REVISTA MEXICANA DE ANÁLISIS DE LA CONDUCTA 2015 NÚMERO 2 (SEPTIEMBRE)
MEXICAN JOURNAL OF BEHAVIOR ANALYSIS VOL. 41, 1-13 NUMBER 2 (SEPTEMBER)

SOME DIMENSIONS OF RECURRENT OPERANT BEHAVIOR

ALGUNAS DIMENSIONES DE LA CONDUCTA OPERANTE RECURRENTE

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It is not uncommon for previously reinforced, but thereafter eliminated or abandoned respondent or operant behavior to recur. As the articles in this special issue of the *Mexican Journal of Behavior Analysis* attest, such recurrence has implications for both the theoretical understanding of behavior and application. Perhaps the first type of recurrence to be investigated was spontaneous recovery, which occurs after a period of nonexposure to the context in which the response was extinguished (e.g., Pavlov, 1927). Later, other circumstances of recurrent behavior were discovered, and theoretical infrastructures developed to not only account for recurrence, but also to integrate these circumstances according to their commonalities. Observing and harnessing the understanding of these recurrence phenomena for application developed concurrently.

The articles comprising this issue raise a number of general issues and concerns in the experimental analysis and application of recurrent behavior, which we consider here as a way of introducing those articles. We first address questions of definition, followed by those of the behavioral processes in recurrence. Thereafter, we consider some methodological issues in the analysis of recurrence and then conclude by ex-

We are indebted to the authors who contributed their research and time to this special issue, and especially to the Journal's Editor, Dr. Alicia Roca, for her enthusiastic, unwavering support of the project. Correspondence about this manuscript and the special issue more generally may be directed to either klattal@wvu.edu or dwacker@uiowa.edu

amining more directly themes that recur throughout our review, the basic to applied continuum and the applied implications of recurrence.

A Note on the Term "Recurrence"

"Recurrence" is but one of several terms used to describe such behavior. Another term frequently used is "relapse." The latter is used largely in translational and applied work where it appropriately describes the recurrence of maladaptive or inappropriate behavior such as drug-taking or aggression. The term is less credible when applied to the "calling forth" of variations on previously learned behavior when a problem in everyday living is encountered that does not lend itself to a linear forward extension of a current behavioral path. Such positive problem solving behavior seems oddly characterized as "relapsed" behavior. Recovery sometimes has been used, most notably as "spontaneous recovery." Recovery lacks the more narrow therapeutic connotations of relapse, but two potential issues render it less useful than recurrence, in our view. Frist, it might be equated with one type of recurrence, spontaneous recovery. Second, it could be contrasted with "spontaneous" recovery and be taken to imply that the organism is an agent of the recovery, as in "voluntary" recovery, an idea antithetical to an environmentalist stance on the variables controlling recurrence. A term like regression, which was used by Carey (1951) (along with reinstatement, which nowadays defines a specific recurrence procedure) to describe what we now call resurgence (see Epstein, 2015, *this issue,* for other terms he considered instead of resurgence) has the problem of the term relapse, but also too much conceptual baggage related to its history of association with psychoanalysis. Because recurrence can involve any topography of behavior, adaptive or maladaptive, as a generic term we prefer it to relapse or recovery, for the reasons noted above. It seemed to us sufficiently generic and neutral to describe the variety of procedures, as well as both the adaptive and maladaptive behavioral topographies that have been studied by the authors of the articles assembled in this special issue, as well as by many others not represented here.

A Variety of Recurrence Phenomena, or Not?

We previously mentioned spontaneous recovery as the first example of recurrence to be systematically investigated. Neither it nor rapid reacquisition (e.g., Bouton, 2014; Nieto & Bernal-Gamboa, 2015, *this issue*) are discussed in any detail in the present articles on recurrence. The other three recurrence phenomena conveniently all begin with the letter R, and, in fact, often are referred to as the three Rs: reinstatement, resurgence, and renewal. All involve first establishing a response, then extin-

guishing or otherwise reducing or eliminating that response, and finally arranging circumstances such that the originally established response recurs. The term "extinction" is used, of course, in two ways in the literature of recurrent behavior. It refers to both the operation of eliminating either the reinforcer or the response-reinforcer relation (thereby delivering the previously established functional reinforcer independently of responding) and to the behavioral process of response reduction or probability to zero or near zero.

