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Matching and bias on concurrent performances: Effects of asymmetrical changeover delays[1]

Igualación y sesgo en ejecuciones concurrrentes: Efectos de demoras de cambio asimétricas[1]

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ABSTRACT

Five pigeons were exposed to concurrent variable-interval, variable-interval schedules, one of five different pairs of schedules assigned to each subject. On the first experimental condition, symmetrical 3-sec changeover delays (COD) were in effect. On the second condition, the 3-sec COD was in effect only for changeovers from the white to the green key-color. On the third condition, the COD contingency was reversed: there was no COD for changeovers from white to green, and a 3-sec COD was in effect for changeovers in the opposite direction. For every session, group data from the five pigeons was used to compute the parameters of the generalized matching law $R_1/R_2 = k(r_1/r_2)^a$. The asymmetry in changeover delays affected bias (k) and matching (a). When the 3-sec COD was associated with the green color, response distribution produced bias toward the green color, and time distribution indicated bias toward the white color. Such results were confirmed when the asymmetrical COD contingency was reversed: response bias toward the schedule associated with the COD, time bias toward the other schedule of the concurrent pair. Exponents (a) for time and response distributions were approximately equal for symmetrical CODs, and systematically different for asymmetrical CODs: the exponent for response distribution was higher than for time distribution. Results indicated that the effects of asymmetrical CODs on bias and matching are similar to those observed on concurrent fixed-ratio, variable-interval schedules. In both cases, changes in bias and matching may be due to changes in local response rates.

DESCRIPTORS: matching, bias, concurrent schedules, changeover delay, key peck, pigeons.

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RESUMEN

Cinco pichones fueron expuestos a programas concurrentes de intervalo-variable, intervalo-variable, asignándose a cada sujeto uno de cinco pares diferentes de programas. En la primera condición experimental estuvieron en efecto demoras de cambio (DCA) simétricas de 3 seg. En la segunda condición, la DCA de 3 seg. estuvo en efecto solamente para cambios del color blanco al verde de la tecla. En la tercera condición, la contingencia de DCA fue invertida: no hubo DCA para cambios de blanco a verde, y un DCA de 3 seg. estuvo en efecto para los cambios en la dirección opuesta. Para cada sesión, los datos de grupo de los cinco pichones fueron empleados para computar los parámetros de la ley generalizada de igualación $R_1/R_2 = k(r_1/r_2)^a$. *La asimetría en las demoras de cambio afectó el sesgo (*k*) y la igualación (*a*). Cuando se asoció la DCA de 3 seg. con el color verde, la distribución de respuestas produjo un sesgo hacia el color verde, y la distribución del tiempo indicó un sesgo hacia el color blanco. Estos resultados fueron confirmados cuando se invirtió la contingencia DCA asimétrica: el sesgo de respuesta hacia el programa asociado con la DCA, y el sesgo del tiempo hacia el otro programa del par concurrente. Los exponentes (*a*) para las distribuciones de tiempo y de respuesta fueron aproximadamente iguales para DCAs simétricas, y sistemáticamente diferentes para DCAs asimétricas: el exponente para la distribución de respuesta fue mayor que para la distribución de tiempo. Los resultados indicaron que los efectos de DCAs asimétricas en el sesgo y la igualación son similares a los observados en programas concurrentes razón-fija, intervalo-variable. En ambos casos, los cambios en el sesgo y la igualación pueden ser debidos a cambios en las tasas locales de respuesta.*

DESCRIPTORES: igualación, sesgo, programas concurrentes, demora de cambio, picoteo en la tecla, pichones.

