ence, M. T. (1983). Duration-reduction of avoidance sessions as negative reinforcement. *Journal of the Experimental Analysis of Behavior, 40,* 57–67.

Sidman, M. (1955). Some properties of the warning stimulus in avoidance behavior. *Journal of Comparative and Physiological Psychology, 48,* 444–450.

Sidman, M. (1962). Reduction of shock frequency as a reinforcement for avoidance behavior. *Journal of the Experimental Analysis of Behavior, 5,* 247–257.

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A FEW MINOR SUGGESTIONS

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We agree with almost all of the analysis in this excellent presentation of the molecular view of avoidance behavior. A few suggestions are made as follows: Referring to response-generated stimuli as ''readily observable'' seems not quite right for the kinesthetic components of such stimuli, although their scientific legitimacy is not questioned. Interpreting response-generated stimuli as a form of positive reinforcement is contested, and an alternative interpretation is offered. A possibly simpler interpretation of the Sidman (1962) two-lever experiment is suggested. We question Dinsmoor's (2001) explanation for warning stimuli not being avoided, except for the reference to the weakness of third-order conditioning effects. A final question is raised regarding the nature of the variables that are responsible for the momentary evocation of the avoidance response.

Key words: avoidance, response-generated stimuli, stimulus-change decrement, stimulus transition, evocative effect

Dinsmoor (2001) provides a persuasive and richly detailed analysis of avoidance theory and some of its experimental literature in terms of the role of response-produced ''safety signals.'' We found ourselves in agreement with most of the analysis, and our comments consist of minor terminological suggestions and slightly different interpretations of some of the experimental results.

Scientific Legitimacy of Response-Dependent Stimuli

This is a very useful treatment that directly challenges an often-made criticism, and we have only a slight disagreement with respect to the observability of the relevant stimuli. Dinsmoor states that ''The occurrence of a physically defined response is just as material, just as observable, just as specifiable a source of stimulation as the presentation of a light or a tone'' (2001, p. 315). Here a *response* is being described as observable, which is certainly true. But on page 316 the response-generated *stimuli* are referred to as ''readily observable.'' This seems not quite correct if kinesthetic response-generated stimuli are included. As observers we can make *direct* contact with exteroceptive stimuli that affect another organism in ways that we have strong reasons to believe are very similar to the contact made by the experimental organism, but we only make *indirect* contact with kinesthetic stimuli that affect that organism. Strictly speaking, they do not seem just as readily observable as a light or a tone. This does not detract from the scientific legitimacy of such stimuli, however, but only makes the issue a little more complex.

Response-Generated Positive Reinforcement for the Avoidance Response

Dinsmoor (2001) considers the possibility that response-generated stimuli that are ''in-

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versely or negatively correlated with the shock'' (p. 316; cf. pp. 311, 314, 315–316) become positive reinforcers. Whether valid or not, this point does not seem to be critical to interpreting the reinforcement for avoidance behavior in terms of response-generated stimuli, or perhaps we are missing something that Dinsmoor will clarify in his reaction to this comment. However, from the perspective of considering behavioral consequences always to be stimulus changes or transitions, we find Dinsmoor's interpretation unconvincing.

With respect to the standard signaled avoidance procedure, it is acknowledged that the presence of a safety signal constitutes the absence of the warning signal, and vice versa, and therefore ''it is difficult to say which relation between stimulus and shock is responsible for the effect on the subject's behavior'' (Dinsmoor, 2001, p. 315). Next the Dinsmoor and Sears (1973) study is cited as providing evidence for ''a positive reinforcing effect that is separate and distinct from any negative reinforcing effect exerted by termination of a warning signal'' (p. 315). During ordinary unsignaled avoidance training, when the pigeon depressed a pedal a 1000-Hz tone was sounded for 5 s, and the next shock was postponed for 20 s. ''During interspersed test periods in which no more shocks were administered, continued response-dependent presentations of the tone served as positive reinforcers, maintaining higher rates of pressing than during corresponding test periods when no tones were presented'' (Dinsmoor, 2001, p. 315). But when tone presentation is viewed as a stimulus change from the ordinary contextual stimuli that had often been paired with shock to a stimulus condition that had never been paired with shock, the change is still from a dangerous condition to a safe one, and the presence of the latter is indistinguishable from the absence of the former.

The key part of the argument for an independent positive effect is in reference to a generalization gradient around the frequency of the tone. Tones of 250 Hz, 500 Hz, 2000 Hz, and 4000 Hz were also presented, and they maintained lower treadle response frequencies than the original 1000-Hz tone, with the tone frequencies closest to the original frequency maintaining the higher response frequencies. That the tone-frequency dimension is orthogonal to the presence-absence dimension was taken as strong evidence that ''it was the production of the safety signal, rather than or in addition to the termination of a warning signal, that was responsible for the maintenance of the pigeons' behavior'' (Dinsmoor, 2001, p. 316).

