



Short report

Super-resurgence: ABA renewal increases resurgence



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ABSTRACT

Previously extinguished operant responding recurs under both resurgence and renewal procedures, but the effects of combining these procedures on recurrence has not been studied. Because renewal and resurgence are known to independently produce response recurrence, we examined whether greater resurgence would occur if the resurgence procedure was combined with an ABA renewal procedure, relative to a resurgence procedure without contextual changes. Three pigeons were exposed to a concurrent resurgence procedure in which key colors served as contextual stimuli. In the Training phase, reinforcement for pecking two keys was scheduled on concurrent variable-interval (VI) 120-s VI 120-s schedules, each correlated with different key colors. In the Alternative Reinforcement phase, reinforcement occurred when neither key was pecked for 20-s (a differential-reinforcement-of-other-behavior [DRO] 20-s schedule). During this phase, one of the key colors was changed (ABA key), while the other key color remained as in the Training phase (AAA key). In the third phase, reinforcement was not provided and the color of the ABA key was changed back to the color in effect during the Training phase while the same color remained in effect on the other key. Greater resurgence occurred on the ABA renewal key with each pigeon, demonstrating that a superimposed ABA renewal procedure increases resurgence.

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1. Introduction

The recurrence of previously reinforced but currently extinguished behavior can occur under a variety of circumstances. Two of the most extensively studied of these are resurgence and renewal. The former is the label given by Epstein and Skinner (1980) to the recurrence of a previously reinforced response when a more recently reinforced response is extinguished. It is typically studied using a three-phase procedure. In the first (Training) phase, a response produces reinforcement. In the second (Alternative Reinforcement) phase, a second response produces reinforcement, and the original response does not produce reinforcement (i.e., is under extinction). In the third (Resurgence) phase, neither response produces reinforcers. An increase in the originally reinforced response during this phase relative to its occurrence in the Alternative Reinforcement phase constitutes resurgence. One variation of the procedure for studying resurgence is to reinforce concurrently two responses under different contingencies during the Training phase and subsequently comparing the relative rates of resurgence of those two responses. da Silva et al., (2008) established key pecking on concurrent schedules that con-

trolled different rates of responding on two keys. In the Alternative Reinforcement phase, responding on both keys was eliminated with a differential-reinforcement-of-other-behavior (DRO) schedule such that reinforcement followed any 20-s period without a response on either key. In the Resurgence phase, reinforcement was discontinued and resurgence on either key was measured. This procedure, thus allows assessment of relative resurgence simultaneously resulting from different contingencies within individual subjects.

Renewal occurs when there is a context change following extinction of the response (Bouton et al., 2011). Renewal, like resurgence, is generated using a three-phase procedure. Three procedures used to study operant renewal have been labeled ABA, ABC, and AAB, where each successive letter identifies the context in each of the three phases (e.g., Bouton et al., 2011). For example, ABA denotes a procedure in which a response first is reinforced in one condition, or context, (A) and extinguished in another (B). When the original (A) context is reinstated, the originally reinforced response recurs, despite extinction still being in effect for that response. This ABA procedure leads to the most reliable renewal of operant behavior. Renewal studies typically differentiate between contexts with simultaneous changes in several background or “contextual” stimuli, which have included different experimental chambers in different laboratory rooms, odor, chamber flooring, and striped vs. solid walls (e.g., Bouton et al., 2011). Podlesnik and Shahan (2009)

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differentiated between contexts with a single stimulus modality (flashing vs. steady houselight) and still observed ABA renewal.

The difference between the procedures for generating resurgence and renewal is that the former largely involves manipulations of reinforcement parameters and the latter, stimulus, or context, manipulations. In fact, both procedures involve the training of one response, then extinguishing that response, and a test phase in which the stimulus or context is changed. In renewal the contingency remains the same as in the previous condition and the context is changed by changing the exteroceptive stimulus associated with extinction. In resurgence, removing the reinforcement of the alternative response is a contingency change, but that change also may be construed as a context/stimulus change. This similarity between the two procedures invites the question of how resurgence would be affected if, in the third phase, both reinforcement of the alternative response was eliminated and the exteroceptive stimulus were changed simultaneously. To answer the question, resurgence with and without an exteroceptive stimulus change in the resurgence test phase were compared within individual pigeons using the da Silva et al. (2008) concurrent resurgence procedure.

2. Materials and methods

2.1. Subjects

Three experimentally naïve mature male White Carneau pigeons were maintained at $80\% \pm 3\%$ of their free-feeding weights. They were housed in individual cages in a temperature-controlled room with a 12:12 h light:dark cycle. They had free access to water and health grit in the home cages.