Reinstatement occurs when an extinguished response recurs as a function of the delivery of response-independent reinforcers. These reinforcers typically have been of the same type as those used prior to extinction to maintain the response, and the question of whether different reinforcers would have the same effect remains unanswered. Almost as soon as it is reinstated, such behavior becomes susceptible to maintenance by adventitious reinforcement, making the assessment of reinstatement *per se* possible only immediately following the first reinforcer delivery. Operant reinstatement has been investigated with human children (Falcomata, Hoffman, Gainey, Muething, & Fienup, 2013; Spradlin, Giradeau, & Hom, 1966). Falcomata et al. (2013) found that reinstatement can be disruptive to clinical programs using a differential-reinforcement-of-other behavior procedure to reduce problem behavior. They noted that in clinical programs, it is often very difficult or impossible to eliminate the delivery of reinforcers that have historically maintained problem behavior. For example, if teacher attention maintains problem behavior, and problem behavior is eliminated with extinction, the probability is very high that teacher attention will continue to be delivered independently of problem behavior. Translational studies focused on how such reinstatement affects the durability and generalizability of treatment effects have not yet been forthcoming.

Resurgence in the context of an experimental analysis conventionally is said to occur when a previously extinguished response recurs following the "worsening of conditions" associated with the reinforcement of a second, topographically different response. Extinction ensures that the response is not in the organism's proximate history, within the experiment. It is possible, of course, to resurge behavior that is a part of the organism's history but is unlikely in the proximate environment. Okouchi (2015, *this* issue) demonstrates resurgence of a response previously reduced by negative punishment and Mechner and Jones (2015, *this* issue), suggest that resurgence is the "reappearance of behavior that occurred earlier in the individual's history but not recently, without restoration of the conditions under which the earlier behavior occurred" (p. 63). The worsening of the alternative response conditions that result in resurgence typically means nonreinforcement, but punishment (Wilson & Hayes, 1996) or reductions in reinforcement rate (Lieving & Lattal, 2003) of the alternative response also may resurge previously established but currently low-probability behavior.

Many of the studies in this issue use a three-stage procedure for assessing resurgence, with almost as many labels assigned to the stages as there are studies reporting them! Labels aside, a critical question in assessing resurgence of the first-trained response is whether that response resurges because it was not eliminated before the alternative response was reinforced. In several experiments (e.g., Berg et al., 2015, *this issue*; Epstein, 1983; Lieving & Lattal, 2003, Experiment 1) a four-stage procedure has been used in which the original response is indeed extinguished before the alternative response is reinforced, suggesting that any return of the original response is not because it was not eliminated prior to the second phase. Studies employing differential-reinforcement-of-other-behavior (DRO) schedules in the second phase (e.g., da Silva, Maxwell, & Lattal, 2008; Doughty, da Silva, & Lattal, 2007) also ensure that the first-learned response is eliminated prior to the resurgence test.

Epstein (2015, *this issue*) reviews some of the early reports of resurgence. To those we would add the work of Carey (1951), which we believe to be the first experimental analysis of resurgence from a behavior-analytic perspective. Carey called the phenomenon "regression" (with the quotation marks included). The published abstract of his original report of it appears as the first piece in this special issue. The research described in the abstract appears to have comprised a portion of his 1953 doctoral dissertation at Columbia University, although attempts to locate that dissertation at Columbia have proven unsuccessful. Both Epstein (2015, *this issue*) and St. Peter (2015, *this issue*) outline some of the reasons that resurgence has relevance in, respectively, human problem solving and clinical application.

