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SHORT NOTE

FIXED INTERVAL PERFORMANCE IN A LARGE SAMPLE OF RATS (N=113): INTER-INDIVIDUAL DIFFERENCES

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Hundred and thirteen male adult albino rats (Wistar) have successively been submitted to 3 CFR, 3 FI 30, 3 FI 60, 3 FI 90 and 40 FI 120 seconds sessions. The daily sessions lasted in every case 30 minutes. Daily distributions of the Curvature Indice (Fry, Kelleher & Cook, 1960) values showed that the mean value increased up to a stabilization point at the 20th FI 120 seconds session and that the inter-individual differences as estimated by the standard deviation increased progressively throughout the session series. Rank correlations (Kendall Tau τ) computed between individual Curvature Index values from adjacent or remote sessions were highly significant and showed that the level of adjustment to the FI schedule early in training has a predictive value.

The use of operant techniques has been traditionally associated with an emphasis on the analysis of individual behavior. In the context of the laboratory psychology of the thirties and forties, swamped with short-term group studies in which the real locus of behavior, i.e. the individual organism was completely disregarded, the shift was a significant and a highly fruitfull one, as evidenced by data accumulated over half a century. However, individual differences are still with us, and they are part of what a science of behavior is about.

A description of the variation of a behavioral «trait» in a population is, for example, a necessary step in any study in behavior genetics. Many aspects of animal behavior exhibited in the operant conditioning chambers are legitimate candidates for behavior genetics investigations. Of special interest in this respect are the temporal regulations of behavior, i.e. the capacity for timing one's own behavior or for discriminating between the duration of external events. The possible relations between temporal regulations of behavior as controlled by schedules such as FI (Fixed Interval), DRL (Differential Reinforcement of Low Rates), DRRD (Differential Reinforcement of Response

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Durations) and biological periodicities, as investigated by modern chronobiology, has only recently retained the attention of experimenters (Innis, 1975; Innis & Vanderwolf, 1981; Richelle, 1968; Richelle & Lejeune, 1980; see also Elsmore & Hursh, 1982, for circadian rhythms and operant behavior in general).

What is known of the genetic component of biological rhythms suggests a parallel investigation of the part of genetic endowment in the performance of animals under contingencies involving temporal regulations. Along these lines, interindividual variations in behavior strictly controlled and recorded at the individual level should be looked at more systematically than has been the case up to now.

The present experiment is a contribution to the study of interindividual differences observed in a large sample of subjects submitted to an FI schedule of reinforcement. More specifically, it aims at answering the following two questions. First, do the central tendency and the dispersion of the distribution of a selected index of temporal regulation, i.e. the Curvature Index of Fry, Kelleher and Cook (1960) change as a function of the exposure to the schedule? Second, do the individual subjects rank similarly throughout prolongated exposure?

Method

Subjects

The subjects were 113 male adult albino (Wistar) rats. They were housed in individual cages in the animal quarters, except for the daily experimental session. They were maintained at 80 percent of ad libitum body weight.

Apparatus

The conditioning chamber (30 × 20 × 20 cm) was located in an illuminated (40 W white light bulb) sound-attenuating enclosure and was equipped with a lever (required force: .25N) and a Gerbrandts pellet dispenser (45 mgr). The experimental operations were controlled by automated circuitry. The interval of the Fixed Interval schedule was subdivided into 4 successive fractions. The number of responses emitted in each fraction was summated on separate counters.

Procedure

Ten series of 12 subjects were run daily in separate but identical conditioning chambers. The data of seven subjects were incomplete because of various technical defects and were discarded from the present analysis. The subjects were submitted to a total of 52 daily sessions of 30 minutes each. After three sessions during which each lever-press was reinforced, the FI contingencies were introduced according to the following program: 3 sessions under FI 30,3 sessions under FI 60,3 sessions under FI 90 and 40 sessions under FI 120 seconds.

The quality of the performance of the 113 rats in the FI 120 seconds schedule was evaluated with the Curvature Index of Fry, Kelleher and Cook (1960). This index has been widely used in temporal regulation of behavior studies. It is sensible and integrates the performance over the whole Fixed Interval. This index is correlated with other temporal regulation indices in FI, such as pause duration, and is unrelated to response rate, that is not an estimate of the distribution of responses within the interval (Gollub, 1964; see also Richelle & Lejeune, 1980).

Curvature Indices (maximal value: .75) were computed for each FI session and for each subject, and the distributions for the group were drawn session by session. Each individual rat was ranked for every session according to its Curvature Index value. Using the Kendall rank correlation coefficient (τ), correlations were computed between adjacent sessions and between sessions selected in the early and final stages of FI exposure. All data treatment was made on a PET Commodore computer.