2.2. Apparatus

Sessions were conducted in two light- and sound-attenuating plywood operant conditioning chambers, 32 cm high $\times$ 30 cm wide $\times$ 30 cm long. Three Gerbrands response keys were located on the front, aluminum, panel, 26.6 cm above the floor. The keys were centered on the front panel, 7.6 cm apart, center to center. The two side keys were used. Reinforcement consisted of 3-s access to mixed grain from a hopper located behind a 4.5 cm square food aperture centered directly below the center response key, with the lower edge 8.5 cm from the floor. A houselight, located 5.7 cm to the right of the feeder aperture and 3.8 cm above the floor, provided general illumination at all times except during reinforcement. A computer in an adjacent room operated MedPC software which controlled experimental events and recorded session data.

2.3. Procedure

Sessions occurred daily at approximately the same time each day. A 3 min blackout period, during which the key lights and houselights were off, preceded each session. Key pecking first was hand-shaped. Then, pecks to the two keys were reinforced using a concurrent variable interval (VI) 10-s VI 10-s schedule arranged on the side keys. The VI schedules arranged reinforcers on each key independently. A 3-s changeover delay was in effect, such that pecks to a key were not reinforced within 3-s of a response on the other key. The mean interreinforcer interval of both schedules was gradually increased across sessions until the mean value for both VI schedules was 2 min. Following this preliminary training, the following conditions were effected in the order described. The independent variable was the colors of the two response keys in the different phases. These colors are shown in Table 1.

2.4. Training phase

Reinforcement of responding on both keys was arranged according to a concurrent VI 2 min VI 2 min schedule. Sessions were 60 min, excluding reinforcement time. The Training phase was in effect for at least 10 sessions, and until no increasing or decreasing trends in response rate were evident across the last 6 sessions on visual inspection. This phase was completed after 15, 11, and 10 sessions for pigeons 718, 824, and 1130, respectively.

2.5. Alternative reinforcement phase

A DRO 20-s schedule replaced both VI schedules such that reinforcement occurred every 20-s so long as neither key was pecked during the interval. Both left and right keys remained illuminated, and a response on either key reset the interval to 20-s. The color of the key that hereafter will be labeled the AAA key was the same as in Phase 1, and the color of the key that hereafter will be labeled the ABA key was changed as noted in Table 1. This phase was in effect for at least 7 sessions and until response rates were less than one response per min on both keys during a single session. Responses per minute for the last session of the Alternative Reinforcement phase were 0.15, 0.29, and 0.49 on the ABA key, and 0.10, 0.00, and 0.15 on the AAA key for Pigeons 718, 824, and 1138, respectively.

2.6. Resurgence phase

During this phase, extinction was in effect on both keys (i.e., food delivery was discontinued). The color of the AAA key remained the same, but the ABA key returned to the original color in effect in Phase 1 (see Table 1). This procedure allowed a direct comparison of resurgence with and without the added stimulus change that characterizes tests of renewal. The colors of the two side keys thus constituted a test of the resurgence-renewal interaction, with resurgence only on the AAA key and resurgence and renewal on the ABA key. Sessions ended after 30 min. This phase was in effect for at least 5 sessions and until response rates during a single session were less than one response per minute on both keys. Responses per minute during the last session of the Resurgence phase were 0.00, 0.13, and 0.10 on the ABA key, and 0.30, 0.00, and 0.00 on the AAA key for pigeons 718, 824, and 1138, respectively.

3. Results and discussion

Table 1 shows the mean response rate and obtained reinforcement rate during the last 6 sessions of the Training phase for each pigeon. Fig. 1 shows responding during Alternative Reinforcement and Extinction phases as proportions of the mean Training phase response rates shown in Table 1. During the Alternative Reinforcement phase, response rates decreased on both keys. All pigeons responded more on the key that remained the same color (AAA key) than the key that changed color (ABA key) throughout the Alternative Reinforcement phase. For 2 of 3 pigeons, a more rapid decline in responding was observed on the ABA key during the first several sessions of Alternative Reinforcement. For 824, response rates initially declined comparably on both keys, but greater persistence on the AAA key occurred in the last several sessions of Alternative Reinforcement. During the Resurgence phase, resurgence occurred on both the AAA and ABA keys for all pigeons. Proportionally greater resurgence occurred on the ABA key relative to the AAA key for all pigeons during the first session of the Resurgence phase. This effect occurred despite slightly higher response rates on the AAA key during the Alternative Reinforcement phase. Thus, an exteroceptive stimulus change in combination with extinction of the alternative response resulted in greater resurgence than did the same procedure but without an accompanying exteroceptive stimulus

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