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REINFORCEMENT RATE AND RESURGENCE: A PARAMETRIC ANALYSIS

TASA DE REFORZAMIENTO Y RESURGIMIENTO: UN ANÁLISIS PARAMÉTRICO

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Abstract

The effects of reinforcement rates of alternative responding on resurgence were studied in two experiments with rats. In both experiments, left-and right-lever pressing were reinforced according to a multiple schedule in the Training and Alternative Reinforcement phase, respectively. In the Test phase, reinforcers were discontinued. In Experiment 1, reinforcement rates were similar between components in the Training phase, and different between components in the Alternative Reinforcement phase. This latter difference was manipulated parametrically across conditions. Resurgence occurred more frequently (i.e., in more sessions) and was of greater magnitude (i.e., response rates were relatively higher) in the rich (i.e., higher reinforcement rate) than in the lean (i.e., lower reinforcement rate) component. Additionally, for two of the four rats, the magnitude of resurgence in both components was positively related to reinforcement rates in the Alternative-Reinforcement phase. In Experiment 2, reinforcement rates were different between components in the Training phase, and similar between components in the Alternative Reinforcement phase. Across conditions, the

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total reinforcement rate in the Alternative-Reinforcement phase was manipulated. Resurgence also occurred more frequently and was of greater magnitude in the component associated with more frequent reinforcement, and the magnitude of resurgence was positively related to reinforcement rates in the Alternative-Reinforcement phase for three of the four rats. These results replicate and extend some previous findings on the effects of reinforcement rates on resurgence.

Keywords: resurgence, reinforcement rate, parametric analysis, alternative responding, behavioral history, lever press, rats

Resumen

En dos experimentos con ratas se estudiaron los efectos de las tasas de reforzamiento de respuestas alternativas sobre el resurgimiento. En ambos experimentos, se reforzaron las presiones a las palancas izquierda y derecha conforme a un programa múltiple durante las fases de Entrenamiento y de Reforzamiento alternativo, respectivamente. En la fase de Prueba, se descontinuaron los reforzadores. En el Experimento 1, las tasas de reforzamiento fueron similares entre los componentes en la fase de Entrenamiento, y fueron diferentes entre los componentes en la fase de Reforzamiento alternativo. Esta diferencia se manipuló paramétricamente entre condiciones. El resurgimiento ocurrió más frecuentemente (i.e., durante más sesiones) y fue de mayor magnitud (i.e., las tasas de respuesta fueron relativamente más altas) en el componente denso (i.e., mayor tasa de reforzamiento) que en el componente pobre (i.e., menor tasa de reforzamiento). Adicionalmente, para dos de las cuatro ratas, la magnitud del resurgimiento en ambos componentes estuvo relacionada positivamente con las tasas de reforzamiento en la fase de Reforzamiento alternativo. En el Experimento 2, las tasas de reforzamiento fueron diferentes entre componentes en la fase de Entrenamiento, y similares entre los componentes en la fase de Reforzamiento alternativo. A través de las condiciones, se manipuló la tasa total de reforzamiento en la fase de Reforzamiento alternativo. El resurgimiento también ocurrió con mayor frecuencia y fue de mayor magnitud en el componente asociado con una mayor frecuencia de reforzamiento, y la magnitud del resurgimiento estuvo relacionada positivamente con las tasas de reforzamiento en la fase de Reforzamiento alternativo para tres de las cuatro ratas. Estos resultados replican y extienden algunos hallazgos previos sobre los efectos de las tasas de reforzamiento sobre el resurgimiento.

Palabras clave: resurgimiento, tasa de reforzamiento, análisis paramétrico, respuesta alternativa, historia conductual, presión a la palanca, ratas

Resurgence is the recurrence of previously reinforced responding when reinforcers for alternative responding are discontinued (Epstein, 1983, 1985). It is commonly

studied by using a three-phase procedure. In the first phase (*Training*), a response (R1) is reinforced. In the second (*Alternative Reinforcement*), R1 reinforcers are discontinued and an alternative response (R2) is reinforced. In the third (*Test*), R2 reinforcers also are discontinued. An increase in the occurrence of R1 in the Test phase, relative to the Alternative Reinforcement phase, characterizes resurgence (da Silva, Maxwell & Lattal, 2008; Doughty, da Silva & Lattal, 2007; Leitenberg, Rawson & Bath, 1970; Lieving & Lattal, 2003).

Variables in the Training, Alternative Reinforcement and Test phases all may affect resurgence – for example, differential response rates and patterns, schedules of reinforcement, response topography, phase duration and strategy for reinforcer discontinuation (see Doughty and Oken, 2008; Lattal and St. Peter Pipkin, 2009, and Pritchard, Hoerger and Mace, 2014, for reviews). The focus of the present experiments was the effects of reinforcement rates on resurgence, reports of which have been inconsistent (Cançado & Lattal, 2013; da Silva et al., 2008; Leitenberg, Rawson & Mulick, 1975; Podlesnik & Shahan, 2009, 2010; Pritchard, Hoerger, Mace, Penney & Harris, 2014; Sweeney & Shahan, 2013a).

Podlesnik and Shahan (2009, Experiment 2), for example, suggested that more resurgence occurs when Training-phase reinforcement rates are high rather than low. They exposed pigeons to a multiple variable-interval (VI) VI schedule in the Training phase. A variable-time (VT) schedule superimposed in one (the rich) component produced higher reinforcement rates, and lower response rates, than in the other (the lean) component. More resurgence occurred in the rich than in the lean component (see Podlesnik & Shahan, 2010, for replications of these findings). da Silva et al. (2008; Experiment 3), however, reported nondifferential resurgence when Training-phase reinforcement rates were varied while holding response rates more or less constant. They exposed pigeons to a concurrent tandem VI differential-reinforcement-of-low-rate (DRL) tandem VI differential-reinforcement-of-high-rate (DRH) schedule in the Training phase. This schedule generated different reinforcement rates, and similar response rates, between components of the concurrent schedule. Resurgence occurred in both components, but its magnitude was not related systematically to the differential reinforcement rates in the Training phase.

Inconsistent results across studies also have been reported when differential reinforcement rates occur in the Alternative Reinforcement phase. On the one hand, Leitenberg et al. (1975, Experiment 3), for example, obtained more resurgence when pigeons were exposed to high (i.e., VI 30 s) rather than low (i.e., VI 240 s) reinforcement rates in the Alternative Reinforcement phase. Sweeney and Shahan (2013 a) replicated this finding, reporting more resurgence with rats exposed, in that phase, to high (VI 10 s) rather than low (VI 100 s) reinforcement rates. On the other hand, Winterbauer and Bouton (2010) obtained nondifferential resurgence of lever pressing with rats when, relative to the Training phase, an increase (e.g., a change from a ran-

dom-interval, RI, 30-s schedule to an RI 10 s), a decrease (e.g., a change from an RI 10 s to an RI 30 s), or no change in reinforcement rate was effected in the Alternative Reinforcement phase across experiments.

More recently, Pritchard, Hoerger, Mace, Penney et al. (2014) replicated Leitenberg et al.'s (1975) and Sweeney and Shahan's (2013 a) findings in an experiment with one human participant. When they manipulated reinforcement rates in the Alternative Reinforcement phase between components of a multiple schedule, more resurgence of problem behavior occurred in the presence of a therapist that delivered reinforcers at higher rates (two reinforcers per min) than in the presence of another therapist that delivered reinforcers at lower rates (0.5 reinforcers per min). In general, the results of these three studies support the predictions of Shahan and Sweeney's (2011) model of resurgence based on behavioral momentum theory.

Other things being equal, the model predicts more resurgence when higher, rather than lower, reinforcement rates are in effect in the Training phase. In addition, Shahan and Sweeney (2011) assumed that reinforcement of alternative responding (in the same context in which Training-phase responding was reinforced) *both* disrupts Training-phase responding and strengthens it (cf. Nevin, Tota, Torquato & Shull, 1990), leading subsequently to its resurgence. Thus, more resurgence also is predicted when reinforcement rates in the Alternative Reinforcement phase are high rather than low. Finally, the model predicts that the degree of differential resurgence is a function of reinforcement rates in the Training and Alternative Reinforcement phases. For example, given differential reinforcement rates between multiple-schedule components in the Training phase (e.g., arranged by a multiple VI 30-s VI 120-s schedule), more resurgence is predicted in the rich (VI 30 s) than in the lean (VI 120 s) component. Increasing reinforcement rates in the Alternative Reinforcement phase (e.g., by arranging equal VI schedules for alternative responding in both components ranging from 240 s to 15 s) should increase the magnitude of resurgence in both schedule components. In addition, this latter operation should decrease the difference in the magnitude of resurgence between components (see Figure 4 in Shahan & Sweeney, 2011, p. 100, for simulated data based on the above schedule values). This latter outcome also is predicted when reinforcement rates in the Training and Alternative Reinforcement phases are, respectively, similar and different between components of a multiple schedule.

Cançado and Lattal (2013), however, reported six experiments with pigeons in which resurgence was not systematically related to reinforcement rates in the Alternative Reinforcement phase. In their experiments, keypecking was maintained on a multiple VI 30 s VI 30 s in the Training phase. In the Alternative Reinforcement phase, reinforcement rate was manipulated by arranging, for example, interreinforcer intervals (IRIs) of 60 s in the lean component and of 20 s in the rich component (across experiments in their study, differential-reinforcement-of-other-behavior, DRO, or VI,

schedules, were in effect in each multiple-schedule component in the Alternative Reinforcement phase). Recently, Fujimaki, Lattal and Sakagami (2015, *this issue*) replicated Cançado and Lattal's report of an unsystematic effect of reinforcement rates of alternative responding on resurgence in a series of experiments with pigeons. In their experiments a multiple VI 30 s VI 30 s was in effect in the Training phase, and fixed or variable DROs of 20 s – in the rich component —and 60 s— in the lean component —in the Alternative Reinforcement phase.

The results reported by Cançado and Lattal (2013; see also Fujimaki et al., 2015, *this issue*; and Winterbauer & Bouton, 2010) are inconsistent with those reported by Leitenberg et al. (1975), Sweeney and Shahan (2013 a), and Pritchard, Hoerger, Mace, Penney et al. (2014). Because of such inconsistencies, and because in each of the previously described studies only a few schedule values were used to program differential reinforcement rates in the Alternative Reinforcement phase, the relation between resurgence and reinforcement rates in this phase is not clear. As suggested by Cançado and Lattal, parametric analyses of the effects of reinforcement rates on resurgence, not reported previously, might be useful in better understanding the effects of this variable and to clarify the inconsistencies across studies noted previously. To do this, the effects on resurgence of differential reinforcement rates in the Alternative Reinforcement phase were studied parametrically when, in the Training phase, reinforcement rates were similar (Experiment 1) or different (Experiment 2) between components of a multiple schedule.