RESULTS

Figure 1 shows the distribution of the Curvature Indices throughout the exposure to the FI contingencies. As a rule, the distributions fit into a bell shaped frame. One will note the extended left tail that gets more marked as learning progresses. The mean Curvature Index increases from session to session up to an asymptotic value reached around session 29. The performance seems to stabilize from the 20th session under FI 120 seconds. The mean Curvature Index fluctuates between .40 and .45 from this session on. Also, the standard deviation increases as the exposure to the schedule progresses (Figure 2).

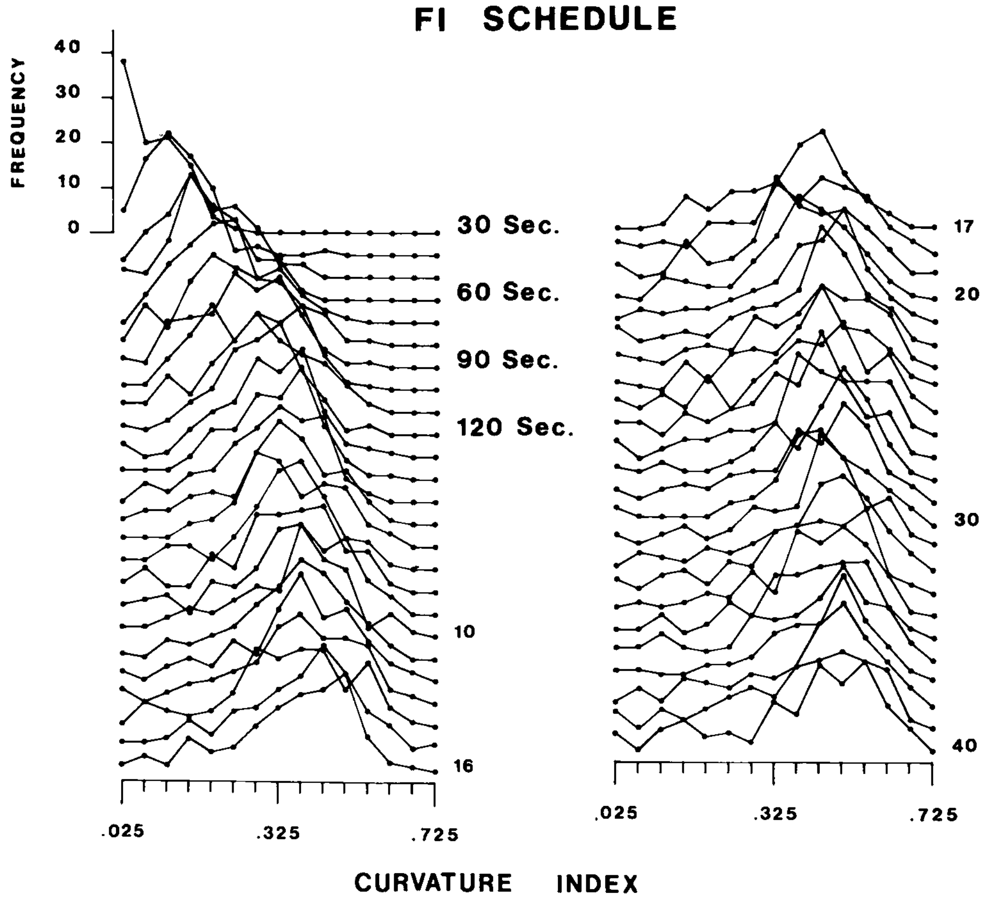

Fig. 1. — Frequency polygons presenting the distribution of the 113 rat's Curvature Indices at each FI session. From top to bottom and from left to right, successively, 3 FI 30, 3 FI 60, 3 FI 90 and 40 FI 120 seconds sessions. The abscissa at the bottom of each column gives the class marks of the distributions. The top left ordinate gives the frequency scale.

Rank correlations for adjacent sessions (from the first FI 60 seconds session on) are significant at $P \leqslant .001$. Correlation coefficients were also computed between selected sessions early in training, namely the third and last sessions under FI 60 seconds and the third session under FI 120 seconds on the one hand and each of the last ten sessions under FI 120 seconds on the other. All coefficients are significant at $P \leqslant .001$, except for two coefficients involving the FI 60 seconds early session, which are significant at $P \leqslant .01$.

