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RESURGENCE OF THREE-RESPONSE SEQUENCES IN RATS

RESURGIMIENTO DE SECUENCIAS DE TRES RESPUESTAS

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ABSTRACT

Resurgence is defined as the reappearance of behavior patterns observed earlier in a subject's learning history but not observed in the present. Response resurgence has been observed when both simple and complex operants are used. The present experiment was designed to evaluate the resurgence of response sequences when using an extinction procedure in the third phase. Rats were trained to emit sequences of three responses on two levers [left (L) and right (R)]. In the first phase, the subjects were assigned to one of two groups; the first group being reinforced for emitting the sequence RLR, and the second group being trained to emit the sequence RLL. In the second phase, the sequence LLL was reinforced in both groups. Finally, in the third phase, responding by both groups was extinguished. The results showed an increase in the variability of the sequences emitted in the third phase. However, in both groups the greatest increase was observed in the percentage occurrence of the sequence reinforced during the first phase. These results are discussed as evidence of the resurgence of response sequences.

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RESUMEN

Si se expone a un organismo a dos condiciones de reforzamiento en forma sucesiva, y luego a una fase de extinción o un programa de reforzamiento distinto, el sujeto emitirá la conducta reforzada en la primera fase. Este fenómeno se conoce como resurgimiento y se ha observado con operantes simples y complejas. Se diseñó el presente experimento con el propósito de evaluar el resurgimiento observado en secuencias de respuestas utilizando un procedimiento de extinción en la tercera fase. Para ello, se entrenó a seis ratas a emitir secuencias de tres respuestas en dos palancas [izquierda (I) y derecha (D)]. En la primera fase se asignó a los sujetos a uno de dos grupos; el primer grupo fue reforzado por emitir la secuencia DID, mientras que el segundo grupo fue entrenado a emitir la secuencia DII. En la segunda fase se reforzó la secuencia III en ambos grupos. Finalmente, durante la tercera fase se sometió a ambos grupos a extinción. Los resultados mostraron un incremento en la variabilidad de las secuencias emitidas durante la tercera fase. Sin embargo en ambos grupos se registró el mayor incremento en el porcentaje de ocurrencia en la secuencia reforzada durante la primera fase. Se discuten los resultados como evidencia del resurgimiento de secuencias de respuestas.

Resurgence refers to all those behaviors that were reinforced in prior phases and that reappear when there is a change of reinforcement contingencies (Epstein, 1983, 1985). The basic procedure used for the study of resurgence consists of three phases. In the first phase, a response is reinforced under some schedule of reinforcement. In the second phase, a different response to that trained in the previous phase is reinforced. Finally, during the third phase, the responses reinforced in both prior phases are extinguished. During this extinction phase, a transitory increase in the frequency of the response reinforced in the first phase is observed, while the frequency of occurrence of the response reinforced in the second phase diminishes.

Epstein (1985) conducted one of the first studies of response resurgence. In the first of three phases, four pigeons were reinforced under a variable interval (VI) 60s reinforcement schedule for pecking the right-hand key on a standard three-key operant conditioning chamber. In the second phase, the right-hand key was made inoperative and the reinforcement schedule was changed to the center key. During this training phase, responses to the right-hand key diminished, while responses to the center key increased and became more stable. In the tenth session of the second phase, the subjects made no response to the right-hand key. Finally, in the third phase, pecking on both the right-hand and center keys was extinguished.

The results obtained from the extinction phase showed that there were

few responses on the left-hand key. The rate of response to the center key was high (about 2000 responses) during the first 40 minutes of the first extinction session, or 50 responses per min, and later decreasing. During these first 40 min there were no responses to the right-hand key, but as responding to the center key began to diminish, responses to the right-hand key reappeared at a rate of 900 responses in the last 20 min (45 responses per min).