Renewal occurs when a previously extinguished response recurs when the context associated with extinction is changed. As Trask, Schepers, and Bouton (2015, *this issue*) note in their review, renewal is studied by changing the context as the trained response is extinguished. In typical experiments on renewal, the context is broadly defined as the "tactile, visual, and olfactory cues that comprise the operant chamber in which learning takes place" (Trask et al., p. 189). After the response is extinguished, changing the context again often results in the recurrence of the extinguished response. The latter context can be the one associated with the original training of the response (ABA renewal) or an entirely different one (ABC renewal). Another type, AAB renewal, where the context changes only after the response is extinguished in the original training context, also has been studied. One of the challenges facing investigators studying renewal has been that of defining context in a noncircular manner. For example, if one institutes a nominal ABC renewal procedure, but fails to obtain renewal in the C condition, does one conclude that such renewal does not occur or that the C condition did not really constitute a context change? If the latter, then a C condition exists only if renewal occurs, making renewal both the definition and the cause of the recurrence. From an applied standpoint, analyses of renewal may lead to a better un-

derstand of how training or treatment contexts influence treatment outcomes (see Podlesnik & Kelley, 2015, *this issue*; Tamai & Nakajima, 2015, *this issue*). It is, for example, common for behavioral treatments to be conducted in treatment or training center settings by trained clinicians prior to being implemented at home by parents or in-home workers. This requires that a substantial amount of generalization occur for the effects of treatment to be realized at home. Although such stimulus generalization has been reported for treatments such as functional communication training (e.g., Wacker et al., 2005), studies that show the stimulus conditions that facilitate persistence of new, desired responses across stimulus conditions and suppress the recurrence of undesired historic responses are needed in both the translational and applied literature (See Berg et al., 2015. *this issue,* and St. Peter, 2015, *this issue*).

A broader question that has been raised about the three Rs, and the other two examples of recurrence is whether they are separate phenomena or different manifestations of a singular behavioral process. Bouton and colleagues (e.g., Bouton, Winterbauer, & Todd, 2012) have proposed that the three Rs plus spontaneous recovery and rapid reacquistion, are most usefully considered as instances of renewal. Nieto and Bernal-Gamboa (2015, *this issue*) offer an alternative account of renewal that perhaps may apply to the other recurrence phenomena as well. Others (e.g., Podelsnik & Kelley, 2014, 2015, *this* issue) suggest that resurgence and renewal are controlled in different ways. The articles in this special issue offer new dimensions that invite consideration in evaluating the interrelations among the procedural, circumstances leading to behavioral recurrence.

One final comment on these recurrence phenomena is that they all are behavioral outcomes resulting from the manipulations described in the previous section. They are not explanations, that is, behavior does not occur *because* of resurgence or any of the other recurrence phenomena. Such behavior invites explanations of the sort discussed in the articles mentioned in the preceding paragraph, but labels should not be confused with accounts of the behavior so labeled (see also Lit & Mace, 2015, *this issue*).

The Three-Term Contingency and Recurrence

Recurrence has been investigated as a function of antecedent and discriminative stimuli, responses, and consequences. Several of the articles in this issue consider aspects of the broader configuration of discriminative stimuli and other antecedent events on resurgence (e.g., Podlesnik & Kelley, 2015, *this issue*; Tamai & Nakajima, 2015, *this issue*; Trask et al., 2015, *this issue*) and Nieto and Bernal-Gamboa (2015, *this issue*) suggest how attention might be usefully considered as an antecedent to renewal. Others address the relation between recurrence and response characteristics

such as their frequency of occurrence (Mechner & Jones, 2015, *this issue*) and, in the work of Berg et al. (2015, *this issue*), the relation between recurrence and previously observed problem behavior. Most laboratory experiments, and some applied ones, investigate operants comprised of a single topography and its variants (e.g., single instances of key pecks or lever presses). Recurrence certainly is not confined to such elementary operants, as both previous experimental analyses (e.g., Bruzek, Thompson, & Peters, 2009) and Berg et al.'s analysis of the resurgence of mands illustrate.

