Notes and Comment

Associative control of schedule-induced drinking

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In the November 1982 issue of *Animal Learning & Behavior*, Minor and Coulter reported the findings of a study that had examined associative control of schedule-induced (adjunctive) drinking. They stated that "the main objective of the present study was to determine whether interim responses were, in fact, controlled by signals for nonreinforcement." A number of other investigators also have addressed this issue, and we would like to put Minor and Coulter's interesting findings into perspective by comparing them with those other studies.

Two previous studies were specifically designed to test the theory that S— had inhibitory control over terminal behavior and excitatory control over interim behavior and, conversely, that S+ had inhibitory control over interim behavior and excitatory control over terminal behavior (see Staddon, 1977). Stone, Lyon, and Anger (1978) demonstrated that a tone associated with pellet delivery (i.e., a Pavlovian S+) suppressed post-pellet polydipsic drinking. They concluded that their results supported the notion that schedule-induced drinking was produced by a Pavlovian S— (i.e., the post-pellet period of an interval in which the probability of pellet delivery was at its lowest level). Similarly, Lashley and Rosellini (1980) found that imposition of a CS+ during random-time food schedules resulted in increased levels of schedule-induced polydipsia. They concluded that the establishment of a Pavlovian S— and local periods of low reinforcement probability seemed to be sufficient for the development of schedule-induced polydipsia. A number of other studies also have provided evidence for the theory that S+ has inhibitory control over interim (adjunctive) behavior. They have utilized second-order reinforcement schedules (sometimes referred to as percentage reinforcement schedules) with either fixed-interval components (Allen & Porter, 1977; Allen, Porter, & Arazie, 1975; McCoy & Christian, 1976; Porter, Arazie, Holbrook, Cheek, & Allen, 1975) or fixed-time components (Iversen, 1977), and have consistently failed to find schedule-induced polydipsia during periods of nonreinforcement signaled by a brief stimulus paired with food reinforcement (i.e., CS+). Allen and Porter (1977) have shown that those few studies (Corfield-Sumner, Blackman, & Stainer, 1977;

Porter & Kenshalo, 1974; Rosenblith, 1970) showing polydipsia after presentation of a CS+ probably obtained "spillover" drinking from a previous interval that followed pellet delivery.

Other studies (Flory & Robinson, 1982; Keehn & Colotla, 1970, 1971; Millenson, Allen, & Pinker, 1977; Segal & Deadwyler, 1965; Wuttke & Innis, 1972) also have addressed (either directly or indirectly) the hypothesis that a Pavlovian S— is critical for the development of schedule-induced polydipsia. Although some studies have provided evidence for the S— hypothesis, a number of studies have failed to do so. Minor and Coulter's study is the only one that has reliably obtained schedule-induced polydipsia during the EXT components of MULT food-reinforcement schedules. Jacquet (1972) tested polydipsic drinking in rats on a series of multiple schedules. When the rats were placed on a MULT VI 1-min EXT food-reinforcement schedule, schedule-induced drinking occurred at high levels during the VI 1-min components (i.e., S+) and was reduced to near-zero levels during the EXT components (i.e., S—). Hamm, Porter, and Oster (1978) tested four rats on a MULT VT 50-sec EXT food schedule. Although one rat did show schedule-induced drinking primarily during S— components (as in Minor & Coulter's study), the other three rats displayed high levels of polydipsic drinking during the S+ components and virtually no drinking during the S— components.

In another study, Hamm, Porter, and Kaempff (1981) examined schedule-induced polydipsia with a MULT random time (RT) 30-sec EXT schedule using a true discrimination procedure, yet the results resembled those of the pseudodiscrimination group in Minor and Coulter's article in that drinking was restricted almost entirely to the S+ components. An important aspect of the Hamm et al. (1981) study is that stimulus generalization testing during S— components yielded flat gradients (unlike the results seen in the Minor and Coulter article). However, peaked generalization gradients around S+ were obtained during the RT (S+) components. Thus, both Hamm et al. and Minor and Coulter were able to provide a clear demonstration of stimulus control of schedule-induced drinking, but the results of the Hamm et al. (1981) study indicate that S+ can and does exert control over schedule-induced drinking. Minor and Coulter also found some evidence for the influence of S+ on polydipsic drinking. They found that the number of food pellets delivered during the S+ trial that immediately preceded an S— test trial was an important determinant of the S— drinking. Specifically, drinking during S— increased directly with the number of food pellets delivered during S+. Minor and Coulter suggested that this increased drinking was due to an

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increased thirst as the number of food pellets delivered increased. However, this explanation seems very tenuous in light of findings by Kenney, Wright, and Reynolds (1976) and Stricker and Adair (1966) that rats, during schedule-induced polydipsia, show no deficits in internal water balance and, in fact, may actually be overhydrated during polydipsic testing. Also, thirst explanations clearly cannot explain other schedule-induced behaviors, such as aggression or attack in pigeons.

Minor and Coulter also argued that polydipsia was partially controlled by postprandial stimuli, such as dry-mouth. If simple dry-mouth or postprandial explanations could account for the development of schedule-induced polydipsia, then similar amounts of polydipsia would be expected during fixed-time and random-time food schedules in which the same number of pellets were delivered. However, Lashley and Rosellini (1980) and Millenson et al. (1977) have demonstrated that polydipsia develops more readily on fixed time schedules than on random time schedules and attribute this difference to the differential establishment of a CS—period following food delivery during fixed time schedules but not during random time schedules (however, see Shurtleff, Delamater, & Riley, 1983).

Thus, it appears from the findings of a number of studies that associative control of schedule-induced polydipsia can be demonstrated. Also, there is a growing body of evidence that supports the theory that S—facilitates the development of adjunctive (interim) behaviors and that S+ inhibits the development of adjunctive behaviors. One issue that remains unresolved is why Minor and Coulter were able to obtain schedule-induced drinking almost exclusively during S— components of a MULT schedule, whereas other studies have not been able to reliably demonstrate S— drinking.

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