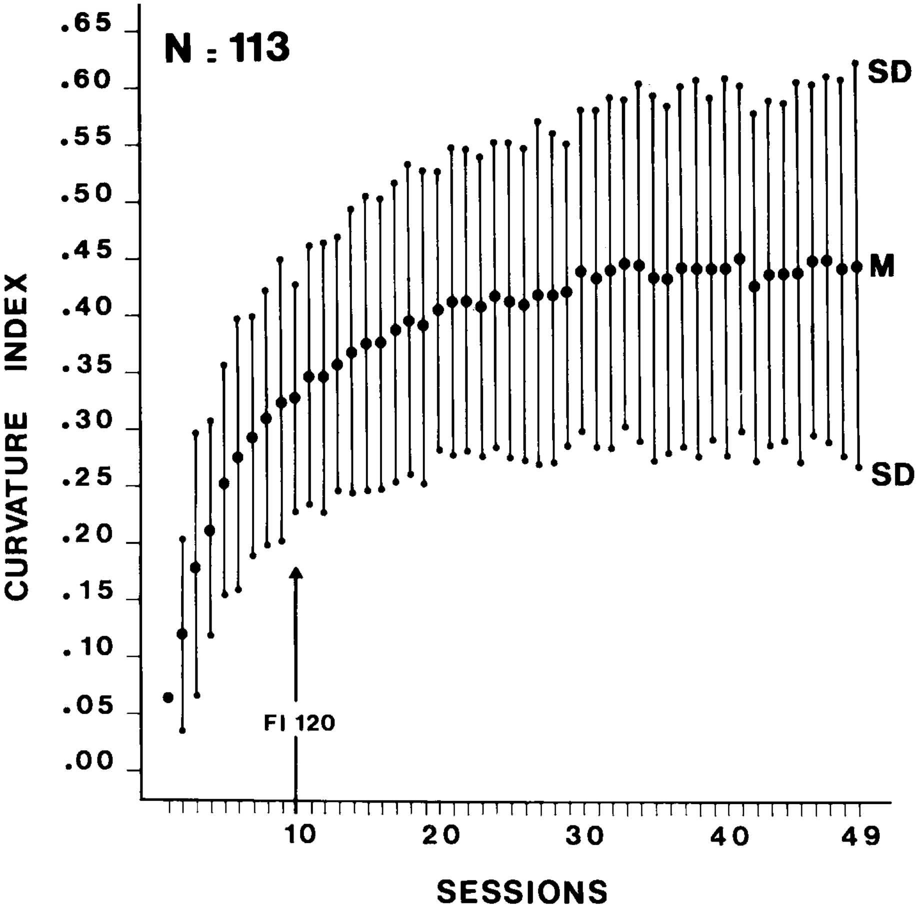

Fig. 2. — Evolution of the group mean Curvature Index value (M) and standard deviation (SD) from the first (left) to the last (right) FI session. Successively, 3 FI 30, 3 FI 60, 3 FI 90 and 40 FI 120 seconds sessions (total: 49 FI sessions). The Curvature Index can take a maximal value of .75.

Discussion

Figure 1 has shown that the performances, as estimated by the mean Curvature Index values, seem to stabilize from the 20th session under FI 120 seconds. Also, the standard deviation increases as the exposure to the schedule progresses (Figure 2). This might indicate that there were subjects with more extreme values in the final stage of exposure to the schedule than in the early stage. Prolongated exposure does not result in the contingencies taking control more homogeneously over behavior, reducing the scatter of the distribution. On the contrary, prolonged exposure seems to reveal individual differences more markedly.

Rank correlations between adjacent and remote sessions are significant. As Sackett and al. (1980) point out in their discussion about continuity in behavioral development, correlation coefficients are independant of the mean of the correlated indices. Indeed, the significant correlations show that bad or good performers tend to remain so later, independently of the general trend of the group as such toward improved adjustment up to a stabilization point. There seems to be idiosyncratic levels of capacity to adjust to the Fixed Interval schedule. Within a group of subjects, adjustment to the early stages of training, as estimated by the Curvature Index, seems to have a predictive value.

Two additional points deserve further experimentation. Would another measure of the same performance yield similar results? Second, would the same subject have ranked in a similar manner if submitted to other tasks involving the temporal regulation of behavior or temporal discrimination? The data collected so far are a first step towards an evaluation of the possible role of genetic variables in the temporal regulation of behavior. They suggest that the Curvature Index of Fry, Kelleher and Cook (1960) could be used as a reliable criterion for selective breeding in behavioral genetic study. They also offer a picture of the development, the steady state and the range of performances in the FI schedule in a large sample of Wistar rats, that can be considered as representative of the population of that species (N = 113). Such data were lacking until now, plausibly because of the emphasis on detailed study of individual behavior on the part of the behavior analysts. Interindividual — or intraindividual — variations are, notwithstanding, facts of nature, and deserve more systematic attention than they have been geven in the conditioning chamber.

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