Because extinction of previously reinforced responding plays such a major role in the generation of recurrent phenomena, it is not surprising that theoretical accounts of recurrence have focused on reinforcement parameters in mapping the phenomenon. One of the most well-developed-to-date models of recurrence derives from behavioral momentum theory (Shahan & Sweeney, 2011) and thus emphasizes the importance of reinforcement rate in determining recurrence (see also Lit & Mace, 2015, *this issue* and Podelsnik & Kelley, 2015, *this issue*). Cançado, Abreu-Rodrigues, and Alo (2015, *this issue*) suggest some of the limiting conditions under which historical reinforcement rates might affect subsequent resurgence.

A potential confounding variable in most demonstrations of functional relations between reinforcement rate and resurgence is that more frequent reinforcement yields higher rates of responding (Cançado et al., 2015, *this issue*; see also Fujimaki, Lattal, & Sakagami, 2015, *this issue*). When the two are unconfounded, lower response rates may be more persistent than higher ones (e.g., Blackman, 1968; Lattal, 1989). The issue becomes more complicated when the findings of da Silva et al. (2008) are added to the mix, because they found greater absolute resurgence when response rates of the initially trained response were higher and unconfounded by differences in reinforcement rates. Such findings suggest that the role of response rate needs to be taken into account when considering how reinforcement rates affect recurrence. Moriyama, Kazama, Obata, and Nakamura (2015, *this* issue) show that eliminating nonconsummatory reinforcers can result in resurgence. Their research raises the question, too, of how qualitatively different reinforcers might differentially affect resurgence. The latter question is particularly important because treatments typically involve different reinforcers than those maintaining the problem behavior being eliminated.

In contrast to the extensive use of reinforcement in the analysis of recurrence, relatively little is known about the role of punishment. In an experiment, mentioned already, that is unusual in its use of both human subjects and negative punishment to examine recurrence, Okouchi's (2015, *this issue*) data suggest that the originally trained response can be resurged after it has been reduced by punishment in the form of point loss. As with the Moriyama et al. (2015, *this* issue) experiment, comparisons of different response elimination procedures, such as positive and negative punishment, as well as extinction and punishment as means of response elimination are raised by Okouchi's analysis.

Measuring Recurrence

An important part of the definition of any phenomenon is how it is to be measured. It is one thing to say that a response has recurred, but another to provide evidence that this is indeed the case. So, a basic question remains that of "what shall we accept as evidence that a response has recurred?" If a response is completely eliminated for some period of time following the discontinuation of reinforcement (formal and functional extinction), then if the response recurs subsequently the evidence for it being an instance of recurrence is straightforward. Sometimes, however, responding is not completely eliminated before the environment is changed to induce behavioral recurrence (see Berg et al., 2015, *this issue*), so decisions have to be made as to whether the recurring behavior is sufficiently different from the extinction baseline to assert that true recurrence has obtained. It also is possible that the recurrence does not occur immediately following the environmental change, introducing the possibility of some process other than that associated with recurrence-related variables playing at least some role in bringing about the observed behavior.

Most of the articles in this issue measure resurgence and renewal in terms of the number or rate of responses occurring during the recurrence test phase. Another index was suggested by Cançado et al. (2015, *this issue*), who measured resurgence not only as magnitude, but also the number of sessions in which it occurred. This latter measure could serve as a resistance to change measure by continuing the recurrence test until a session occurs without recurrence (a sort of persistence measure). It would seem that both measures of recurrence are valuable as a relative index of the persistence or recurrence as a function of different training conditions, either within or across subjects.

Many of the early investigations of recurrence used as the index of such recurrence the absolute number of responses occurring in recurrence sessions following the onset of extinction in the third (or fourth – see discussion of resurgence above) phase of the recurrence procedure. It also may be of value to measure relative recurrence, either with respect to the original response (assuming it is available for measurement – see Mechner & Jones, 2015, *this issue*) or with respect to the occurrence of the target response just prior to the onset of the recurrence test. Such a relative measure may be of particular value when two conditions are being compared (e.g., da Silva et al., 2008; Cançado et al., 2015, *this issue*; Fujimaki et al., 2015, *this issue*), when response rates in the first phase are different from one another in successive recurrence tests, or when alternative responding is not completely eliminated in the second phase.