In concurrent variable-interval, variable-interval schedules (*conc* VI VI), it is common to arrange some consequence for changeovers in order to decrease switching frequency (*e.g.*, Herrnstein, 1961; Stubbs and Pliskoff, 1969; Todorov, 1971; Acuña Santaella, 1979). Reviewing the literature on concurrent schedules, de Villiers (1977) supports the use of a changeover delay (COD; Herrnstein, 1961) contingent on switching responses as a necessary condition for the study of the matching relation (Herrnstein, 1970). However, de Villiers concedes that the role of the COD on the matching-relation is unclear. One of the possible ways of clarifying this role is the experimental manipulation of COD duration, scheduled symmetrically and asymmetrically, as in the study reported by Pliskoff (1971).

The purpose of the present investigation was to verify the effects of asymmetrical CODs on the parameters of the generalized matching law (Baum, 1974):

$$\frac{R_1}{R_2} = k\left(\frac{r_1}{r_2}\right)^a \qquad (1)$$

and

$$\frac{T_1}{T_2} = k\left(\frac{r_1}{r_2}\right)^a \qquad (2)$$

R, r, and T refer to responses, reinforcements, and time, respectively; subscripts identify schedules in the concurrent pair. The parameter k is interpreted as a measure of bias due to the effects of uncontrolled variables, and a as a measure of the sensityvity of response or time distribution to reinforcement distribution (Baum, 1974; de Villiers, 1977).

METHOD

Subjects

Five adult, experimentally naive pigeons. Birds were kep at 80% of their free-feeding weights.

Apparatus.

The experiment was conducted in a three-key Grason-Stadler pigeon chamber, Model E 3125A-300. The left key was not used in this experiment. The center key was transilluminated with a white or green light (main key) and the right key with a red light (changeover key). The keys required a minimum operating force of approximately 0.1N. Experimental control and data acquisition were accomplished by standar electromechanical equipment.

Procedure

Throughout the experiment, a given pair of variable interval schedules was in effect for each subject, with different pairs for different birds (Table 1). In the first 45 sessions, symmetrical 3-sec CODs were contingent on pecks at the changeover key (Findley, 1958). In the second experimental condition (35 sessions), the 3-sec COD was in effect only for switchings from white to green. Changeovers from green to white could be followed by reinforcement for the first response on the white key; changeovers from white to green were never followed by a reinforced response on green before 3 sec had elapsed since the switching response. In the third experimental condition (35 sessions), the COD contingency was reversed; the 3-sec COD was then contingent only on switchings from green to white.

Reinforcements were periods of 5-sec access to mixed grain. During reinforcements key lights were off, time counters and VI programmers stopped, and the feeder light was on.

TABLE 1

Concurrent variable-interval, variable-interval schedules used in the experiment, in reinforcements per hour and for each subject.

Subjects	Schedules	
	key-color	
	white	green
P 1	20	60
P 2	60	20
P 3	70	10
P 4	10	70
P 5	24	56

RESULTS

Data analysis was directed to the effects of asymmetrical CODs on measures of bias (k) and sensitivity to reinforcement distribution (a), according to Equations 1 and 2. Data from all five birds were used to compute the parameters of Equations 1 and 2 for each session. Thus, the results here presented refer to group data only.

TABLE 2

Changeover delay lenght scheduled for switching responses on different experimental conditions, and number of sessions in each condition.

COD length (sec) white	green	Number of sessions
3	3	45
0	3	35
3	0	35

Figure 1 shows values of parameters a and k obtained on the three experimental conditions. The values presented refer to the medians of obtained values in blocks of five sessions. The values of response and time bias were similar and varied unsystematically around 1.0 when symmetrical CODs were in effect. The change to asymmetrical CODS in the second condition