Experiment 1

In this experiment, the effects of differential reinforcement rates in the Alternative Reinforcement phase on resurgence were studied parametrically when Training-phase reinforcement rates were nondifferential between multiple-schedule components.

Method

Subjects. Four experimentally-naïve female Wistar rats (R1, R2, R3, and R4), 90 days old at the start of the experiment, served as subjects. Each was maintained with free access to food in individual homecages, in a room with a 12 hr: 12 hr light-dark cycle (lights on at 0700 am). Throughout the experiment, each rat was water deprived. That is, 20 min after each session, rats were given 3-10 min of access to water in their homecages (time of access to water was established for each rat in the Pretraining phase – see Procedure section, below —as that which maintained consistent within session responding and a stable body weight).

Apparatus. Four Med Associates® operant chambers (30cm long x 25cm wide x 22cm high), located in sound attenuating enclosures, were used. The floor of each chamber was made of stainless steel bars (0.5cm in diameter, separated by 1.3 cm), the side walls and ceiling of Plexiglas®, and the front and rear walls of aluminum. The front wall contained two stainless steel levers (4.5cm long, separated by 9 cm, center-to-center) located on the middle of the left and right portions of the panel, 7 cm from the floor. The rear wall also contained one stainless steel lever (4.5cm long) located at the center of the panel, 7 cm from the floor, and a 28V houselight, located above the lever and 18 cm from the floor. Each lever could be operated by a minimum force of 0.25 N. Reinforcers consisted of 3-s access to water (0.05 ml) from a dipper behind a 5 cm x 5 cm aperture between the right and left levers in the front wall, with its lower edge 2 cm from the floor. A ventilation fan masked extraneous sounds. Programming and data recording were accomplished by using a computer equipped with MED-PC® IV.

Procedure.

General Features. A two-component multiple schedule of reinforcement was used in the Training, Alternative Reinforcement and Test phases. One exposure to these three phases defined a condition. Six conditions were conducted for Rats R1, R3 and R4, and five conditions were conducted for Rat R2. Conditions differed regarding the programmed reinforcement rate in each schedule component in the Alternative Reinforcement phase.

In each phase, sessions started after 180 s during which the houselight was off. In one component, the houselight was on continuously (i.e., constant houselight) and, in the other, the houselight flashed on and off every 0.5 s (cf. Podlesnik & Shahan, 2010). The first component in a session was selected semirandomly, with the restriction that no more than three consecutive sessions started with the same component. Then, components alternated strictly after 180 s (excluding reinforcement-access time) and were separated by intercomponent intervals (ICI) of 30 s during which the houselight was off, until each component occurred five times in a session. A 10-s change-over delay (COD) was in effect during the last 10 s of the ICI to avoid close temporal proximity between lever pressing at the end of the ICI and presentation of stimuli correlated with a schedule component (i.e., left-, right- or rear-lever presses during the last 10 s of the ICI restarted the 10-s interval thereby delaying the start of the next components by 10 s).

In the Training and Alternative Reinforcement phases, respectively, a VI and a tandem VT fixed-ratio (FR) schedule were in effect in each schedule component. The VI and VT schedules were constructed by using 15 intervals from Fleshler and Hoffman's

(1962) distribution. In each session, and in each component, intervals were selected randomly without replacement and reinforcers programmed, but not produced, in a component were carried over to the next presentation of the same component.

Reinforcers were produced only by left-lever pressing, in the Training phase, and only by right-lever pressing, in the Alternative Reinforcement phase. A 3-s COD was in effect in these two phases such that responses that did not produce reinforcers (right- and rear-lever pressing, in the Training phase, and left- and rear-lever pressing, in the Alternative Reinforcement phase) started a 3-s interval during which reinforcers could not be produced. Responses on the rear lever had no additional programmed consequences. That is, responding on this lever served as an additional control to differentiate resurgence from other extinction-induced phenomena (Epstein, 1983; Podlesnik, Jimenez-Gomez & Shahan, 2006). Due to limitations in the configuration of all chambers used in the present study, the control lever was located on the rear wall, instead of on the front wall, which likely would have been more effective. Sessions occurred seven days a week, approximately at the same time, during the light portion of the light-dark cycle.

Each phase is described below. Except for the Pretraining phase (conducted only once for each rat), the description of each phase is valid for each condition of this experiment.

Pretraining. Left-lever pressing was established by differential reinforcement of successive approximations. The houselight was on continuously and an FR 1 was in effect during sessions, which lasted until the rat produced 60 reinforcers or 60 min elapsed. When the rat produced 60 reinforcers in one session (which occurred after two sessions, for Rats R3 and R4, and after three sessions, for Rats R1 and R2), the multiple schedule of reinforcement described in the General Features was effected during one session with the following changes: (a) an FR 1 was in effect in each component; (b) components alternated after reinforcer deliveries and no ICIs were programmed; and (c) the session ended after 60 reinforcers, 30 in each component, or 60 min. Then, a multiple schedule similar to that described in the General Features (except for the duration of each component, which was 30 s instead of 180 s) was in effect for two sessions. In these sessions, a VI 5 s was in effect in each component.

Training. The multiple schedule described in the General Features was in effect. A VI 10-s schedule operated in each component and reinforcers were produced only by left-lever pressing. For each rat, this phase lasted a minimum of 20 sessions and until there were (a) no decreasing trends in response rates in both components, and (b) no systematic differences in response rates and reinforcement rates between components for six consecutive sessions.

Alternative Reinforcement. Reinforcers were discontinued for left-lever pressing and only right-lever pressing produced reinforcers. For each rat, a tandem VT 10 s FR

always was in effect in the rich component, which was correlated with the constant houselight. In the other, lean component, which was correlated with the flashing houselight, a tandem VT FR also was in effect, and the value of the VT was changed across conditions.

Across conditions the VT value was 15 s, 30 s, 60 s or 90 s (programming, respectively, four, two, one and 0.66 reinforcers per min) in the lean component in the order shown for the four rats in Table 1 (upper portion; the schedules of reinforcement in each condition in the Alternative Reinforcement phase for each rat also are shown in this table). The FR value was the same in both components for each rat, but varied between rats and across conditions. For some rats, an FR 5 was used in some conditions. For other rats, the FR value was changed from 5 to 2 to equate programmed and obtained reinforcement rates in each component.

As in the Training phase, a 3-s COD was in effect in this phase. Left- and rear-lever presses started a 3-s interval during which reinforcers could not be produced. In addition, if left- or rear-lever presses occurred during the FR link of the tandem schedule, the response count towards completing the ratio (i.e., 5 or 2) restarted and only after the 3 s COD elapsed would right-lever presses count towards completing the ratio. Thus, in each component, reinforcers occurred when a fixed number of consecutive right-lever presses occurred after the VT interval elapsed. For each rat, this phase lasted for a minimum of 10 sessions and until (a) reinforcement rates approximated the programmed rates in each component during six consecutive sessions, and (b) left-lever rates in both components were less than one response per min for three consecutive sessions.

Test. Reinforcers were discontinued in this phase, which lasted for 10 sessions. Resurgence was defined as an increase in the occurrence of left-lever pressing (above the occurrence of rear-lever pressing, i.e., the control response), relative to the highest occurrence of left-lever pressing during the last three sessions of the Alternative Reinforcement phase.

Results and Discussion

In previous studies of resurgence (e.g., da Silva et al., 2008; Doughty et al., 2007; Podlesnik & Shahan, 2009), descriptions of “more” or “less” resurgence refer to its *magnitude*, that is, how much response rates increase during sessions of the Test phase relative to those of the Alternative Reinforcement phase. The magnitude of resurgence has been described in both absolute (e.g., responses per min) and relative measures (e.g., responding as proportion of response rates in the Training or Alternative Reinforcement phases). Resurgence also can be described in terms of its *frequency*, that is, how many sessions of the Test phase it occurs. In the present experiment (see also Experiment 2, below) both magnitude and frequency of resurgence were assessed.

Table 1

Mean Reinforcement Rates (Reinforcers per Min, with Standard Deviation in Parentheses) in Each Schedule Component during the Last Six Sessions of the Training and Alternative Reinforcement Phases, Number of Sessions in these Phases, and the Schedules of Reinforcement in the Alternative Reinforcement Phase, for Each Rat, in Each Condition of Experiments 1 (Upper Portion) and 2 (Lower Portion).

EXPERIMENT 1									
Training					Alternative Reinforcement				
		Reinf. Rate			Schedule		Reinf. Rate		
Rat	Condition	Rich	Lean	Sessions	Rich	Lean	Rich	Lean	Sessions
R1	1	5.51 (0.12)	5.52 (0.12)	30	VT 10 s FR 2	VT 90 s FR 2	3.69 (0.48)	0.37 (0.20)	15
	2	5.34 (0.15)	5.46 (0.20)	22		VT 90 s FR 2	5.09 (0.23)	0.60 (0.12)	12
	3	5.33 (0.20)	5.32 (0.14)	21		VT 30 s FR 2	5.10 (0.18)	1.61 (0.13)	13
	4	5.33 (0.24)	5.32 (0.13)	25		VT 60 s FR 2	4.77 (0.32)	0.82 (0.13)	14
	5	5.48 (0.14)	5.33 (0.17)	20		VT 30 s FR 2	5.26 (0.12)	1.70 (0.07)	18
	6	5.22 (0.16)	5.38 (0.15)	20		VT 15 s FR 2	5.14 (0.12)	3.50 (0.16)	10
R2	1	5.08 (0.24)	4.94 (0.25)	33	VT 10 s FR 2	VT 30 s FR 5	4.29 (0.10)	1.62 (0.10)	17
	2	4.76 (0.18)	4.69 (0.25)	37		VT 90 s FR 2	3.58 (0.57)	0.44 (0.13)	23
	3	4.24 (0.50)	4.33 (0.37)	37		VT 60 s FR 2	3.53 (0.76)	0.70 (0.14)	12
	4	4.94 (0.19)	4.94 (0.29)	20		VT 30 s FR 2	4.45 (0.10)	1.46 (0.15)	11
	5	5.20 (0.13)	5.07 (0.21)	20		VT 15 s FR 2	4.61 (0.21)	3.19 (0.07)	15
R3	1	5.23 (0.14)	5.24 (0.18)	31	VT 10 s FR 5	VT 30 s FR 5	4.24 (0.11)	1.57 (0.09)	21
	2	5.20 (0.13)	5.14 (0.16)	25		VT 90 s FR 5	4.73 (0.12)	0.53 (0.12)	19
	3	5.26 (0.14)	5.27 (0.16)	20		VT 60 s FR 5	4.48 (0.18)	0.72 (0.13)	24
	4	5.22 (0.29)	5.21 (0.10)	22		VT 30 s FR 5	4.27 (0.12)	1.46 (0.09)	10
	5	5.21 (0.14)	5.19 (0.12)	21		VT 90 s FR 5	4.59 (0.08)	0.56 (0.14)	16
	6	5.09 (0.15)	5.20 (0.17)	20		VT 15 s FR 5	4.42 (0.18)	2.97 (0.05)	12
R4	1	5.53 (0.16)	5.44 (0.13)	30	VT 10 s FR 5	VT 90 s FR 5	4.42 (0.12)	0.67 (0.16)	15
	2	5.33 (0.19)	5.40 (0.18)	28		VT 30 s FR 5	4.47 (0.15)	1.56 (0.15)	15
	3	5.13 (0.32)	5.31 (0.14)	22	VT 10 s FR 2	VT 60 s FR 2	4.98 (0.17)	0.78 (0.11)	21
	4	5.29 (0.05)	5.36 (0.07)	24		VT 30 s FR 2	4.99 (0.24)	1.72 (0.19)	15
	5	5.33 (0.16)	5.43 (0.10)	21		VT 90 s FR 2	5.28 (0.11)	0.60 (0.11)	22
	6	5.46 (0.11)	5.43 (0.16)	21		VT 15 s FR 2	5.36 (0.19)	3.58 (0.09)	10