The procedures normally used to study resurgence employ extinction in the third phase (Epstein, 1983; Leitenberg, Rawson, & Mulick, 1975; Mowrer, 1940; Rawson, Leitenberg, Mulick, & Lefebvre, 1977). However, resurgence has also been reported when the requirement for reinforcement is increased in the third phase, that is, when there is a reduction in reinforcement density during the third phase (Lieving & Lattal, 2003; Mechner, Hyten, Field, & Madden, 1997), or when the extinction phase follows a second non-contingent reinforcement phase of an autoshaped pecking response (Epstein & Skinner, 1980). It is also known that resurgence can occur on repeated occasions in the same subject (Lieving & Lattal, 2003).

Although the experiments designed to study resurgence have been few, they have demonstrated that it reliably occurs in diverse species, such as humans (Mechner et al., 1997; Willson & Hayes, 1996), rats (Mowrer, 1940), chickens (Cleland, Foster, & Temple, 2000) and pigeons (Epstein, 1983; Epstein & Skinner, 1980).

At least two explanations for resurgence have been proposed. On one hand, Epstein (1985) suggested the hypothesis of extinction-induced resurgence, in which resurgence of Behavior 1 occurs due to the fact that Behavior 2 is being extinguished. Thus, subjects switch to Behavior 1 as a response to changing reinforcement contingencies at the onset of extinction. On the other hand, Leitenberg et. al. (1975) proposed the response prevention hypothesis which suggests that the amount of resurgence is a function of the degree of response prevention by competing responses during extinction. Cleland et. al. (2000) have shown that extinction of the behavior reinforced in the second phase does not always lead to the resurgence of the response reinforced in the first phase. Thus, induction of Behavior 1 by extinction of Behavior 2 is not a necessary condition for observing resurgence.

Resurgence has been described employing simple operants (Epstein, 1983, 1985; Epstein & Skinner, 1980; Mowrer, 1940; Rawson et al., 1977); derived relational responses (Willson & Hayes, 1996); revealed operants (Mechner et al., 1997); and rule-following behavior (Dixon & Hayes, 1998). Additionally, experiments carried out by Bachá and coworkers (Bachá, Reid, & Mendoza, in press; Bachá & Sánchez-Carrasco, 1998; Sánchez-Carrasco, 2001) have shown response sequences resurgence. In those experiments, rats were trained to emit two-response sequences. The experiments basically consisted of four phases and, in each phase, the emission of one of four possible response sequences

[Left – Left (LL), Left – Right (LR), Right – Left (RL) and Right – Right (RR)] was reinforced. During the first phase, the emission of a heterogeneous sequence (LR or RL) was reinforced. In the second phase, the emission of a homogeneous (LL or RR) or a heterogeneous (LR or RL) was reinforced. In the third phase, a homogeneous sequence was trained. Finally, in the fourth phase, either a homogeneous or heterogeneous sequence was reinforced.

Findings reported by Bachá, et. al. (in press) showed resurgence when changes between phases involved two homogeneous sequences, such LL to RR or RR to LL. Their data also showed greater resurgence when the resurgence sequence was trained until reach stability criteria. Even though some phases on Bachá's experiments provided the opportunity to observe resurgence of homogeneous sequences, it was not observed in any subject. In other unpublished experiments Bachá and coworkers (Bachá & Sánchez-Carrasco, 1998; Sánchez-Carrasco, 2001) have shown resurgence of heterogeneous sequences when other heterogeneous sequence was reinforced on the third phase.

The data obtained by Bachá et. al.(in press), and Bachá & Sánchez-Carrasco (1998) indicated that when a heterogeneous sequence is trained, then a new homogeneous sequence is reinforced and finally a new homogeneous or heterogeneous response sequence is trained, that heterogeneous sequence trained in the first phase resurges during the last phase. Although these findings were interpreted by Bachá et al. (in press) as resurgence of response sequences, a limitation of these experiments is that they do not allow differentiate between a possible induction effect generated by the sequence reinforced in the resurgence phase, from the resurgence of that sequence reinforced in the first phase.

