears, G. W. (1973). Control of avoidance by a response-produced stimulus. *Learning and Motivation, 7,* 284–293.

Feild, G. E., & Boren, J. J. (1963). An adjusting avoidance procedure with multiple auditory and visual warning stimuli. *Journal of the Experimental Analysis of Behavior, 6,* 537–543.

Hackenberg, T. D., & Hineline, P. N. (1987). Remote effects of aversive contingencies: Disruption of appetitive behavior by adjacent avoidance sessions. *Journal of the Experimental Analysis of Behavior, 48,* 161–173.

Hammond, L. J. (1980). The effect of contingency upon the appetitive conditioning of free-operant behavior.

Journal of the Experimental Analysis of Behavior, 34, 297–304.

Herrnstein, R. J. (1969). Method and theory in the study of avoidance. *Psychological Review, 76,* 49–69.

Herrnstein, R. J. (1970). On the law of effect. *Journal of the Experimental Analysis of Behavior, 13,* 243–266.

Herrnstein, R. J., & Hineline, P. N. (1966). Negative reinforcement as shock-frequency reduction. *Journal of the Experimental Analysis of Behavior, 9,* 421–430.

Hineline, P. N. (1970). Negative reinforcement without shock reduction. *Journal of the Experimental Analysis of Behavior, 14,* 259–268.

Hineline, P. N. (1973). Avoidance sessions as aversive events. *Science, 176,* 430–432.

Hineline, P. N. (1977). Negative reinforcement and avoidance. In W. K. Honig & J. E. R. Staddon (Eds.), *Handbook of operant behavior* (pp. 364–414). Englewood Cliffs, NJ. Prentice Hall.

Hineline, P. N. (1981). The several roles of stimuli in negative reinforcement. In P. Harzem & M. D. Zeiler (Eds.), *Advances in analysis of behaviour: Vol. 2. Predictability, correlation, and contiguity* (pp. 203–246). Chichester, England: Wiley.

Hineline, P. N. (1984a). Aversive control: A separate domain? *Journal of the Experimental Analysis of Behavior, 42,* 495–509.

Hineline, P. N. (1984b). What, then, is Skinner's operationism? *Behavioral and Brain Sciences, 7,* 560.

Hineline, P. N. (1995). The extended psychological present. *Behavioral and Brain Sciences, 18,* 128–129.

Hineline, P. N., & Sodetz, F. J. (1987). Appetitive and aversive schedule preferences: Schedule transitions as intervening events. In M. L. Commons, H. Rachlin, & J. Mazur (Eds.), *Quantitative analyses of behavior: Vol. 5. Reinforcement value—The effects of delay and intervening events* (pp. 141–157). Hillsdale, NJ: Erlbaum.

Krasnegor, N. A., Brady, J. V., & Findley, J. D. (1971). Second-order optional avoidance as a function of fixed-ratio requirements. *Journal of the Experimental Analysis of Behavior, 15,* 181–187.

Mackintosh, N. J. (1983). *Conditioning and associative learning.* Oxford: Oxford University Press.

McDowell, J. J. (1988). Matching theory in natural human environments. *The Behavior Analyst, 11,* 95–109.

Mellitz, M., Hineline, P. N., Whitehouse, W. G., & Laurence, M. T. (1983). Duration-reduction of avoidance sessions as negative reinforcement. *Journal of the Experimental Analysis of Behavior, 40,* 57–67.

Moore, J. (1983). On molarism and matching. *The Psychological Record, 33,* 313–336.

Morris, E. K., Higgins, S. T., & Bickel, W. K. (1982). Comments on cognitive science in the experimental analysis of behavior. *The Behavior Analyst, 5,* 109–125.

Rachlin, H. (1995). Self-control: Beyond commitment. *Behavioral and Brain Sciences, 18,* 109–121.

Rescorla, R. A. (1967). Pavlovian conditioning and its proper control procedures. *Psychological Review, 74,* 71–80.

Sidman, M., & Boren, J. J. (1957). The relative aversiveness of warning signal and shock in an avoidance situation. *Journal of Abnormal and Social Psychology, 55,* 339–344.

Skinner, B. F. (1984). Coming to terms with private events. *Behavioral and Brain Sciences, 7,* 572–581.

Wanchisen, B. A., Tatham, T. A., & Hineline, P. N. (1988). Pigeons' choices in situations of diminishing returns: Fixed- vs. progressive-ratio schedules. *Journal of the Experimental Analysis of Behavior, 50,* 375–394.

Warren, W. H., Jr., & Shaw, R. E. (1985). Events and encounters as units of analysis for ecological psychology. In W. H. Warren, Jr. & R. E. Shaw (Eds.), *Persistence and change: Proceedings of the First International Conference on Event Perception* (pp. 1–27). Hillsdale, NJ: Erlbaum.

Received November 10, 2000
Final acceptance December 12, 2000