In relation to application, measuring resurgence relative to the problem-behavior baseline may prove the more useful index because the concern is how effective the treatment is in sustaining the absence of the problem behavior once that treatment is terminated. Also in application, the measurement waters can be muddied further by

attempts to measure 'clinically significant' recurrence (cf. St. Peter, 2015, *this issue*). Although there are undoubtedly episodes, types, durations, and magnitudes of recurrence that "matter more" than others, the finding of translational studies on recurrence need to be empirically driven and not based on clinical importance. If we consider the basic studies to be the first generation of research, and translational studies to be the second generation, then the clinical significance of a finding is a question for third generational applied researchers.

As noted above, measuring reinstatement poses unique problems because of the possibility of adventitious reinforcement once the previously reinforced response occurs in the presence of response-independent food deliveries. Mace et al. (2010) also noted how reinforcement within a stimulus context likely strengthens all of the members of a response class and not just the target response. Thus, measures of reinstatement may need to capture the occurrences of responses that are correlated with the target response, even if those responses did not occur during baseline (see St. Peter, 2015, *this issue*). It is possible that over the course of treatment, these correlated responses are strengthened to the point that they now occur post-treatment when, for example, the target behavior does not produce reinforcement (See Berg et al., 2015, *this issue*).

The Transience of Behavioral Recurrence

Because recurrent behavior is studied in the absence of reinforcement, it is fleeting. It exemplifies what Sidman (1960) discussed as transient behavior, behavior that deviates from a baseline for a short period of time before returning to that baseline level. Recurrent phenomena typically are observed for at most just a few sessions before the behavior disappears. In the case of resurgence, its onset often is delayed from the onset of the resurgence phase, probably because it takes time for the behavior to come into contact with the extinction contingency. Once this happens, the recurrent behavior soon peaks and then dissipates, as is to be expected of behavior that is not reinforced. Generally speaking, the onset of recurrence with reinstatement and renewal is more rapid, perhaps because the discriminative stimulus change from the preceding condition is more abrupt and thus is more immediately disruptive.

There is some evidence that, although transient, recurrence is repeatable with reexposure to either the entire recurrence procedure (e.g., training, alternative reinforcement, and resurgence test in the case of resurgence; da Silva et al., 2008; Lieving & Lattal, 2003) or to only repeated returns to the alternative reinforcement phase (Sweeney & Shahan, 2013). Although Lieving and Lattal showed no systematic differences between a first and second resurgence test, their analysis was limited to only two of the previously noted sequences. Sweeney and Shahan found that with their

procedure the amount of resurgence not surprisingly dissipated with repeated tests. Wacker et al. (2011) also showed that repeated returns to a baseline extinction condition resulted in repeated, but progressively less, resurgence over the long-term (many months) course of a DRA treatment. Conclusions about the general nature and controlling variables of recurrent behavior have been constrained by the transience of recurrent behavior and the amount of time required to examine it repeatedly.

The Occurrence and Nonoccurrence of Recurrence

It may be tempting to some to conclude that the transient nature of recurrent behavior makes it both less interesting and more problematic than more persistent and steady state behavior. Because transient may describe everything from a temper tantrum to grieving the death of a beloved family member, the applied implications of the experimental analysis of transient phenomena are enormous. Compound that with the power of changed (often worsening) circumstances to evoke previously reinforced behavior and the applied significance of recurrence is overwhelming.

Many of the articles in this special issue —as is the case, appropriately, with most of the extant literature on recurrent behavior— address the conditions under which recurrence occurs. Sometimes the recurrence of behavior is not a desirable outcome and sometimes it is highly desirable. The generation of recurrence, as Epstein has noted not only in his present article (Epstein, 2015, *this issue*; see also Mechner & Jones, 2015, *this issue*), but in many others as well (e.g., Epstein, 1991) is important in problem solving and what is called creative behavior. Of equal significance, but much less well investigated, are the circumstances that result in the prevention or elimination of recurrence (e.g., Mace et al., 2010). The importance of this is illustrated by the research of Wacker et al. (2011), who observed that resurgence of problem behavior occurred within 5 min of the placing of all alternative responding on extinction. This occurred in some cases even following months of reinforcement of the alternative responding as part of the treatment program. Findings delineating the conditions under which recurrence develops can be extrapolated to suggest controlling variables and behavioral mechanisms/processes involved in the prevention or elimination of recurrence, but the applied significance of recurrence invites more direct analyses of how the prevention or elimination of recurrent behavior might be effected. In the applied literature, these analyses are, therefore, analyses of the conditions under which treatment effects are maintained (Nevin & Wacker, 2013). As mentioned previously, to date, applied researchers have approached maintenance in a categorical (yes/no) rather than in a functional fashion. Applied studies that identify stimuli that disrupt treatment effects over the long-term course of treatment are needed to better program for maintenance. Reflecting the general trends in the literature, most