An alternative interpretation might be made in terms of what could be called stimulus-change decrement. When the behavioral significance of a stimulus event is due to the organism's learning history, any change in that stimulus usually leads to a decrement in whatever effect is being studied. In this case we are dealing with a stimulus change that functions as conditioned reinforcement, and a change in either the prechange condition (the contextual stimuli that had been paired with shock) or the postchange condition (the 1000-Hz tone) would be expected to decrease the effect—here the reinforcing effect in maintaining the treadle pressing. Changing the postchange condition from a 1000-Hz to a 250-Hz tone, just as superimposing a flickering houselight on the contextual stimuli, would be expected to produce such a decrement. In this alternative interpretation, the reinforcing event is the change from contextual stimuli alone to contextual stimuli plus the 1000-Hz tone, not the presentation of the tone.

Sidman's Two-Lever Experiment

Without contesting Dinsmoor's interpretation (2001, pp. 317–318) of Sidman's (1962) experiment, we propose a related analysis based more explicitly on a stimulus change or transition perspective, which seems in some respects simpler and possibly just as valid. The experiment involved two levers, each associated with independent timers: one (the R1 timer) with response–shock (RS) and shock–shock (SS) intervals of 20 s, and the other (the R2 timer) with RS and SS intervals of 40 s. With no responding on either lever, the general stimulus situation (including stimuli resulting from ineffective responses) was paired with shock 4.5 times per minute: 3 shocks per minute from the R1 timer and 1.5 shocks per minute from the R2 timer. Responding exclusively on the R1 lever at a rate high enough to prevent most of the shocks programmed on the R1 timer will reduce the overall shock rate from 4.5 per minute to 1.5 per minute. The stimulus change is from a stimulus context associated with 4.5 shocks per minute to a response-generated safety signal associated with 1.5 shocks per minute.

Responding exclusively on the R2 lever at a rate high enough to prevent most of the shocks programmed on the R2 timer will reduce the overall number of shocks per minute from 4.5 to 3. Thus, responding on the R1 lever is followed by a form of reinforcement that is, in a sense, twice as large as that following responding on the R2 lever. This is a set of response–reinforcement relations that lead us to expect more responding on the R1 lever.

In addition, accidental punishment of each type of responding may play some role in determining the differential response rates. When the rat responds exclusively on the R2 lever, response-independent shocks will occur at the rate of 3 per minute, and it might be expected that some of these would be close enough in time to a response on that lever to function as punishment. Exclusive responding on the R1 lever would be subjected to such accidental punishment half as often, another factor favoring R1 responding.

Warning Stimuli Are Not Postponed

Dinsmoor (2001) provides ample evidence for the aversiveness of the warning stimulus in the earlier section on discrete trial avoidance, but his analysis of failures to obtain avoidance of the warning stimulus is somewhat puzzling. It is of course third-order conditioning that would be involved in the avoidance of the warning stimuli, which Hineline (e.g., 1977, 1981) apparently takes for granted. Nothing mentioned in this section except the reference to the assumed weakness of third-order conditioning seems relevant to the argument. One wonders why Dinsmoor did not simply state that avoidance of the warning stimuli assumes third-order conditioning and that such an effect is presumably too weak to produce avoidance behavior. In principle, replacing the warning stimulus with its absence is no different from replacing stimuli that have been paired with the warning stimulus with stimuli that have not been so paired. There may be more to the problem than the simple weakness of third-order conditioning effects. The fact that the warning stimulus is only a conditioned aversive stimulus (compared with the shock) may be less important than that the warning stimulus can be and is frequently escaped. The capacity of an *escapable* learned aversive stimulus to transform stimuli that precede it into learned aversive stimuli may be considerably less than if the learned aversive stimulus could not be escaped. Somewhere in this literature there is probably a study in which a warning stimulus that cannot be escaped is in fact avoided. But even if not, the aversiveness of the warning stimulus does not seem to be really in question.

Evocative Effects

This last comment does not bear on any of the general points made so well by Dinsmoor (2001), but represents an additional issue related to avoidance on which we would value his opinion. From a molecular orientation it seems important to identify and classify the momentary variables that are responsible for the occurrence of a type of behavior *at the time it occurs*. For behavior maintained by more conventional positive reinforcement, the identification of an appropriate history of reinforcement does not suffice for a complete explanation of the occurrence of a particular type of behavior at a particular moment in time. It is more complete to report that this type of behavior had been previously reinforced with food in the presence of a particular exteroceptive stimulus situation, and at the time the behavior occurred the organism was again food deprived and the exteroceptive stimulus situation was again in effect. Why does the organism respond at this time? Because the relevant establishing operation is in effect at this time and a relevant discriminative stimulus is now present.

With respect to avoidance behavior, there are two questions. What causes the avoidance response at the time that it occurs? How should this causative variable be behaviorally classified? With respect to discrete-trial avoidance, it seems observationally uncontroversial that it is the onset of the warning stimulus that causes a sudden increase in the frequency of (evokes) the response that terminates the warning stimulus. Would Dinsmoor agree, and if so how would he classify this event as a behavioral independent variable? As a discriminative stimulus? Or as something else? Similarly, for unsignaled avoidance, how would Dinsmoor identify and interpret the events 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.

REFERENCES

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, 4,* 284–293.

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.

Sidman, M. (1962). Reduction of shock frequency as reinforcement for avoidance behavior. *Journal of the Experimental Analysis of Behavior, 5,* 247–257.

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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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