Several experiments (Fetterman & Stubbs, 1982; Reid, 1994; Schwartz, 1980, 1981, 1982, 1984) on complex behavioral patterns have shown that sequences can act as functional units and that reinforcing one sequence may affect the emission of other response sequences (Grayson & Wasserman, 1979; Reid, 1994). Additionally other experiments (Wasserman, Deich, & Cox, 1984; Wasserman, Nelson, & Larew, 1980) have provided information regarding the dynamics of response sequences becoming behavioral units. The present experiment also uses resurgence as a procedure to asses how learned response patterns change when reinforcement contingencies change. Thus, rats were trained to emit three-response sequences and an extinction procedure was employed in the resurgence phase. In this way, it would be possible to evaluate the resurgence isolated from the effects of reinforcement, and to compare resurgence of response sequences to results with procedures that used simple operants.

METHOD

Subjects

Six female, four month-old, experimentally-naive, Wistar-strain rats were used with initial *ad-libitum* weights ranging from 174 to 201 g. The rats were housed individually with free access to water and, at the end of each experimental session, received sufficient solid food (Harlan Teklad Mouse/Rat Diet) to maintain them at 80% of their *ad libitum* weights.

Apparatus

Four MED Associates (model ENV-007) rat operant conditioning chambers were used; they were placed inside sound-attenuating boxes which had a fan that attenuate external noises. The operant chamber had two levers (model ENV-110M from MED Associates) located in its front panel, the levers were situated 4 cm from the floor, a light bulb (MED model ENV-221M) was placed 3 cm above each lever; the distance between levers was 10 cm. The feeding dish, where the reinforcer was delivered, was located in the center of the front panel, 1 cm from the floor. On the rear panel, a house light located 2 cm below the ceiling provided general illumination. The reinforcers employed were 45 mg Noyes pellets of Formula F sucrose. The chambers were connected to a Pentium computer that controlled the experimental sessions and collected the data. The stored data included lever presses and stimulus changes with their respective times of occurrence.

Procedure

During the period of the experiment, all of the subjects were exposed to a discrete-trial procedure. At the beginning of each trial, the lights above the levers and the house light were switched on. All of the lights remained on until the subject pressed any lever (or combination of levers) three times. Thus, the combination of left (L) and right side (R) lever presses, and the order of their occurrence, resulted in eight possible sequences of responses: LLL, LLR, LRR, LRL, RLR, RLL, RRL and RRR. The emission of the sequence specified by the contingency of reinforcement was followed by the delivery of the reinforcer, while any of the other sequences was followed by a 10 second timeout. After reinforcement or timeout, a 1 second inter-trial interval initiated, during which the lever lights and the houselight remained off.

Before beginning the experiment, all subjects were exposed to a phase in which response sequences were trained. In the first stage of this phase, the emission of any of the eight possible sequences was reinforced. In the sec-

ond stage of this phase, only the emission of heterogeneous sequences was reinforced; that is, only the sequences that included at least one response on each lever (LLR, LRR, LRL, RLR, RLL and RRL). The criterion for switching a subject from the first to the second stage was when it received more than 80% of available reinforcers in a given session. In contrast, ending the second stage required that the subjects obtained more than 40 reinforcements during three consecutive sessions. Each session of the training phase lasted 50 trials or 40 min, whichever occurred first.

The experiment proper consisted of the three phases that correspond to the typical resurgence procedure. In each phase, the subjects were reinforced for emitting a sequence during a fixed number of sessions. Throughout the three phases of the experiment sessions lasted 100 trials or 40 min, whichever happened first.

In the first phase, the subjects were assigned to either the RLR or RLL group (three subjects per group). In this phase, a different sequence was reinforced for each group. The RLR group was reinforced for emitting the RLR sequence, while the RLL group was reinforced for emitting the RLL sequence. This phase lasted 50 sessions for each group.

During the second phase, both groups were reinforced for emitting the LLL sequence. This phase lasted 10 sessions. Finally, in the third phase, responding in both groups was extinguished, that is, none of the eight possible sequences were reinforced.

The changes between phases always occurred in the 51st trial of a designated session, without signaling the change of reinforcement contingency. For example, when a subject from the RLL group changed from the first to the second phase, it was reinforced over the first 50 trials of the session for emitting the RLL sequence and, from the 51st trial on, was reinforced for emitting the LLL sequence.