of the present articles are concerned with the generation of recurrent behavior. Noteworthy in their concern with elimination or reduction of recurrent behavior are the analysis of renewal by Tamai and Nakajima (2015, *this issue*) and Nieto and Bernal-Gamboa (2015, *this* issue) and some of the observations of Trask et al. (2015, *this issue*, pp. 203–204).

Recurrence and the Basic - Applied Continuum

We view this special issue as building a bridge (cf. Hake, 1982) between basic and applied research and researchers. The area of recurrence, and especially resurgence, has become an important common ground between the two. Novel and dynamic developments are occurring in both our identification of the basic mechanisms that underlie recurrence (Nieto & Bernal-Gamboa, 2015, *this issue;* Trask et al., 2015, *this issue*; Podlesnik & Kelley, 2015, *this issue*) and the conditions that lead to successful application (Berg et al., 2015, *this issue*; Lit & Mace, 2015, *this* issue; Podlesnik & Kelley, 2015, *this* issue; St. Peter, 2015, *this issue*). Thus, contributions to the understanding of resurgence are occurring concurrently on both ends of the applied-basic continuum. Many of the articles comprising this issue exemplify the bridge discussed by Hake (1982), and it is this bridge that makes behavior analysis distinct from most other areas of psychology or the social sciences.

As noted by Lit and Mace (2015, *this issue*) the first generation of translations often involve replications of the findings of studies conducted with nonhuman subjects with humans, but in more highly controlled environments such as laboratories. The initial translation of a recurrence phenomenon by Mace et al. (2010) is one example of a bridge study. As described by St. Peter (2015, *this issue*), other translations involve changes in clinical treatment that occur frequently in applied settings. For example, problems with treatment fidelity provide for an excellent disrupter of treatment in applied situations, and if studied carefully, can advance our understanding of critical applied outcomes such as maintenance (e.g., different levels of disruption correlated with omission versus commission errors). As translational studies morph into application, the results have the potential to alter clinical practice, such as the way programming for maintenance (cf. Stokes & Baer, 1977) occurs and how fading programs are developed. Translational studies of resurgence offer an empirical model for documenting the relation between changes in specific stimulus conditions and the persistence of both desired and problem responding in less controlled settings such as schools and homes. Thus, they offer the potential of maintenance studies that identify the conditions under which therapeutic changes in responding persist and continue to evolve in adaptive ways even when challenged, and to identify challenges to treatment that result in the recurrence of problem behavior.

Conclusion

It seems fitting to end this overview of the special issue on the recurrence of operant behavior with an observation of Mechner and Jones (2015, *this issue*). Their observation specifically directs the reader's attention to the significance of resurgence, which is the topic of their article. By substituting "recurrence" for resurgence, however, we believe their questions nicely capture the significance and potential of recurrence more generally, both as represented in this special issue and in the field as a whole:

> Is substantially *all* operant behavior composed of pieces of or variants on earlier forms? Does resurgence occur only if recently effective behavior has ceased to produce its reinforcing result, or does it also occur if the same result has become less reinforcing? Does it occur when behavior has aversive consequences? When successive versions of recent behavior don't work, does resurgence tap into behavior of ever greater antiquity —a kind of regression effect? Is the resurgence phenomenon associated with motivational modality? With stress? What are the similarities and differences between resurged behavior and its antecedents? These and many related questions define the frontier of resurgence research. (Mechner & Jones, p. 81).

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