On Terms

A Suggestion for Describing Combinations of Response-Dependent and Response-Independent Events

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If two or more operants are controlled by two or more schedules operating independently and simultaneously, the contingency is described as a concurrent schedule.¹ If a single operant is controlled by two or more schedules similarly operating independently and simultaneously, the contingency has been described as conjoint (Catania, Deegan, & Cook, 1966). But what of an operant controlled by one schedule while simultaneously response-independent food presentations or other events occur? This note critically analyzes current descriptions of combinations of response-dependent and response-independent events and suggests an alternative description.

The arrangement in time of response-independent events is commonly described as a "schedule" (e.g., Schoenfeld & Cole, 1975). Combinations of response-dependent and response-independent events (e.g., Imam & Lattal, 1988; Lattal & Bryan, 1976; Rachlin & Baum, 1972; Zeiler, 1976, 1977a) are compound schedules because they involve combinations of two or more single schedules (Reynolds, 1968). The class of compound schedules includes concurrent and conjoint schedules. As with other schedules, both conjoint and concur-

rent schedules are defined in relation to particular operanda or, more precisely, in relation to particular operants. Therein lies the problem in using either label to describe the combinations under discussion here.

According to Catania (1991), a conjoint schedule is one in which "two or more schedules, usually involving different reinforcers, operat[e] for a single response, as when lever presses are reinforced according to an FR schedule and simultaneously postpone shock according to an avoidance schedule" (p. G8; italics added). The conjoint label often is applied when the same qualitative positive reinforcer is arranged by two different schedules dependent on responses on a single operandum (e.g., Imam & Lattal, 1988; Marr & Zeiler, 1974; Zeiler & Blakely, 1983) as well as when combinations of schedules of reinforcement and punishment are correlated with the same operant (e.g., Arbuckle & Lattal, 1987). *Conjoint* also has been used to describe combinations of response-dependent and response-independent events (e.g., Zeiler, 1976).

The definition of a conjoint schedule in terms of both schedules being correlated with a single operandum precludes its unambiguous description of combinations of response-dependent and response-independent events. Lattal and Poling (1981) noted that "if response-dependent and response-independent reinforcers are delivered together, it remains an empirical question as to which and how many response classes are being affected by a single reinforcer" (p. 149). Whether or in what sense both of the schedules influence the measured operant response is unclear, because the re-

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¹ In Findley's (1958) changeover-key procedure for scheduling concurrent operants, the responses in the two components would be considered to be different because of the different contexts (e.g., different discriminative stimuli control the behavior).

sponse-independent food delivery schedule could strengthen a number of topographically defined operants other than, or in addition to, the measured operant and is not by procedural necessity related to key pecking. It could be argued that the interest in combinations of response-dependent and response-independent events usually is in terms of the behavior controlled by the response-dependent event; therefore, the term *conjoint* adequately describes the contingency. However, the definition of a conjoint schedule requires that each of the operants be defined by a single operandum. This simply is not the case when response-dependent and response-independent events are combined.

Describing combinations of response-dependent and response-independent events as *concurrent* schedules is more common and accurate (e.g., Imam & Lattal, 1988; Lattal & Bryan, 1976; Rachlin & Baum, 1972). The concurrent label refers to arrangements in which "two or more schedules operat[e] simultaneously and independently, *each for a different response*, as when separate VI schedules are arranged for a pigeon's pecks on each of two keys" (Catania, 1991, p. G7; italics added). The different responses may be defined by a single operandum correlated with different stimuli that change as a function of responding on a second, changeover, operandum (Findley, 1958), by two or more distinct operanda as in Catania's example above, or even by a single operandum defining two different operants, as in Shimp's (e.g., 1973) concurrent reinforcement of different inter-response times. When describing combinations of response-dependent and response-independent food availability schedules, *concurrent* has the advantage over *conjoint* of not relating both schedules to one operandum.

If Catania's (1991) widely accepted definition of a concurrent schedule is taken literally, then each component of a concurrent schedule is correlated with a different operant controlled by both the reinforcement schedule and correlated discriminative stimuli. This is the case in every schedule of response-dependent reinforcement. In addition, some exper-

imenters (e.g., Bauman, Shull, & Brownstein, 1975) have used changeover-key arrangements involving combinations of response-dependent and response-independent food availability for which the concurrent label seems accurate because the response-independent food schedule was correlated with a unique discriminative stimulus.