RESULTS

The upper panel of Figure 1 shows the total percentage occurrence of each response sequence during the first and second phases, for each group in blocks of five sessions. The upper left panel shows the data for the RLR group, while the upper right panel shows the data for the RLL group.

As may be observed, upon completing the first phase, the groups were emitting the sequence reinforced in that phase, at a higher percentage. However, in group RLL a greater number of incorrect sequences was observed than in group RLR. The second most frequently emitted sequence on group RLL was LLL; these incorrect sequences involved two responses to the lever most contiguous to reinforcement.

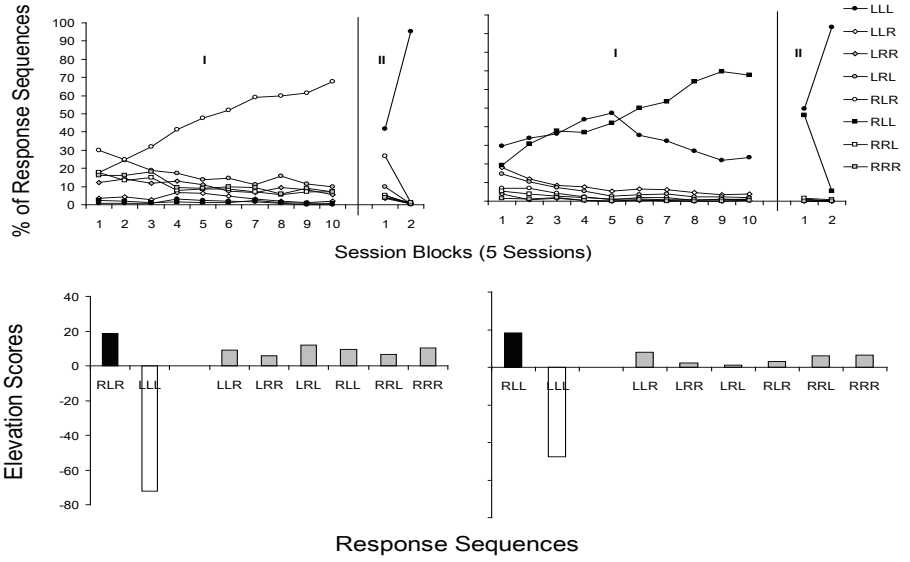

Figure 1. The upper panel shows, for the RLR and RLL groups, the percentage occurrence of each of the sequences during the first two phases of the experiment. The lower panel shows, for each group, the elevation scores computed for the third phase.

In the second phase, the percentage of trials where the LLL sequence was emitted increased to almost 100% of trials, whereas the percentage of trials with the sequence reinforced in the first phase gradually diminished. In spite of this, it could be observed that RLL sequence persisted longer than RLR. Reid (1994) has also shown that extinction occurs substantially more rapidly when the two sequences differ in the last response in the sequence than when they differed in the first response in the sequence.

With the aim of evaluating the effect of the change in reinforcement conditions during the extinction phase, the elevation score employed by Bouton & Peck (1989) was computed for each of the eight sequences. The elevation score was obtained by calculating the total percentage of each sequence during the first five sessions of the third phase. Then the percentage obtained in the last session of the second phase was subtracted from the percentage calculated for the third phase. A positive elevation score indicates that the percentage of trials with the target sequence increased after the phase change. Conversely, a negative score reflects a decrease in the percentage of emission of that sequence. Values close to 0 indicate no change in the percentage of occurrence of that sequence.

The lower panel of Figure 1 shows the elevation score for all sequences in the two groups. As may be observed, the percentage occurrence of the response sequences reinforced during the first phase increased in both groups. This is, the percentage occurrence of the RLR sequence increased during the third phase for the RLR group, whereas the RLL sequence increased for the RLL group (both sequences were reinforced in the first phase). On the other hand, a decrease was observed in the percentage occurrence of the sequence reinforced during the second phase (LLL) in both groups. A larger decrease may be observed for the RLR group, whose elevation score was –72, whereas, for the RLL group, the elevation score was -48. With the purpose of assessing if the distribution of frequencies recorded on extinction was due to random chance, an χ^2 test was conducted for both groups. Results showed that the distribution of frequencies was not due to random chance in neither of both groups [group RLR (χ^2=132.35, df=7, p<0.00) and group RLL (χ^2=543.96, df=7, p<0.00)].

