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Introduction: Schedules of Termination of Drug Injections*

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OVER a wide range of experimental conditions, schedule-controlled patterns of responding can be maintained in experimental animals by injections of various drugs that are abused by man (3, 11). In contrast, some drugs with pronounced behavioral effects, such as nalorphine and chlorpromazine, generally fail to maintain responding in experimental animals (6, 7) and are not abused by man. Indirect evidence suggests that these drugs may function as punishers (6, 7, 10). In 1971, Goldberg *et al.* (5) reported that behavior of morphine-dependent rhesus monkeys could be maintained by the termination of a stimulus associated with periodic injections of nalorphine or naloxone. Subsequent experiments with narcotic antagonists studied this behavior under different schedule conditions using a wider variety of drugs and drug doses in both morphine-dependent and nondependent rhesus monkeys (1, 2, 4, 8, 9, 17). In the following papers: Downs and Woods (2) describe behavior maintained by termination of a visual stimulus associated with injection or infusion of naloxone under different schedules of stimulus termination, including fixed-ratio, fixed-interval and second-order schedules; Tang and Morse (17) describe behavior maintained under fixed-ratio schedules by termination of a stimulus associated with injections of nalorphine; and Hoffmeister and Wuttke (9) describe behavior maintained by termination of a stimulus associated with chlorpromazine or LSD.

The techniques that have been used to study behavior maintained by termination of stimuli associated with drug injections are modifications of techniques originally developed by experimental psychologists to study the behavioral effects of electric shocks. Responses that occur in the presence of a stimulus preceding electric shock, which have the consequence of terminating the stimulus and postponing the shock, often are called *avoidance* responses, whereas responses that terminate the shock and any associated stimuli, often are called *escape* responses. Similar terms are sometimes applied to behavior maintained by termination or postponement of drug injections (1, 5, 10). The papers by Holz and Gill (10) and McKearney (15) relate the findings on behavior maintained by termination of stimuli associated with drug injections to the general behavioral literature with electric shock and suggest directions for future research.

Although behavior of experimental animals can be maintained by termination of stimuli associated with the injection or infusion of drugs such as the narcotic antagonists, opposite effects have been reported. In morphine-dependent rhesus monkeys, for example, responding can be maintained by the termination of a visual stimulus associated with periodic 50 μg per kg injections of the narcotic antagonists, pentazocine and propiram, but in nondependent monkeys response-produced injections of the same dose of pentazocine

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or propiram can maintain responding (4). There is also evidence that in morphine-dependent rhesus monkeys the injection of nalorphine or naloxone can maintain behavior leading both to its presentation and to its termination or postponement (2, 5). Goldberg *et al.* reported that morphine-dependent monkeys responded at high rates under conditions in which responding terminated a visual stimulus associated with periodic injections of nalorphine; under other conditions, however, response-produced injections of nalorphine maintained responding in the same morphine-dependent monkeys (5). Also, Downs and Woods report in this volume that responding of morphine-dependent rhesus monkeys can be maintained for limited periods of time under second-order schedules of naloxone injection (2).

Disparate effects of consequent events are not restricted to drug injections. Under a wide variety of conditions, responding can be maintained by termination or postponement of electric shock. By carefully controlling a subject's ongoing behavior and past experience with electric shock, however, it is possible to develop schedule-controlled performances that are maintained by response-produced electric shocks (12–14). Similarly, Steiner, Beer and Shaffer have reported that responding of rats can be maintained by either the presentation or the postponement of the same intensity of intracranial stimulation, depending on the precise nature of the schedule relating responses to intracranial stimulation (16). These results strongly suggest the importance of factors other than the intrinsic properties of different events, including injections, of drugs, in determining their behavioral effects.

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