(continued)

Table 1 (*continued*)

EXPERIMENT 2									
Training				Alternative Reinforcement					
Reinf. Rate				Schedule		Reinf. Rate			
Rat	Condition	Rich	Lean	Sessions	Rich	Lean	Rich	Lean	Sessions
R5	1	5.02 (0.13)	0.88 (0.07)	30	VT 90 s FR 2	0.56 (0.09)	0.53 (0.10)		16
	2	5.10 (0.05)	0.84 (0.03)	20	VT 30 s FR 2	1.69 (0.09)	1.54 (0.18)		26
	3	5.19 (0.18)	0.82 (0.10)	20	VT 60 s FR 2	0.70 (0.14)	0.77 (0.11)		15
	4	5.01 (0.28)	0.71 (0.14)	21	VT 90 s FR 2	0.53 (0.09)	0.44 (0.07)		16
	5	5.33 (0.15)	0.84 (0.06)	20	VT 10 s FR 2	4.77 (0.06)	4.58 (0.11)		10
	6	5.26 (0.26)	0.72 (0.11)	20	VT 5 s FR 2	8.91 (0.44)	8.06 (0.56)		10
R6	1	5.36 (0.13)	0.81 (0.10)	30	VT 30 s FR 2	1.69 (0.14)	1.74 (0.10)		13
	2	5.27 (0.26)	0.87 (0.09)	20	VT 90 s FR 2	0.39 (0.21)	0.53 (0.09)		21
	3	5.33 (0.20)	0.82 (0.10)	25	VT 60 s FR 2	0.60 (0.19)	0.52 (0.12)		18
	4	5.34 (0.24)	0.82 (0.07)	20	VT 30 s FR 2	1.29 (0.22)	1.23 (0.11)		11
	5	5.38 (0.17)	0.84 (0.07)	20	VT 10 s FR 2	4.92 (0.14)	4.92 (0.09)		10
	6	5.57 (0.11)	0.81 (0.11)	20	VT 5 s FR 2	9.46 (0.24)	9.12 (0.48)		10
R7	1	4.78 (0.16)	0.78 (0.11)	30	VT 30 s FR 2	1.62 (0.09)	1.61 (0.14)		12
	2	4.04 (0.17)	0.83 (0.07)	45	VT 90 s FR 2	0.42 (0.14)	0.52 (0.17)		20
	3	3.74 (0.17)	0.81 (0.11)	28	VT 60 s FR 2	0.52 (0.14)	0.47 (0.14)		17
	4	3.46 (0.47)	0.70 (0.13)	21	VT 30 s FR 2	1.46 (0.09)	1.38 (0.10)		10
	5	4.34 (0.19)	0.77 (0.11)	26	VT 10 s FR 2	3.79 (0.20)	3.61 (0.21)		10
R8	1	4.88 (0.32)	0.88 (0.06)	30	VT 90 s FR 2	0.63 (0.12)	0.59 (0.12)		26
	2	4.57 (0.31)	0.80 (0.09)	25	VT 90 s FR 2	0.50 (0.11)	0.56 (0.15)		21
	3	4.64 (0.18)	0.81 (0.08)	21	VT 30 s FR 2	1.72 (0.14)	1.67 (0.09)		13
	4	5.16 (0.08)	0.89 (0.03)	20	VT 60 s FR 2	0.79 (0.06)	0.77 (0.11)		20
	5	5.23 (0.18)	0.87 (0.08)	20	VT 10 s FR 2	5.03 (0.15)	4.91 (0.12)		11

Note. In the Training phase of Experiments 1 and 2, respectively, a multiple VI 10 s VI 10 s and a multiple VI 10 s VI 60 s was in effect across conditions. Highlighted columns (dark and light gray representing, respectively, the rich and lean components) indicate that programmed reinforcement rates were differential between components in the Alternative Reinforcement phase (Experiment 1) and in the Training phase (Experiment 2). The Test phase lasted for 10 sessions for each rat, in each condition of Experiments 1 and 2 (except for Rat R7, in Condition 5 of Experiment 2, for which this phase lasted for 5 sessions).

Table 1 (upper portion) shows, for each rat, the mean reinforcement rate in each schedule component during the last six sessions of the Training and Alternative Reinforcement phases, and the total number of sessions in these phases, across conditions. In Figure 1, response rates are shown in each component during the last six sessions of the Training and Alternative Reinforcement phases, and each session of the Test phase. In the Training phase, across conditions, response (Figure 1) and reinforcement (Table 1) rates were similar between schedule components. Obtained reinforcement rates in this phase generally approximated the programmed rates for each rat. In the Alternative Reinforcement phases, reinforcement rates were slightly lower than the programmed rates in the rich and lean components, for each rat. Across conditions, left-lever response rates were near zero in each component, and right-lever response rates generally were higher in the rich than in the lean component, for each rat. In addition, in this phase, the difference in right-lever response rates between components generally was higher when reinforcement rates in the lean component were lower (i.e., programmed by a VT 90 s or 60 s) than higher (i.e., programmed by a VT 30 s or 15 s). In the Test phase, right-lever response rates decreased in each component and were near zero in the last sessions of this phase.

Figure 2 shows, on a logarithmic scale, left-lever response rates in the rich and lean components during Test-phase sessions as a proportion of the highest left-lever response rate during the last three sessions of the Alternative Reinforcement phase (Table A1, in the Appendix, shows absolute response rates on the left and rear levers in these phases, in both components and across conditions). Data points equal to, above, and below zero indicate, respectively, no change, an increase (i.e., resurgence), and a decrease in response rates relative to those during the Alternative Reinforcement phase. Missing data points indicate that no left-lever pressing occurred in a Test-phase session. An asterisk next to data points indicates that left-lever rates were lower than rear-lever (control) rates in a session (i.e., that the increase in left-lever rates was not resurgence; this occurred only in the rich component, in Session 2, Condition 1, for Rat R2; as shown in Table A1, rear-lever pressing was generally low, occurring at near zero rates across Test-phase sessions of each condition, for each rat). To evaluate resurgence magnitude in the entire Test phase of a condition, the log proportions of Alternative Reinforcement phase response rates in the rich and lean components (shown in Figure 2) in Test sessions in which resurgence occurred were summed. These data are shown in the upper portion of Table 2, along with the total number of Test sessions with resurgence.

The data in Figure 2 and Table 2 show that, especially for Rats R2, R3 and R4, resurgence of greater magnitude occurred in the rich than in the lean component. Also, for each rat, resurgence occurred more frequently in the rich than in the lean component. Considering the total number of sessions with resurgence in one or in both components across conditions, resurgence occurred in the rich and lean components, respectively, in 9 and 7 sessions out of 16 sessions for Rat R1; in 21 and 7 out of 22

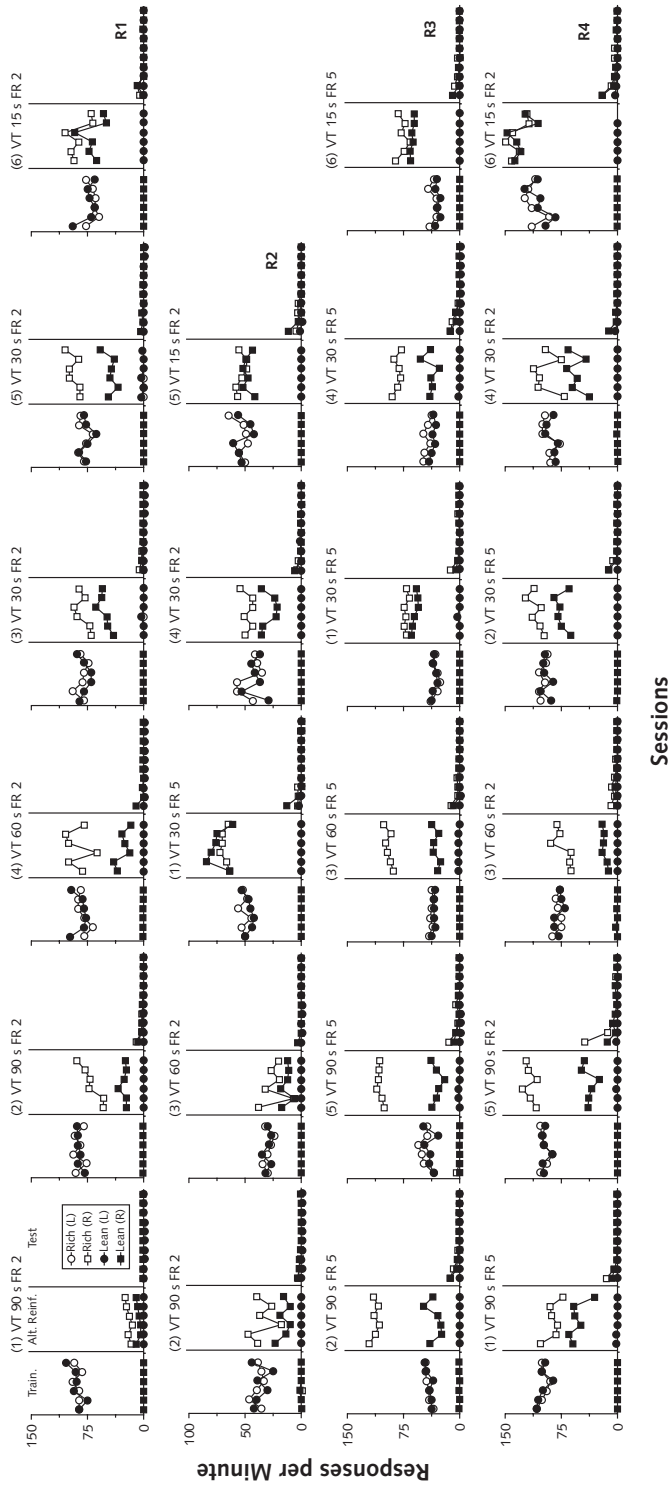


Figure 1. Responses rates (responses per min) in each schedule component during the last six sessions of the Training and Alternative Reinforcement phases, and each session of the Test phase of Experiment 1. For each rat, graphs are ordered from lower to higher programmed reinforcement rate in the lean component in the Alternative Reinforcement phase (the schedule in the lean component is indicated above each graph; numbers in parentheses above each graph indicate the order of conditions). Open and closed symbols represent rich and lean components, and circles and squares represent left and right-lever pressing, respectively. Note the different Y-axis scales for Rat R2.