The total number of times that a particular sequence was emitted across five sessions divided by the total number of trials are shown in Figure 2, reinforcement and extinction phases probabilities are shown separately. Sequences were ordered from the most to the least probable during extinction phase. For both groups the most probable sequence was LLL which was the most probable sequence of the two reinforcement phases. The next most probable sequence was the RLR or RLL sequences which were reinforced on first phase for each group respectively. Lastly, during extinction some sequences that were never reinforced increased slightly.

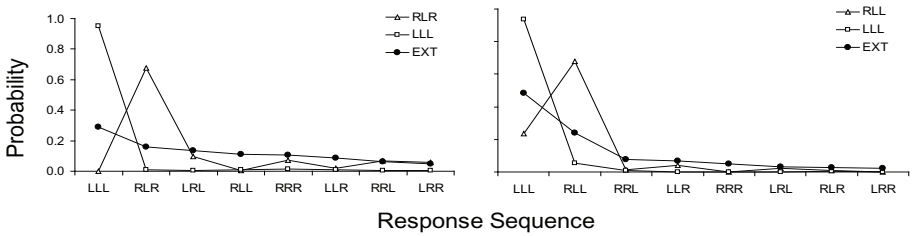

Figure 2. Probability of occurrence of each sequence during reinforcement (phase 1, RLR or RLL) and phase 2 (LLL)) and extinction phases. Left panel shows data for RLR group and right panel shows data for RLL group.

DISCUSSION

Epstein (1985) defined resurgence as “the reappearance of behavioral patterns that had not been recently observed in the behavioral repertoire of a subject”. The results of the present experiment fit this definition. For example, subject A6 was reinforced in the first phase for emitting the RLR sequence, in the second phase for emitting the LLL sequence and, in the third phase responding was extinguished. The occurrence of the RLR sequence during several extinction sessions can be considered as an example of resurgence. Furthermore, as was previously argued, resurgence should be reflected as a positive elevation score of the sequence reinforced in the first phase, as Figure 1 showed for both groups. In addition, it was shown that this increase was greater for the RLR and RLL sequences than that observed for the sequences that were never reinforced. Statistical analysis confirmed that sequence distributions in extinction were not due to random chance. Therefore, it can be concluded that the present results show resurgence of response sequences.

Additionally, this finding suggests that subjects emitted the reinforced response sequences as if they were conditionable behavioral units affected by the reinforcement contingency as a whole (see Zeiler,1977). These findings are consistent with several studies that have demonstrated that response sequence become complex response units on various reinforcement schedules and that these complex response units show similar behavioral patterns to those observed with simple operants (Fetterman & Stubbs, 1982; Schneider & Morris, 1992; Schwartz, 1981, 1982, 1986).

In the present experiment rats were reinforced when emitting RLR or RLL sequence during the first phase. Despite that the sequences reinforced in the first phase differed just in the last response, different effects in the percentage of occurrence of the non reinforced sequences were observed. For the group RLL the most common non reinforced sequence was LLL, a finding that is consistent with accounts stressing response-reinforcer contiguity (e.g. Catania, 1971).

Catania (1971) studied the effect of reinforcement following different two-key response (A or B) sequences on the pigeon’s relative rates of responding to the two keys. He found that when a particular response sequence was reinforced (e.g. BAAA, ABAA, AABA, BBAA, BABA, ABBA or BBBA), the percentage of pecks to either key was related to the temporal distance of A and B pecks from the reinforcement. Catania suggested the time that separated each response from reinforcement led each response contributing independently to subsequent responding. Consistent with Catania’s findings, in the group RLL of the present experiment, the L responses that were closer in time to reinforcement were emitted with a higher frequency than more distant responses. Catania also reported that when an alternation pattern (e.g. BABA)

was reinforced, pigeons responded at similar response rates to both keys. The present findings are also similar to Catania´s results in that few non reinforced sequences occurred when RLR sequences were reinforced in the first phase.