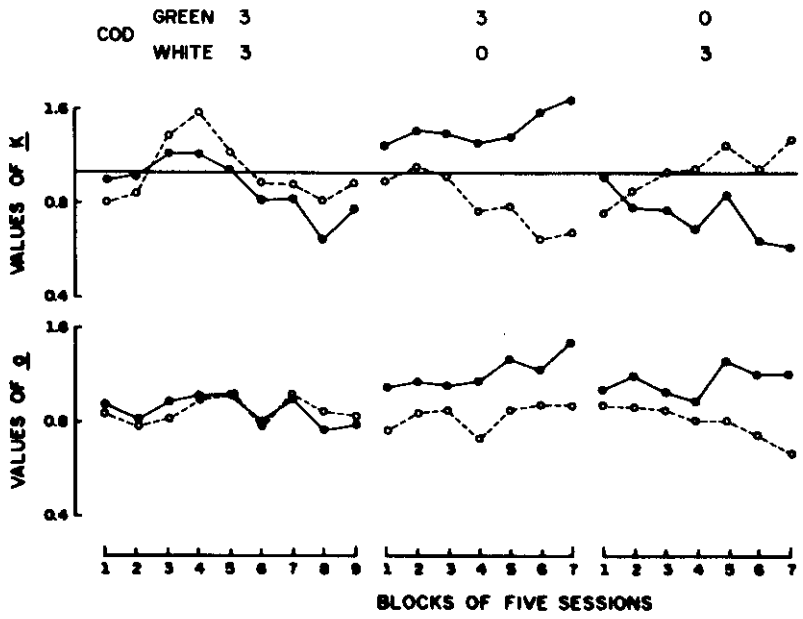

Fig. 1. Values of parameters a and k in Equations 1 and 2 in the three experimental conditions. Each point represents the median of a block of five sessions. Filled circles refer to data from response distribution; unfilled circles refer to time distribution. The solid horizontal line indicates values of $k = 1$ (no bias). Changeover delay (COD) contingencies, in seconds, are indicated in the upper part of the figure.

resulted in values of response bias greater than 1.0, showing a response bias toward the schedule associated with the 3 sec COD; the values for time bias were lower than 1.0 in the last 20 sessions (four blocks), indicating a time bias toward the schedule associated the absence of a COD contingency. In the third experimental condition, the reversal of the asymmetrical COD contingency resulted in a reversal in bias, confirming the data obtained in the second condition.

Exponent (a) values for response and time distributions were about equal and around 0.8 when CODs were symmetrical. The change to asymmetrical CODs in the second and third experimental conditions resulted in larger values of the exponent for responses than for time.

DISCUSSION

The data from the present experiment clearly show two kinds of effects produced by the asymmetry in the changeover delay contingency:

(1) The measures of bias (k) for responses and for time were differentially

affected by the change to asymmetrical CODs. Results show a response bias toward the schedule associated with the COD contingency and a time bias toward the other schedule.

(2) The measures of sensitivity to reinforcement distribution (a) also were differentially affected. With asymmetrical CODs, exponents for responses were always higher than exponents for time.

The present data indicate that the effects of asymmetrical CODs on *conc* VI VI are similar to those observed when the schedules of the concurrent pair are variable-interval, fixed-ratio schedules (Bacotti, 1977; Todorov and Hackradt, 1981). In *conc* VI FR schedules, even when symmetrical CODs are programmed, response and time bias will be different and dependent upon the FR requirement, with exponents for responses generally higher than exponents for time (Todorov and Hackradt, 1981). As subjects develop a consistent pattern of FR responding, an actual asymmetry in consequences for switching responses is observed. Responding on the VI schedule after a changeover may be followed by reinforcement after the COD period have elapsed; responding on the FR schedule after a changeover will be followed by reinforcement after n responses occur, since subjects almost never switch to the VI schedule before completing a ratio.

Both in *conc* VI VI with asymmetrical CODs and in *conc* VI FR, different local response rates are observed (*e.g.*, Pliskoff, 1971; Todorov and Hackradt, 1981). The similar findings concerning the parameters of Equations 1 and 2 in those schedules may be reflecting the similarity in effects on local response rates found in such schedules.

As pointed out before, the present results refer to group data from five pigeons. There could be argued that such results do not apply necessarily to data from individuals. However, the literature on concurrent schedules shows that Equations 1 and 2 have been used both with group and individual data, with similar results: the general findings are consistently replicated in both cases (*e.g.*, de Villiers, 1977; Baum, 1979).

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