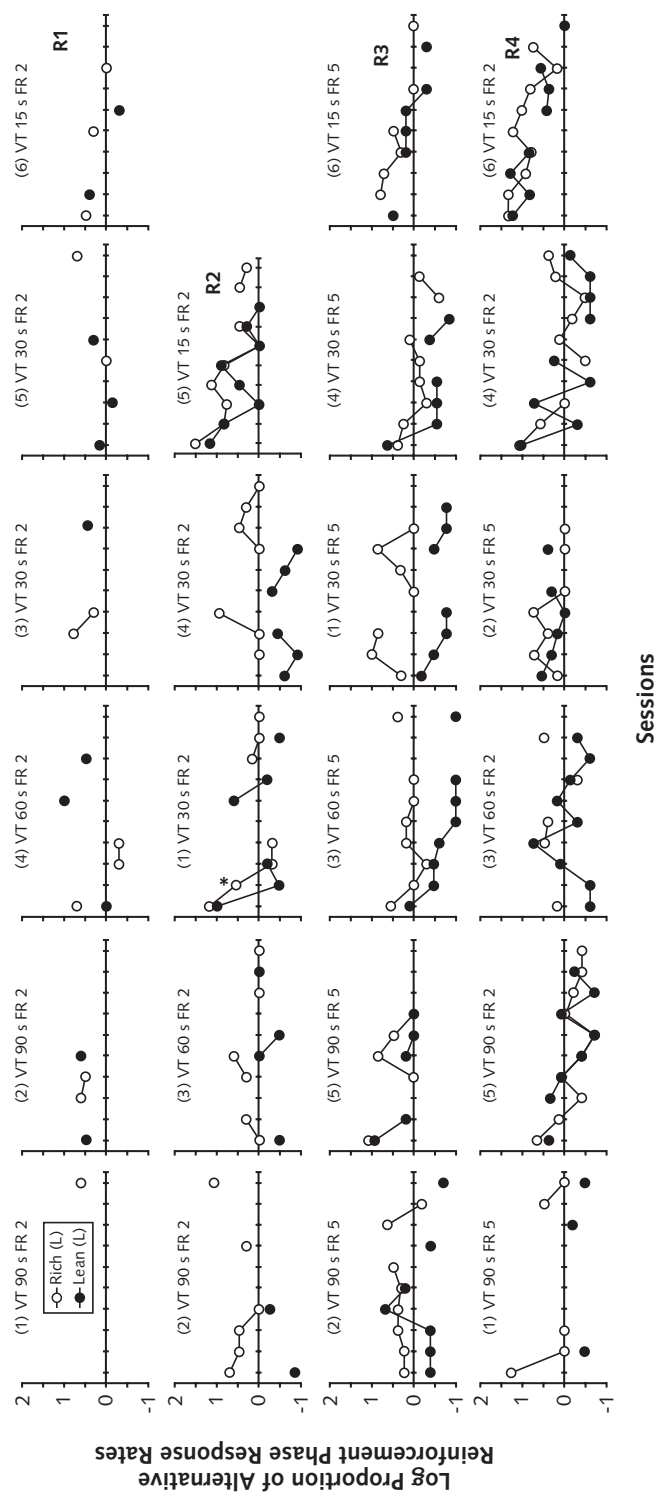


Figure 2. Left-lever response rates (on logarithmic scale) in each session of the Test phase as a proportion of the highest response rate during the last three sessions of the Alternative Reinforcement phase, for each rat in Experiment 1. Data points were generated by dividing response rates in each Test-phase session by the highest response rate during the last three sessions of the Alternative Reinforcement phase (when no responses occurred in each of these three sessions, a value of 0.067 responses per min, which was equal to the rat emitting one left-lever press during the session, was used as denominator to calculate proportions). For each rat, graphs are ordered from lower to higher programmed reinforcement rate in the lean component in the Alternative Reinforcement phase (the schedule in the lean component is indicated above each graph; numbers in parentheses above each graph indicate the order of conditions). Open and closed circles represent the rich and lean components, respectively. An asterisk (*) next to data points indicates that left-lever response rates were lower than (rear lever) control-response rates in a session.

sessions for Rat R2; in 26 and 11 out of 29 sessions for Rat R3; and in 27 and 22 out of 35 sessions for Rat R4. These results generally support Shahan and Sweeney's (2011) predictions of greater resurgence in the component correlated with the highest reinforcement rates in the Alternative Reinforcement phase.

Figures 3 and 4 summarize the results shown in Figure 2 and Table 2, and highlight aspects of the relation between the magnitude of resurgence and reinforcement rates in the Alternative Reinforcement phase. Figure 3 shows the total left (resurgence) lever responding (on a logarithmic scale) in both components in sessions in which resurgence occurred as a function of reinforcement rate in the lean component (data points were generated by summing the log-proportion of left-lever rates across Test-phase sessions in which resurgence occurred in each component – see actual values in Table 2 – and correlating it with the mean obtained reinforcement rate in the lean component in the last six sessions of the Alternative Reinforcement phase). In this figure, solid and dashed regression lines represent the rich and lean components, respectively; equations and coefficients of determination (R^2) also are shown near each regression line, for each rat. For Rats R2 and R4 only, these data suggest a positive relation between the magnitude of resurgence in both components and reinforcement rates in the lean component (note the relatively low R^2 value for the rich component for Rat R2). In addition, only for these two rats, the degree of differential resurgence was not related systematically to reinforcement rates in the lean component in the Alternative Reinforcement phase as is predicted by Shahan and Sweeney (2011; their model predicts that the degree of differential resurgence between components should decrease as reinforcement rates in the Alternative Reinforcement phase increase).

This latter aspect is highlighted in Figure 4, which displays the difference in total left-lever responding (Rich component – Lean component) as a function of reinforcement rates in the lean component (the analysis included the data shown in Figure 3 and in the upper portion of Table 2). Data points above and below the dashed horizontal line indicate that the magnitude of resurgence was greater, respectively, in the rich and in the lean component. Data points equal to or near zero indicate no difference in the magnitude of resurgence between components. There was no systematic relation between reinforcement rates in the lean component and the degree of differential resurgence between components. Although for Rats R2 and R4 increasing reinforcement rates from 0.66 to 2 reinforcers per min in the lean component seemed to decrease the degree of differential resurgence, at higher reinforcement rates, the difference in resurgence between rich and lean components increased.

The present results replicate and extend previous findings of differential resurgence as a function of reinforcement rates in the Alternative Reinforcement phase (Leitenberg et al., 1975; Pritchard, Hoerger, Mace, Penney, et al., 2014; Sweeney & Shahan, 2013

Table 2

Sum of the Log-proportion of Left-lever Response Rates Across Test-phase Sessions in Which Resurgence Occurred in Rich and Lean Schedule Components, and Total Number of These Sessions. Also Shown are the Schedules of Reinforcement in the Alternative Reinforcement Phase, for Each Rat, in Each Condition of Experiments 1 (Upper Portion) and 2 (Lower Portion).

EXPERIMENT 1							
Alternative Reinforcement Phase Schedule							
Rat	Condition	Rich	Lean	Sum Rich	Sessions	Sum Lean	Sessions
R1	1	VT 10 s FR 2	VT 90 s FR 2	0.590	1	0.000	0
	2		VT 90 s FR 2	1.079	2	1.079	2
	3		VT 30 s FR 2	1.079	2	0.000	0
	4		VT 60 s FR 2	0.699	1	1.477	2
	5		VT 30 s FR 2	0.699	1	0.456	2
	6		VT 15 s FR 2	0.778	2	0.398	1
R2	1	VT 10 s FR 5	VT 30 s FR 5	1.366	2	1.602	2
	2	VT 10 s FR 2	VT 90 s FR 2	3.033	5	0.000	0
	3		VT 60 s FR 2	1.204	3	0.000	0
	4		VT 30 s FR 2	1.732	3	0.000	0
	5		VT 15 s FR 2	6.401	8	3.702	5
R3	1	VT 10 s FR 5	VT 30 s FR 5	3.292	5	0.000	0
	2		VT 90 s FR 5	2.595	7	0.885	2
	3		VT 60 s FR 5	1.294	4	0.097	1
	4		VT 30 s FR 5	0.738	3	0.632	1
	5		VT 90 s FR 5	2.401	3	1.282	3
	6		VT 15 s FR 5	2.255	4	1.005	4
R4	1	VT 10 s FR 5	VT 90 s FR 5	1.756	2	0.000	0
	2		VT 30 s FR 5	2.055	4	1.720	5
	3		VT 60 s FR 2	1.528	4	1.013	3
	4	VT 10 s FR 2	VT 30 s FR 2	2.346	5	2.005	3
	5		VT 90 s FR 5	0.869	3	0.881	4
	6		VT 15 s FR 5	8.408	9	5.552	7

(continued)

Table 2 (continued)

EXPERIMENT 2							
Alternative Reinforcement Phase Schedule							
Rat	Condition	Rich	Lean	Sum Rich	Sessions	Sum Lean	Sessions
R5	1	VT 90 s	FR 2	6.879	10	4.171	7
	2	VT 30 s	FR 2	1.660	6	0.222	1
	3	VT 60 s	FR 2	1.479	5	0.000	0
	4	VT 90 s	FR 2	1.082	2	0.449	2
	5	VT 10 s	FR 2	0.978	3	2.225	5
	6	VT 5 s	FR 2	11.125	10	10.174	10
R6	1	VT 30 s	FR 2	3.840	6	0.574	2
	2	VT 90 s	FR 2	0.000	0	0.000	0
	3	VT 60 s	FR 2	0.000	0	0.000	0
	4	VT 30 s	FR 2	0.301	1	0.954	2
	5	VT 10 s	FR 2	0.176	1	0.426	2
	6	VT 5 s	FR 2	3.917	7	1.868	5
R7	1	VT 30 s	FR 2	4.258	7	3.246	5
	2	VT 90 s	FR 2	0.301	1	0.000	0
	3	VT 60 s	FR 2	0.204	1	0.097	1
	4	VT 30 s	FR 2	0.509	4	1.189	3
	5	VT 10 s	FR 2	1.635	3	1.301	4
R8	1	VT 90 s	FR 2	0.000	0	0.000	0
	2	VT 90 s	FR 2	0.092	2	0.000	0
	3	VT 30 s	FR 2	1.001	4	0.590	2
	4	VT 60 s	FR 2	0.000	0	0.403	2
	5	VT 10 s	FR 2	2.522	6	6.440	8

Note. In the Training phase of Experiments 1 and 2, respectively, a multiple VI 10 s VI 10 s and a multiple VI 10 s VI 60 s was in effect across conditions.