As figure 2 shows, the most frequent sequences in the reinforcement phases (LLL and RLR for group RLR and LLL and RLL for group RLL) also occurred at a high frequency during extinction. The least frequent sequences during reinforcement phases (those which never were reinforced) continued to occur least frequently, but increased its frequency in extinction. This analysis indicates that the hierarchy of occurrence of the sequence during reinforcement phases was generally maintained during extinction, as Neuringer, Kornell, & Olufs (2001) have also shown. As Neuringer et. al. (2001) pointed out, this was not a necessary outcome because distribution could have flattened – all sequences becoming equally probable, or the most likely sequences could have predominated. In the same way as Neuringer's et al.(2001) results, sequence variability observed in extinction in the present experiment shows that rats generally emitted the sequences that has succeeded in producing reinforcement in the past, and only rarely did something completely different (see also Epstein,1990, 1999).

The results of the present experiment do not allow an accurate prediction of the frequency distribution that may predominate during extinction. There are two variables that may interact to produce the effect. The most frequent of the two reinforced sequences was also the most probable during extinction, but it was also the closer to the extinction phase. Thus temporal proximity and reinforcement frequency are mixed. Davenport & Davenport (see Davenport & Davenport, 1993; Davenport, 1994 and Davenport, 1998) have advanced a model that assumes that recent information accounts more precisely current environmental conditions than earlier information, thus the former information weights more than the latter. The model also assumes that if a response alternative has been consistently reinforced, or has led to a richer patch, it is quite likely that animals return to it and emit the response. Thus, according to this idea both temporal proximity and reinforcement frequency would interact to establish a response hierarchy during extinction.

REFERENCES

Bachá, G., Reid, A. K., & Mendoza, A. (In press). Resurgence of complex behavioral units. *Journal of Experimental Analysis of Behavior*.

Bachá, G., & Sánchez-Carrasco, L. (1998, Noviembre). *Análisis de secuencias Conductuales en animales de laboratorio y humanos.* Paper presented at the II Congreso del programa de Fundación UNAM de Iniciación Temprana a la Investigación y la Docencia, Ciudad Universitaria, D.F.

Bouton, M. E., & Peck, C. A. (1989). Context Effects on conditioning, extinction and reinstatement in an appetitive conditioning preparation. *Animal Learning and Behavior, 17*(2), 188-198.

Catania, A. C. (1971). Reinforcement schedules: the role of response preceding the one that produce the reinforcer. *Journal of Experimental Analysis of Behavior, 15*, 271-287.

Cleland, B. S., Foster, T. M., & Temple, W. (2000). Resurgence: the role of extinction. *Behavioural Processes, 52*, 117-129.

Devenport, J. A., & Devenport, L. D. (1993). Time-dependent decisions in dogs (Canis familiaris). *Journal of Comparative Psychology, 107*, 169-173.

Devenport, L. D. (1998). Spontaneous recovery without interference: Why remembering is adaptative. *Animal Learning and Behavior, 26*(2), 172-181.

Devenport, L. D., & Devenport, J. A. (1994). Time-dependent averaging of foraging information in least chipmunks and golden-mantled ground squirrels. *Animal Behaviour, 47*, 787-802.

Dixon, M. R., & Hayes, L. J. (1998). Effects of differing instructional histories on resurgence of rule-following. *The Psychological Record, 48*, 275-292.

Epstein, R. (1983). Resurgence of previously reinforced behavior during extinction. *Behaviour Analysis Letters, 3*, 391-397.

Epstein, R. (1985). Extinction-induced resurgence: Preeliminary Investigations and Possible Applications. *The Psychological Record, 35*, 143-153.

Epstein, R. (1990). Generativity Theory and Creativity. In M. A. Runco & R. S. Albert (Eds.), *Theories of creativity*. Newbury Park: Sage Publications.

Epstein, R. (1999). Generativity Theory. In M. A. Runco & S. Pritzker (Eds.), *Encyclopedia of Creativity* (Vol. 1, pp. 759-766). San Diego, USA: Academic Press.