A potential problem with the concurrent label arises when a single operandum is accompanied by the same discriminative stimulus in the presence of a combination of schedules of response-dependent and response-independent events (in the following example, food availability), so that it is unclear which schedule the organism is "in the presence of." For Catania's (1991) definition to apply precisely in this case, another class of responses must be assumed to be controlled by the response-independent food schedule because the operandum defines the response-dependent food schedule. There is precedent for this assumption in Herrnstein's (1970) use of a free parameter (e.g., R_0 in Equation 18, p. 259) to describe the reinforcement of hypothetical responses that compete with the response controlled by the operandum. R_0 is by definition controlled by unspecified variables, whereas the response-independent events under discussion here can be described and controlled precisely. The hypothetical responses can be identified, as in the matching relation, only by inference through observing changes in responding correlated with the operandum. These hypothetical responses cannot be differentiated from one another nor from responses controlled by the operandum, let alone quantified. Moreover, there is debate over whether schedules of response-independent food availability unequivocally strengthen operant behavior (cf. Nevin, 1974; Skinner, 1948) or whether their behavioral effects are non-operant in nature (e.g., Staddon & Simmelhag, 1971; Timberlake & Lucas, 1985). As a result, the assumption underlying this use of the concurrent label, that response-independent food availability controls operant behavior, may or may not be supportable.

Because neither of the compound

schedule labels precisely describes combinations of schedules of response-dependent and response-independent events, other descriptions warrant consideration. Describing such combinations as "superimposed" schedules (e.g., "A sup B" in Burgess & Wearden, 1986) implies the primacy of one schedule over the other, but it is a functional, empirical issue as to whether one of the components is behaviorally superordinate to the other. The superimposition issue becomes even more complicated if more than two schedules operate simultaneously. Another possibility is to consider one schedule interpolated on the other. Ferster and Skinner (1957) described an interpolated schedule as a probe procedure wherein "A single block of reinforcements in one schedule [is] interpolated into a sustained period of responding on a different background schedule" (p. 728); this does not accurately describe the combinations under discussion here.

We suggest the term *concomitant* to describe combinations of schedules of response-dependent and response-independent events in the presence of a single operandum and set of stimuli. *Concomitant* means "existing or occurring with something else, often in a lesser way; accompanying; concurrent" (*Random House Dictionary of the English Language*, 1971, p. 305). Although synonymous with *concurrent*, the term is distinct and can be operationalized differently from cases in which concurrent is unambiguous. The term has no usage history in behavior analysis, so there are no competing verbal responses of investigators controlled by it. Furthermore, *concomitant*, *conjoint*, and *concurrent*, all describing related compound schedules, are etymologically and phonetically similar to one another.

Concomitant can be used like any other compound schedule label. For example, combining a fixed-ratio (FR) and a fixed-time (FT) schedule (e.g., Edwards, Peeke, & Wolfe, 1970) could be described as a concomitant FR FT schedule; combining a free-operant avoidance schedule with regularly delivered response-independent shock (e.g., Sidman, Herrnstein,

& Conrad, 1957) could be described as a concomitant avoidance FT schedule. Delivering response-independent shocks while positively reinforcing responding (e.g., Azrin, 1956) also could be described as a concomitant schedule.

Concomitant schedules should be distinguished from schedules in which a response-dependent reinforcer schedule is combined with a schedule in which not responding on the operandum is reinforced (an $\bar{R} > t$ or differential-reinforcement-of-pausing, DRP, schedule; cf. Zeiler, 1977b). The latter combination is accurately described as a conjoint schedule, assuming that the DRP is referenced with respect to the operandum correlated with the response-dependent reinforcer schedule. The same operandum directly controls behavior under both schedules: one through a positive correlation with operandum responses and the other through a negative correlation with operandum responses.

The ultimate test of a new term is not only in its logic but also in its adoption. Aware of the fate of previous calls for more logically based descriptions of other reinforcement schedules (e.g., differentiation schedules, Morse, 1966, pp. 93–94; Zeiler, 1977b, p. 203), we proffer our suggestion with the trepidation that *concomitant* may never consistently grace the pages of the *Journal of the Experimental Analysis of Behavior*. On the other hand, the language of behavior analysis has been described aptly as its calculus (Hineline, 1980), underlining the value of precision in description. A distinct term for a contingency that is ambiguously described by existing terminology seems to be a useful step in eliminating confusion and in clarifying the operative contingencies when response-dependent and response-independent events are combined.

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