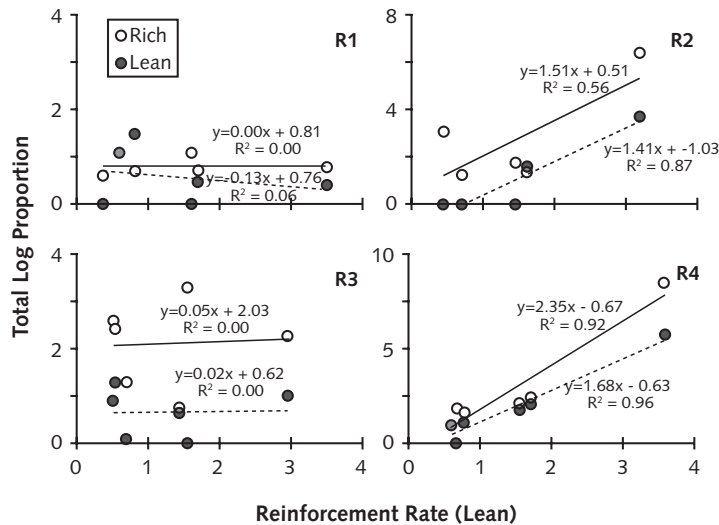


Figure 3. Total left-lever responding (on logarithmic scale) in the Test phase as a function of obtained reinforcement rate in the lean component in the Alternative Reinforcement phase, for each rat in Experiment 1. Data points were generated by summing the log-proportion of left-lever response rates across Test-phase sessions in which resurgence occurred in each component and correlating it with the mean obtained reinforcement rate in the lean component in the last six sessions of the Alternative Reinforcement phase. Open and closed circles represent the rich and lean components, respectively. Regression lines for the rich and lean components are solid and dashed, respectively. Equations and coefficients of determination are shown near each regression line. Note the different Y-axis scale for Rats R2 and R4.

a; but see Cançado & Lattal, 2013; and Fujimaki et al., 2015, *this issue*). In general, the frequency and the magnitude of resurgence were greater in the rich than in the lean component across conditions, and, for two rats, the magnitude of resurgence in both components was positively related to reinforcement rates in the Alternative Reinforcement phase (see Figures 2 and 3). These results qualify the lack of a relation between resurgence and reinforcement rates in the Alternative Reinforcement phase reported by Cançado and Lattal, and Fujimaki et al. Similar to the latter studies, in some Test-phase sessions of the present experiment the magnitude of resurgence was greater in the lean than in the rich component (or was nondifferential between components) but, generally, it was greater in the rich than in the lean component (cf. Shahan & Sweeney, 2011). Obtaining resurgence of greater magnitude in the rich than in the lean component in the present experiment suggests that the unsystematic relation between resurgence and reinforcement rates in the Alternative Reinforcement phase reported by Cançado and Lattal (see also Fujimaki et al., 2015, *this issue*, and Winterbauer & Bouton, 2010) may have been due to their manipulation of only a few schedule values in that phase.

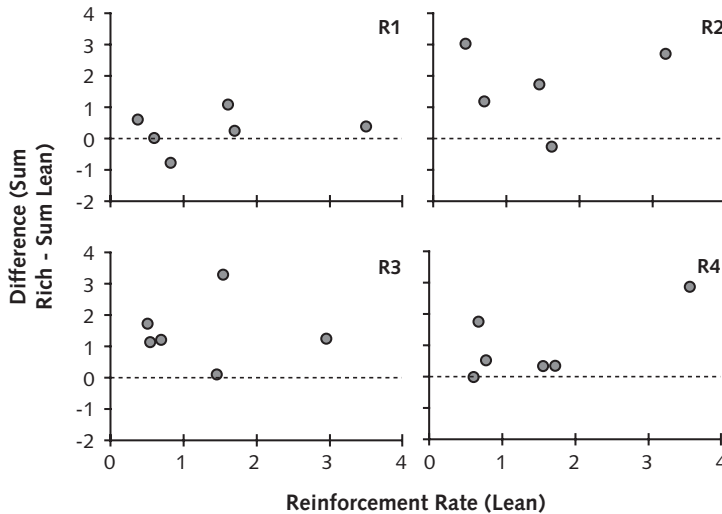


Figure 4. Difference (Rich component – Lean component) in total left-lever responding (on logarithmic scale) in the Test phase as a function of obtained reinforcement rate in the lean component, for each rat in Experiment 1. Data points were generated by calculating the difference (Rich component – Lean component) of the sum of the log-proportion of left-lever response rates across Test-phase sessions in which resurgence occurred in each component and correlating it with the mean obtained reinforcement rate in the lean component in the last six sessions of the Alternative Reinforcement phase. The dashed horizontal line in each graph indicates no difference between components.

Experiment 2

In this experiment, the effects of differential reinforcement rates in the Alternative Reinforcement phase on resurgence were studied parametrically when Training-phase reinforcement rates were differential between multiple schedule components.

Method

Subjects and Apparatus. Four experimentally-naïve female Wistar rats (R5, R6, R7 and R8), 90 days old at the start of the experiment, were maintained as in Experiment 1. The apparatus was the same as in that experiment.

Procedure. The General Features of the procedure were as in Experiment 1. Six conditions were conducted for Rats R5 and R6, and five for Rats R7 and R8. Conditions differed regarding the programmed reinforcement rate in each multiple-schedule component in the Alternative Reinforcement phase.

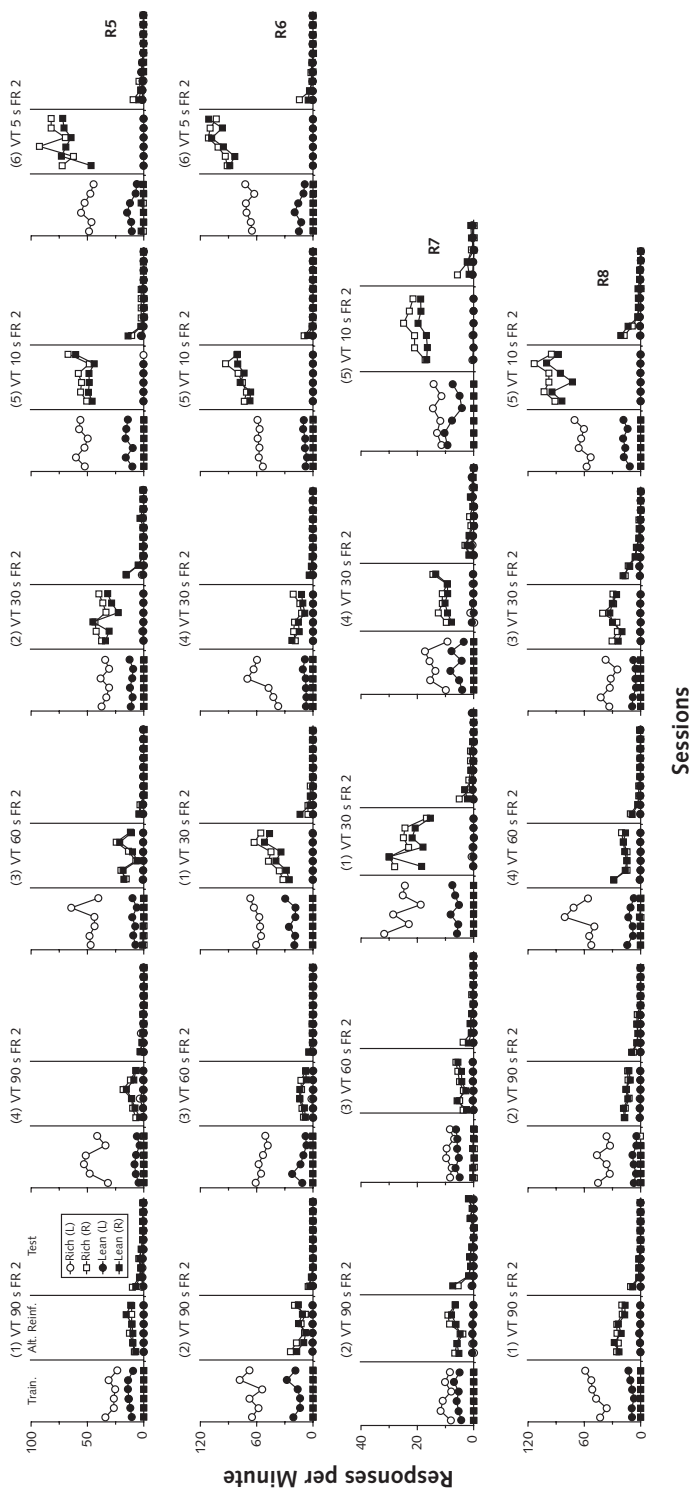


Figure 5. Responses rates (responses per min) in each schedule component during the last six sessions of the Training and Alternative Reinforcement phases, and each session of the Test phase of Experiment 2. For each rat, graphs are ordered from lower to higher programmed reinforcement rate in both components in the Alternative Reinforcement phase (the schedule in both components is indicated above each graph; numbers in parentheses above each graph indicate the order of conditions). Note the different Y-axis scales for Rats R5 and R7. Other details as in Figure 1.