Epstein, R., & Skinner, B. F. (1980). Resurgence of responding after the cessation of response-independence reinforcement. *Proceedings of the National Academy of Science, U.S.A, 77*, 6251-6253.

Fetterman, J. G., & Stubbs, D. A. (1982). Matching, maximazing and the behavioral units: concurrent reinforcement of response sequences. *Journal of Experimental Analysis of Behavior, 37*, 97-114.

Grayson, R. J., & Wasserman, E. A. (1979). Conditioning of two-responses patterns of key pecking in pigeons. *Journal of the Experimental Analysis of Behavior, 31*(1), 23-29.

Leitenberg, H., Rawson, R. A., & Mulick, J. A. (1975). Extinction and reinforcement of alternative behavior. *Journal of Comparative Physiological Psychology, 88*, 640-652.

Lieving, G., & Lattal, K. (2003). Recency, repeatability, and reinforcer retrenchment: An experimental analysis of resurgence. *Journal of Experimental Analysis of Behavior, 80*(2), 217-233.

Mechner, F., Hyten, C., Field, D. P., & Madden, G. J. (1997). Using revealed operants to study the structure and properties of human operant behavior. *The Psychological Record, 47*, 45-68.

Mowrer, O. H. (1940). An experimental analogue of “regression” with incidental observations on “reaction-formation”. *Journal of Abnormal and Social Psychology, 35*, 56-87.

Neuringer, A., Kornell, N., & Olufs, M. (2001). Stability and Variability in Extinction. *Journal of Experimental Psychology: Animal Behavior Processes, 27*(1), 79-94.

Rawson, R. A., Leitenberg, H., Mulick, J. A., & Lefebvre, M. F. (1977). Recovery of extinction responding in rats following discontinuation of reinforcement of alternative behavior: A test of two explanations. *Animal Learning and Behavior, 5*, 415-420.

Reid, A. K. (1994). Learning new response sequences. *Behavioural Processes, 32*, 147-162.

Sánchez-Carrasco, L. (2001). *Resurgimiento de Secuencias de Respuestas.* Unpublished Licenciatura thesis, Universidad Nacional Autónoma de México, Ciudad Universitaria.

Schneider, S. M., & Morris, E. K. (1992). Sequences of spaced responses: Behavioral units and the role of contiguity. *Journal of Experimental Analysis of Behavior, 58*, 537-555.

Schwartz, B. (1980). Development of complex and stereotyped behavior in pigeons. *Journal of Experimental Analysis of Behavior, 33*, 153-166.

Schwartz, B. (1981). Reinforcement creates behavioral units. *Behavioral Analysis Letters, 1*, 33-41.

Schwartz, B. (1982). Interval and ratio reinforcement of complex sequential operant in pigeons. *Journal of Experimental Analysis of Behavior, 37*, 349-357.

Schwartz, B. (1984). Creation of stereotyped, functional units. In M. L. Commons, R. J. Herrnstein & A. R. Wagner (Eds.), *Quantitative Analysis of Behavior* (Vol. 4. Discrimination Process). Cambridge, MA,: Ballinger.

Schwartz, B. (1986). Allocation of complex, sequential operants on multiple and concurrent schedules of reinforcement. *Journal of Experimental Analysis of Behavior, 45*, 283-295.

Wasserman, E. A., Deich, J. D., & Cox, K. E. (1984). The learning and memory of response sequences. In M. L. Commons, R. J. Herrnstein & A. R. Wagner (Eds.), *Quantitative analysis of behavior* (Vol. 4. Discrimination Processes, pp. 99-113). Cambridge, MA,: Ballinger.

Wasserman, E. A., Nelson, K. R., & Larew, M. B. (1980). Memory for sequences of stimuli and responses. *Journal of Experimental Analysis of Behavior, 34*, 49-59.

Willson, K. G., & Hayes, S. C. (1996). Resurgence of derived stimulus relations. *Journal of Experimental Analysis of Behavior, 66*(3), 267-281.

Zeiler, M. D. (1977). Schedules of reinforcement. In W. K. Honig & J. E. R. Staddon (Eds.), *Handbook of operant behavior*. Englewood Cliffs, NJ: Prentice Hall.