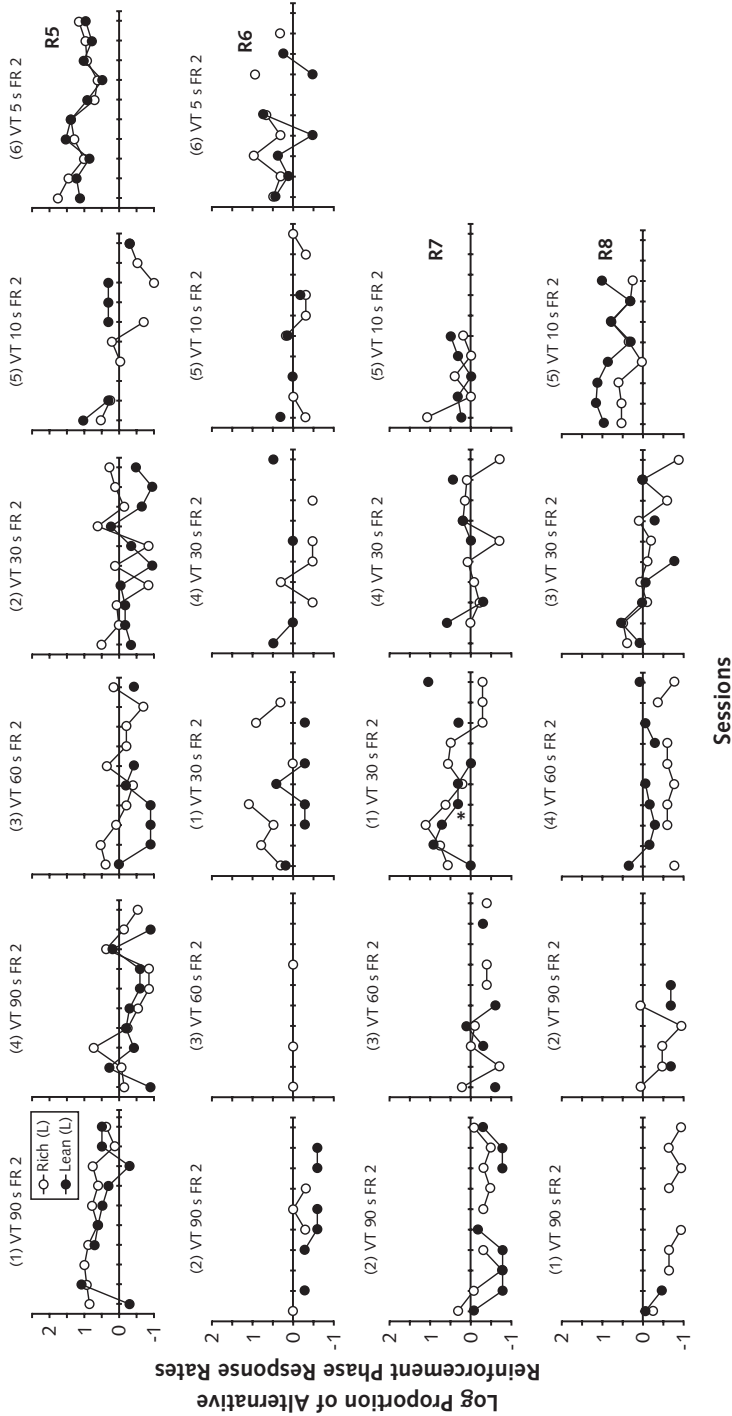


Figure 6. Left-lever response rates (on logarithmic scale) in each session of the Test phase as a proportion of the highest response rate during the last three sessions of the Alternative Reinforcement phase, for each rat in Experiment 2. For each rat, graphs are ordered from lower to higher programmed reinforcement rate in both components in the Alternative Reinforcement phase (the schedule in both components is indicated above each graph; numbers in parentheses above each graph indicate the order of conditions). Note the different Y-axis scale for Rat R5. Other details as in Figure 2.

Pretraining. This phase was conducted as described in Experiment 1, with minor differences. Left-lever pressing was established after two sessions, for Rat R6, three sessions, for Rats R5 and R7, and seven sessions, for Rat R8. After two sessions of exposure to the multiple VI 5 s VI 5 s (with 30-s component duration), each rat was exposed to the multiple schedule as described in the General Features section of Experiment 1. Initially, the value of the VI was 10 s in both components (exposure to this schedule lasted for five sessions, for Rats R5, R6 and R8, and seven sessions for Rat R7). Then, for each rat, the value of the VI in one component (later, the lean component, correlated with the flashing houselight) was changed, every two sessions, to 15 s, 20 s, 30 s, 40 s, and 50 s.

Training, Alternative Reinforcement, and Test. In each condition, the Training, Alternative Reinforcement, and Test phases were conducted as in Experiment 1, with the following exceptions: (a) In the Training phase, a multiple VI 10-s (*rich*) VI 60-s (*lean*) schedule (programming reinforcement rates of six and one reinforcer per min, respectively) was in effect across conditions. For each rat, the rich and lean components were correlated with the constant and the flashing houselight, respectively; (b) in the Alternative Reinforcement phase, a multiple tandem VT FR 2 tandem VT FR 2 was in effect for each rat. The value of the VT was the same in both schedule components within a condition, but differed across conditions (VT values of 5 s, 10 s, 30 s, 60 s, and 90 s were used in both components across conditions; the lower portion of Table 1 shows, for each rat, the schedules of reinforcement in effect in this phase across conditions); and (c) due to a programming error, the Test phase of Condition 5 was conducted for five, instead of 10, sessions for Rat R7.

Results and Discussion

Reinforcement rates in each schedule component, and the number of sessions in the Training and Alternative Reinforcement phases across conditions are shown in the lower portion of Table 1, for each rat. Response rates in each component, across phases and conditions, are shown in Figure 5. In the Training phase, reinforcement rates approximated the programmed rates in the rich and lean components for each rat and response rates were always higher in the rich than in the lean component (for Rat R7, due to relatively lower response rates in both components in this phase, reinforcement rates were lower than programmed, but always higher in the rich than in the lean component). In the Alternative Reinforcement phase, left-lever response rates were zero or near zero and right-lever response rates generally were similar between components (although they were slightly higher in the rich than in the lean component in some sessions of this phase in Conditions 5 and 6, for Rats R5, R7, and R8). In this phase, across conditions, reinforcement rates were similar between components and

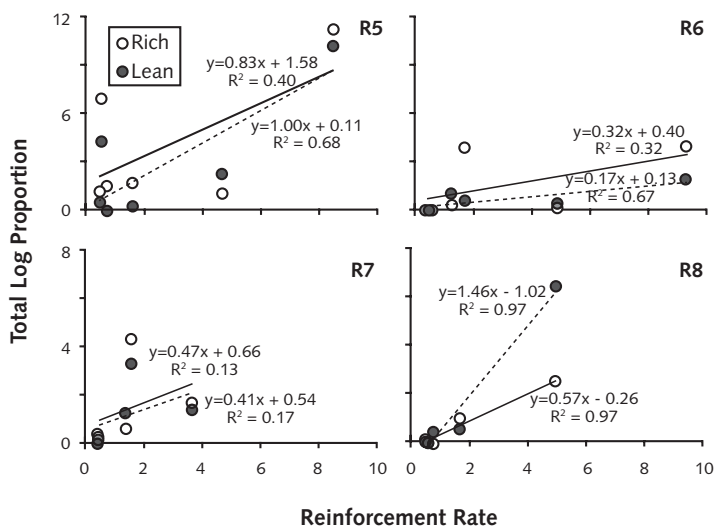


Figure 7. Total left-lever responding (on logarithmic scale) in the Test phase as a function of obtained reinforcement rate in the Alternative Reinforcement phase, for each rat in Experiment 2. Data points were generated by summing the log-proportion of left-lever response rates across Test-phase sessions in which resurgence occurred in each component and correlating it with the mean obtained reinforcement rate in both components in the last six sessions of the Alternative Reinforcement phase. Other details as in Figure 3.

approximated (but were slightly lower than) the programmed reinforcement rates. As reinforcement rates increased in the Alternative Reinforcement phase, right-lever response rates in both components generally increased, indicating control of response rates in both components by the programmed reinforcement rates in each condition. Right-lever response rates decreased to near zero across Test-phase sessions.

Figure 6 shows left-lever response rates (on a logarithmic scale) in the rich and lean components during the Test phase as a proportion of responding in the Alternative Reinforcement phase (Table A2, in the Appendix, shows absolute response rates in the left and rear levers in these phases across conditions). Asterisks next to data points indicate that left-lever response rates were lower than rear-lever (control) response rates in a session (this occurred only in the lean component, in Session 4, Condition 1, for Rat R7; Table A2 also shows that rear-lever pressing was generally low, occurring at near zero rates across Test-phase sessions of each condition, for each rat). The lower portion of Table 2 shows the sum of the log-proportion of left-lever response rates across Test-phase sessions in which resurgence occurred in each component, for each rat, across conditions.

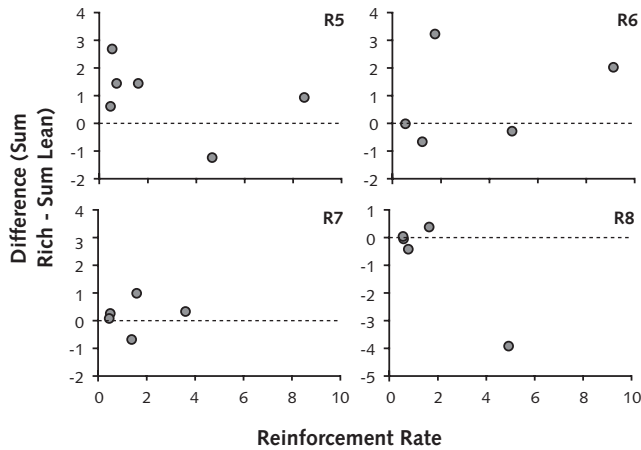


Figure 8. Difference (Rich component – Lean component) in total left-lever responding (on logarithmic scale) in the Test phase as a function of obtained reinforcement rate in the Alternative Reinforcement phase, for each rat in Experiment 2. Data points were generated by calculating the difference (Rich component – Lean component) of the sum of the log-proportion of left-lever response rates across Test-phase sessions in which resurgence occurred in each component and correlating it with the mean obtained reinforcement rate in both components in the last six sessions of the Alternative Reinforcement phase. The dashed horizontal line in each graph indicates no difference between components. Note the different Y-axis scale for Rat R8.

Considering the total number of sessions with resurgence in one or in both components, resurgence occurred in the rich and lean components, respectively, in 36 and 25 sessions out of 41 sessions, for Rat R5; in 15 and 11 out of 20 sessions, for Rat R6; in 16 and 13 out of 22 sessions, for Rat R7; and in 12 and 12 out of 17 sessions, for Rat R8. For Rats R5, R6 and R7, across conditions, resurgence generally was more frequent and of greater magnitude in the rich than in the lean component. For Rat R8, resurgence of greater magnitude occurred in the lean than in the rich component in Conditions 4 and 5 (in which the VTs in each component were, respectively, 60 s and 10 s). In Conditions 2 and 3 (in which the VTs in each component were, respectively, 90 s and 30 s), the relation between resurgence and reinforcement rate in the Alternative Reinforcement phase was unsystematic for this rat.

Figure 7 shows the total left-lever responding in sessions in which resurgence occurred as a function of reinforcement rate in the Alternative Reinforcement phase (i.e., the mean obtained reinforcement rates in both components in the last six sessions of this phase; see also the lower portion of Table 2). As with the similar data analysis in Experiment 1 (see Figure 3), solid and dashed regression lines are for the rich and lean components, respectively; equations and coefficients of determination also are shown

near each regression line, for each rat. For Rats R5, R6 and R8, these data suggest a positive relation between the magnitude of resurgence in both schedule components and reinforcement rates in the Alternative Reinforcement phase, although R^2 values were relatively low, ranging from 0.4 to 0.67 in the rich and lean components, for rats R5 and R6. The degree of differential resurgence, however, was not related systematically to reinforcement rates in the Alternative Reinforcement phase, as shown by the data in Figure 8, which displays the difference in total left-lever responding (Rich component – Lean component) as a function of reinforcement rates in the Alternative Reinforcement phase (the analysis uses the data shown in Figure 7 and in the lower portion of Table 2).

The results of the present experiment replicate and extend previous findings of differential resurgence as a function of reinforcement rates in both Training and Alternative Reinforcement phases (Podlesnik & Shahan, 2009, 2010; but see da Silva et al., 2008, Experiment 3; see also Cançado & Lattal, 2013; and Fujimaki et al., 2015, *this issue*). That is, the frequency and magnitude of resurgence generally were greater in the rich than in the lean component for three of four rats (R5, R6 and R7; cf. Shahan & Sweeney, 2011). In addition, as in Experiment 1, the present results suggest a positive relation between the magnitude of resurgence in both schedule components and reinforcement rates in the Alternative Reinforcement phase, although the difference in magnitude of resurgence between components was not related systematically to reinforcement rates in that phase (e.g., as predicted by Shahan & Sweeney).

General Discussion

In the present experiments, the relation between resurgence and reinforcement rates in the Alternative Reinforcement phase was assessed parametrically, in a within-subject design, when Training phase reinforcement rates were similar (Experiment 1) or different (Experiment 2) between multiple-schedule components. In both Experiments 1 and 2, although generally of low magnitude (see Tables A1 and A2 in the Appendix), resurgence was replicable within and across subjects (Lieving & Lattal, 2003), even after five or six exposures of each rat to the three phases of the resurgence procedure. In this regard, there were no systematic effects of repeated exposures to the procedure on resurgence in either of the present experiments, nor were there systematic effects of the length of the Alternative Reinforcement phase (see Table 1) on the frequency and magnitude of resurgence in both components (Lieving & Lattal; Winterbauer et al., 2013; but see Leitenberg et al., 1975; and Sweeney & Shahan, 2013 b). In both Experiments 1 and 2, the frequency and magnitude of resurgence generally were greater in the rich than in the lean component, a result that replicates and extends, by means of a parametric analysis, previous stud-

ies by Podlesnik & Shahan (2009, 2010), Pritchard, Hoerger, Mace, Penney et al. (2014), and Sweeney & Shahan (2013 a). In addition, the data in both experiments (see especially Figures 3 and 7) suggested a positive relation between the magnitude of resurgence in each component and reinforcement rates in the Alternative Reinforcement phase, as predicted by Shahan and Sweeney (2011). Finally, in contrast with the predictions by Shahan and Sweeney, in both experiments the degree of differential resurgence (i.e., the difference in the magnitude of resurgence between schedule components) was not related systematically to reinforcement rates in the Alternative Reinforcement phase.

The results of the present Experiment 1 qualify the lack of a systematic relation between resurgence and reinforcement rates in the Alternative Reinforcement phase reported by Cançado and Lattal (2013). In the present experiment, the differential resurgence obtained with the manipulation of different schedule values in the Alternative Reinforcement phase suggests that Cançado and Lattal's results were in part due to the manipulation of only a few schedule values in this phase (e.g., 30 s IRIs vs. 60 s IRIs) and highlights the importance of parametric analyses to address inconsistencies in results across studies (Sidman, 1960). Relative to Cançado and Lattal's experiment (see also Fujimaki et al., 2015, *this issue*, which used schedules and schedule values similar to those of Cançado & Lattal; and Winterbauer & Bouton, 2010), in the present Experiment 1 a more extreme difference in reinforcement rates between schedule components in the Alternative Reinforcement phase was programmed, similar to those programmed, for example, by Sweeney and Shahan (2013 a; 10 s IRIs vs. 100 s IRIs) and by Pritchard, Hoerger, Mace, Penney, et al. (2014; 120 s IRIs vs. 30 s IRIs), who also found differential resurgence as a function of reinforcement rates in the Alternative Reinforcement phase. In addition, the differential effects of reinforcement rates in the Alternative Reinforcement phase on resurgence in the present Experiment 1 were not confounded with differences in Training-phase response rates between schedule components (da Silva et al., 2008; Winterbauer et al., 2013), which were generally absent across conditions and rats in Experiment 1. It should be noted, however, that both Cançado and Lattal and Fujimaki et al. (2015, *this issue*) used pigeons as subjects and used, predominantly, DRO schedules in the Alternative Reinforcement phase. These procedural aspects also might be responsible for the differences between their results and those obtained in the present experiment, and warrant attention in future studies of the effects of reinforcement rates on resurgence. In addition, as noted previously, the length of the Alternative Reinforcement phase did not have systematic effects on the frequency and magnitude of resurgence across conditions of the present experiments. However, because in some studies (e.g., Leitenberg et al., 1975; Sweeney & Shahan, 2013 b) lengthier Alternative Reinforcement phases decreased the magnitude of resurgence, it might be useful in

future investigations to arrange Alternative Reinforcement phases of shorter durations to try to obtain resurgence of greater magnitude, especially when the effects of other variables (such as reinforcement rates) on resurgence are being studied.

The results of the present Experiment 2 also replicate and extend by means of a parametric analysis of reinforcement rates in the Alternative Reinforcement phase those reported previously by Podlesnik and Shahan (2009, 2010). Differently from the present Experiment 1, however, in the present Experiment 2 response rates in the Training phase were higher in the rich than in the lean component. As resurgence that was more frequent and of greater magnitude occurred generally in the rich than in the lean component in this experiment, the relative contributions of Training-phase response rates and reinforcement rates to resurgence cannot be assessed. Based on results of previous studies (e.g., da Silva et al., 2008, Experiments 1 and 2; Podlesnik & Shahan, 2010; Winterbauer et al., 2013), however, more resurgence was predicted in the component with higher Training phase response rates *and* reinforcement rates (i.e., the rich component), *independently* of reinforcement rates in the Alternative Reinforcement phase. The present Experiment 2 was designed to assess if, and how, parametrically manipulating reinforcement rates in the Alternative Reinforcement phase would affect this predicted differential resurgence (i.e., resurgence that was more frequent and of greater magnitude in the rich than in the lean component) between components. Across conditions of that experiment, the frequency and magnitude of resurgence were generally greater in the rich than in the lean component. In addition, there was an indication of a positive relation between the magnitude of resurgence in both schedule components and reinforcement rates in the Alternative Reinforcement phase (see Figures 6 and 7).

This is the first investigation of resurgence in which reinforcement rates in the Alternative Reinforcement phase were manipulated parametrically. As such, it contributes to our understanding of the determinants of resurgence by exploring the limits of a functional relation between resurgence and reinforcement rates in that phase. It should be noted that the resurgence obtained across conditions in Experiments 1 and 2 was generally of low magnitude (Cançado & Lattal, 2013; see Tables A1 and A2 in the Appendix), and the time taken to conduct these parametric analyses was relatively long. The development of procedures that generate consistently greater magnitudes of resurgence, and in which the effects on resurgence of reinforcement rates (or any other variable of interest) can be assessed in a more time-efficient manner (e.g., within sessions or within a few sessions) would be a useful pursuit in future experiments.

Systematic analyses of the effects of variables of interest on resurgence are interesting from both theoretical and practical viewpoints. Theoretically, such analyses might enhance our understanding of resurgence and its relations to other types of

recurrence (e.g., renewal and reinstatement; Bouton, 2014; Kinkaid, Lattal, & Spence, 2015; Podlesnik & Kelley, 2014; Podlesnik & Shahan, 2009; Winterbauer & Bouton, 2010), a largely unexplored topic. Practically, given the current interest on the recurrence of behavior by applied behavior analysts (see Pritchard, Hoerger, & Mace, 2014, for a review), such systematic experimental analyses would provide a useful basis for dealing with recurrence in any context in which it is necessary.

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Appendix

Table A1

Left-lever (Left) and Rear-Lever (Control) Response Rates (in Responses per Min) in Each Schedule Component During the Last Three Sessions of the Alternative Reinforcement Phase (n-2, n-1 and n), and Each Session of the Test Phase, for Each Rat, in Each Condition of Experiment 1.

Rat	Condition	Alt. Reinforcement					Test									
		Comp.	Response	n-2	n-1	n	1	2	3	4	5	6	7	8	9	10
R1	1	Rich	Left	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	Rich	Left	0.00	0.00	0.00	0.00	0.00	0.27	0.20	0.00	0.00	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00
		Lean	Left	0.07	0.00	0.00	0.20	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	Rich	Left	0.07	0.07	0.00	0.00	0.00	0.40	0.13	0.00	0.00	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.00	0.47	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	Rich	Left	0.00	0.00	0.13	0.67	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.67	0.00	0.20	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
	5	Rich	Left	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.33
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.40	0.20	0.47	0.67	0.00	0.33	0.00	0.00	0.93	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6	Rich	Left	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.13	0.00	0.00	0.07	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00
		Lean	Left	0.13	0.00	0.00	0.00	0.33	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R2	1	Rich	Left	0.00	0.13	0.00	2.07	0.47	0.07	0.07	0.00	0.00	0.00	0.20	0.13	0.13
			Control	0.00	0.00	0.00	0.07	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.00	0.00	0.20	2.00	0.07	0.13	0.00	0.00	0.80	0.13	0.00	0.07	0.00
			Control	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00
	2	Rich	Left	0.00	0.07	0.00	0.33	0.20	0.20	0.07	0.00	0.00	0.13	0.00	0.00	0.80
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.47	0.13	0.13	0.07	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	Rich	Left	0.00	0.00	0.00	0.07	0.13	0.00	0.13	0.27	0.00	0.00	0.07	0.07	0.07
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.20	0.13	0.07	0.07	0.00	0.00	0.00	0.20	0.07	0.00	0.00	0.20	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	Rich	Left	0.00	0.00	0.00	0.00	0.07	0.07	0.60	0.00	0.00	0.07	0.20	0.13	0.07
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.53	0.07	0.40	0.13	0.07	0.20	0.00	0.27	0.13	0.07	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	Rich	Left	0.07	0.00	0.00	2.27	0.47	0.40	0.93	0.47	0.07	0.20	0.00	0.20	0.13
			Control	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.00	0.07	0.07	1.00	0.47	0.07	0.20	0.53	0.07	0.13	0.07	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(continued)

Table A1 (continued)

Alt. Reinforcement							Test										
Rat	Condition	Comp.	Response	n-2	n-1	n	1	2	3	4	5	6	7	8	9	10	
R3	1	Rich	Left	0.00	0.00	0.07	0.13	0.67	0.47	0.00	0.07	0.13	0.47	0.07	0.00	0.00	
			Control	0.00	0.00	0.00	0.00	0.07	0.13	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.07	0.40	0.00	0.27	0.13	0.07	0.07	0.00	0.00	0.13	0.07	0.07	0.07	0.00
			Control	0.07	0.00	0.00	0.07	0.13	0.07	0.13	0.00	0.00	0.00	0.00	0.33	0.07	0.07
		2	Rich	Left	0.20	0.07	0.00	0.33	0.33	0.47	0.47	0.40	0.60	0.00	0.87	0.13	0.00
				Control	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Lean		Left	0.20	0.33	0.27	0.13	0.13	0.13	1.60	0.53	0.00	0.13	0.00	0.00	0.07	0.00
			Control	0.00	0.00	0.13	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00
	3		Rich	Left	0.13	0.13	0.07	0.47	0.13	0.07	0.20	0.20	0.13	0.13	0.00	0.00	0.33
				Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
		Lean	Left	0.47	0.80	0.73	1.00	0.27	0.27	0.20	0.07	0.07	0.07	0.00	0.00	0.07	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		4	Rich	Left	0.00	0.27	0.00	0.67	0.47	0.13	0.20	0.20	0.33	0.00	0.07	0.20	0.00
				Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Lean		Left	0.27	0.07	0.47	2.00	0.13	0.13	0.13	0.00	0.20	0.07	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5		Rich	Left	0.00	0.00	0.00	0.80	0.00	0.00	0.07	0.47	0.20	0.07	0.00	0.00	0.00
				Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.13	0.13	0.13	1.13	0.20	0.00	0.00	0.20	0.13	0.13	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		6	Rich	Left	0.00	0.00	0.00	0.00	0.40	0.33	0.13	0.20	0.00	0.07	0.00	0.00	0.07
				Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Lean		Left	0.00	0.00	0.13	0.40	0.00	0.00	0.20	0.20	0.20	0.07	0.00	0.07	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R4	1		Rich	Left	0.00	0.00	0.00	1.27	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.20	0.07
				Control	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.20	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.07
			Control	0.07	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.20
		2	Rich	Left	0.07	0.13	0.00	0.20	0.73	0.33	0.73	0.13	0.00	0.13	0.13	0.00	0.00
				Control	0.00	0.00	0.00	0.07	0.00	0.07	0.13	0.07	0.00	0.00	0.00	0.00	0.00
	Lean		Left	0.07	0.13	0.00	0.47	0.27	0.20	0.13	0.27	0.00	0.33	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.13	0.00	0.00	0.00	0.00	0.00
	3		Rich	Left	0.13	0.00	0.00	0.20	0.00	0.00	0.40	0.33	0.00	0.07	0.00	0.40	0.00
				Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00
		Lean	Left	0.20	0.27	0.07	0.07	0.07	0.33	1.47	0.13	0.40	0.20	0.07	0.13	0.00	0.00
			Control	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		4	Rich	Left	0.20	0.07	0.00	2.33	0.73	0.20	0.00	0.07	0.27	0.13	0.07	0.33	0.47
				Control	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Lean		Left	0.27	0.13	0.13	2.93	0.13	1.40	0.07	0.47	0.00	0.07	0.07	0.07	0.07	0.20
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5		Rich	Left	0.07	0.33	0.07	1.47	0.47	0.13	0.40	0.13	0.07	0.33	0.20	0.13	0.13
				Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.33	0.33	0.00	0.80	0.00	0.73	0.40	0.00	0.07	0.40	0.07	0.20	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		6	Rich	Left	0.00	0.13	0.07	2.93	2.93	1.13	0.87	2.27	1.40	0.87	0.20	0.73	0.00
				Control	0.00	0.00	0.00	0.13	0.07	0.07	0.00	0.00	0.00	0.07	0.00	0.00	0.00
	Lean		Left	0.07	0.07	0.20	3.47	1.33	3.87	1.40	0.00	0.53	0.47	0.73	0.00	0.00	0.20
			Control	0.00	0.00	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00

Table A2

Left-lever (Left) and Rear-Lever (Control) Response Rates (in Responses per Min) in Each Schedule Component During the Last Three Sessions of the Alternative Reinforcement Phase (n-2, n-1 and n), and Each Session of the Test Phase, for Each Rat, in Each Condition of Experiment 2.

				Alt. Reinf.			Test									
Rat	Condition	Comp.	Response	n-2	n-1	n	1	2	3	4	5	6	7	8	9	10
R5	1	Rich	Left	0.00	0.20	0.07	1.40	1.67	2.00	1.53	0.80	1.20	0.80	1.13	0.27	0.47
			Control	0.00	0.20	0.00	0.00	0.73	0.20	0.20	0.27	0.33	0.07	0.13	0.13	0.00
		Lean	Left	0.07	0.00	0.13	0.07	1.53	1.40	0.67	0.53	0.40	0.27	0.07	0.40	0.40
			Control	0.73	0.00	0.33	0.27	0.13	0.53	0.07	0.27	0.00	0.00	0.13	0.00	0.00
	2	Rich	Left	0.20	0.47	0.47	1.47	0.47	0.53	0.07	0.60	0.07	1.93	0.33	0.60	0.87
			Control	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.13	0.00
		Lean	Left	0.33	0.60	0.33	0.27	0.40	0.40	0.53	0.07	0.27	1.00	0.13	0.07	0.20
			Control	0.00	0.13	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.13
	3	Rich	Left	0.33	0.27	0.20	0.80	1.13	0.40	0.20	0.13	0.73	0.20	0.20	0.07	0.47
			Control	0.00	0.00	0.00	0.13	0.00	0.00	0.13	0.40	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.13	0.53	0.40	0.53	0.07	0.07	0.07	0.33	0.20	0.00	0.00	0.00	0.20
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00
	4	Rich	Left	0.20	0.47	0.33	0.33	0.40	2.47	0.27	0.13	0.07	0.07	1.07	0.33	0.13
			Control	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.27	0.07	0.53	0.07	1.00	0.20	0.33	0.27	0.13	0.13	0.80	0.07	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	Rich	Left	0.67	0.27	0.33	2.20	1.20	0.00	0.60	1.07	0.13	0.00	0.07	0.20	0.33
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.13	0.00	0.00	1.40	0.27	0.00	0.00	0.00	0.27	0.27	0.27	0.00	0.07
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6	Rich	Left	0.07	0.00	0.00	3.73	1.80	0.67	1.27	1.53	0.33	0.27	0.53	0.60	0.93
			Control	0.00	0.00	0.00	0.13	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.07
Lean		Left	0.00	0.00	0.00	0.87	1.07	0.47	2.20	1.60	0.53	0.20	0.67	0.40	0.60	
		Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	
R6	1	Rich	Left	0.07	0.00	0.00	0.13	0.40	0.20	0.80	0.00	0.07	0.00	0.53	0.13	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.07	0.00
		Lean	Left	0.07	0.00	0.13	0.20	0.00	0.07	0.07	0.33	0.07	0.00	0.07	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.13	0.00	0.00
	2	Rich	Left	0.13	0.00	0.13	0.13	0.00	0.00	0.00	0.07	0.13	0.07	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.20	0.27	0.00	0.00	0.13	0.00	0.13	0.07	0.07	0.00	0.07	0.07	0.00
			Control	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	Rich	Left	0.00	0.07	0.00	0.07	0.00	0.07	0.00	0.00	0.00	0.07	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.00	0.07	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	Rich	Left	0.07	0.00	0.20	0.00	0.00	0.07	0.40	0.07	0.07	0.00	0.07	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.00	0.07	0.00	0.20	0.07	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.20
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	Rich	Left	0.07	0.13	0.13	0.07	0.13	0.13	0.00	0.20	0.07	0.07	0.00	0.07	0.13
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.00	0.20	0.00	0.40	0.00	0.20	0.00	0.27	0.00	0.13	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6	Rich	Left	0.00	0.13	0.07	0.40	0.27	1.20	0.27	0.60	0.00	1.13	0.00	0.27	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lean		Left	0.00	0.00	0.20	0.53	0.27	0.47	0.07	1.07	0.00	0.07	0.33	0.00	0.00	
		Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

(continued)

			Alt. Reinf.				Test										
Rat	Condition	Comp.	Response	n-2	n-1	n	1	2	3	4	5	6	7	8	9	10	
R7	1	Rich	Left	0.00	0.13	0.07	0.47	0.73	1.67	0.53	0.20	0.47	0.40	0.07	0.07	0.07	
			Control	0.00	0.00	0.00	0.13	0.07	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.00	0.00	0.00	0.07	0.53	0.33	0.13	0.13	0.07	0.00	0.13	0.00	0.73	0.73
			Control	0.07	0.27	0.13	0.20	0.27	0.13	0.33	0.00	0.13	0.07	0.00	0.00	0.00	0.13
	2	Rich	Left	0.40	0.27	0.07	0.80	0.33	0.07	0.20	0.00	0.20	0.13	0.20	0.13	0.33	
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.40	0.13	0.13	0.33	0.07	0.07	0.07	0.27	0.00	0.00	0.00	0.07	0.07	0.20
			Control	0.00	0.40	0.20	0.13	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	Rich	Left	0.27	0.27	0.33	0.53	0.07	0.33	0.27	0.00	0.13	0.13	0.00	0.00	0.13	
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.27	0.20	0.27	0.07	0.00	0.13	0.33	0.07	0.00	0.00	0.00	0.00	0.13	0.00
			Control	0.07	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	Rich	Left	0.07	0.33	0.13	0.00	0.33	0.20	0.27	0.40	0.07	0.53	0.47	0.40	0.07	
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.07	0.00	0.27	0.00	1.00	0.13	0.00	0.00	0.27	0.40	0.00	0.73	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Rich	Left	0.00	0.13	0.13	1.53	0.13	0.33	0.13	0.20	-	-	-	-	-		
		Control	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	-	-	-	-	-	-	
	Lean	Left	0.20	0.07	0.07	0.33	0.40	0.00	0.40	0.60	-	-	-	-	-	-	
		Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-	
R8	1	Rich	Left	0.60	0.47	0.47	0.33	0.00	0.13	0.13	0.07	0.00	0.13	0.07	0.13	0.07	
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.00	0.00	
		Lean	Left	0.13	0.40	0.27	0.33	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
			Control	0.00	0.00	0.13	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	Rich	Left	0.27	0.60	0.40	0.67	0.20	0.20	0.07	0.67	0.00	0.00	0.00	0.00	0.00	
			Control	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Lean	Left	0.33	0.07	0.07	0.00	0.07	0.00	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.00
			Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00
	3	Rich	Left	0.53	0.40	0.27	1.27	1.60	0.40	0.60	0.40	0.33					