EFFECTS OF CLASS-INTERVAL SIZE UPON CERTAIN FREQUENCY DISTRIBUTIONS OF INTER-RESPONSE TIMES¹

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Inter-response time distributions with class intervals of 0.05 and 0.04 sec revealed characteristics not observable with class intervals of 0.5 sec or greater. Bimodalities were clearly evident in the inter-response time distributions for two out of three pigeons. These modes seemed to correspond to two discrete response topographies.

Distributions of inter-response times (IRTs) frequently contain their modes within the first class interval. The practical usefulness of this generalization is limited by the extent to which it holds up across arbitrary changes in the size of the class interval. Latency data are often reported in class intervals of 1 sec or greater (*e.g.*, Reynolds and Catania, 1961; Schuster and Zimmerman, 1961) and these intervals may be too wide. For example, one experiment (Brandauer, 1958), reporting a distribution with class intervals of 0.1 sec, produced a suggestion of bimodality not ordinarily seen in IRT distributions that are subdivided more grossly. The experiment reported here attempts to examine the changes in appearance found in IRT distributions as the class interval is broken down into intervals considerably smaller than 1 sec.

METHOD

Subjects and Apparatus

Three female white Carneaux pigeons, all with extensive previous training on random-ratio schedules of reinforcement for key pecking, were used.

The experimental space was a sound- and light-insulated chamber, equipped with a Lehigh Valley pigeon key. Each peck recorded by the response key closed a type 21SM144

microswitch, thereby ensuring a discrete contact closure.

A system of electronic gate circuits and relays, described elsewhere (Schoenfeld, Cumming, and Hearst, 1956; Schoenfeld and Cumming, 1957; Hearst, 1958; Cumming and Schoenfeld, 1958, 1960; Clark, 1959; Millenson, 1959), controlled the recording, scheduling, and reinforcement delivery.

Responses were recorded on an Esterline-Angus events recorder with a chart speed of 24 in. per minute. IRTs were measured manually from these records to the nearest 0.05 sec for Bird 69, and to the nearest 0.04 sec for Birds 96 and 97. A second reader remeasured 300 of the IRTs and placed only five of them in class intervals that differed from the original distribution.

Procedure

All subjects (Ss) were deprived to 80% of their average body weight measured during a week in which they had free access to food. They were then reconditioned by 3-sec exposure to grain each time they pecked the key until they obtained 20 reinforcements. Bird 69 (See Fig. 1) was then placed on a schedule in which each response had the same probability (approximately 0.01) of being reinforced (Brandauer, 1958). Twenty daily sessions were run until recorded behavior appeared to be stable. A distribution of 694 IRTs was then obtained.

The reconditioning procedure was the same for Birds 96 and 97. Following reconditioning, however, these Ss were placed on a variable-ratio reinforcement schedule with an average of 100 responses per reinforcement and a range

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of 25 to 175. Daily sessions lasted until Ss obtained 100 reinforcements. After the recorded performance appeared stable, distributions of IRTs were obtained for three consecutive sessions.

RESULTS

Figure 1 presents the frequency distribution of IRTs obtained from Bird 69. The data are plotted in class intervals of different values,

Fig. 1. The same distribution of IRTs replotted with four different class intervals (e.g., 0.5, 0.2, 0.1, and 0.05 sec). The 694 IRTs composing the distribution were obtained consecutively from the same bird within one experimental session, after the attainment of a stable level of performance to the random-ratio 100 schedule.

starting with 0.5 sec (Fig. 1A) and decreasing to 0.05 sec (Fig. 1D).

The monotonically decreasing, unimodal distribution produced with class intervals of 0.5 sec (Fig. 1A) is changed when 0.2 sec class intervals are used. A slight deviation from the simpler form becomes apparent (Fig. 1B).

The class interval with the highest number of IRTs is, however, still the first one. This remains true even with class intervals of 0.1 sec (Fig. 1C), but an additional mode now appears at 0.35 sec. With class intervals of 0.05 sec (Fig. 1D) the class interval containing the largest frequency becomes the second class interval.³ At this level of resolution the IRTs in the first .5 sec clearly separate into two sub-populations, with modes at 0.08-0.12 sec and 0.36-0.40 sec.⁴

Figure 2 shows two IRT distributions from Birds 96 and 97, with class intervals of 0.04 sec. The third distribution obtained from each S did not differ from these in any consistent way. The distribution for Bird 69 is reproduced from Fig. 1D to permit a comparison of the IRT distributions for three Ss. The temporal location of the modal values demonstrates great consistency between Ss although the first mode is considerably smaller for Bird 97.

DISCUSSION

IRTs divided into class intervals of 0.05 and 0.04 sec reveal characteristics not apparent with larger class intervals. Observation of the Ss indicated that the first two modes were associated with two distinct response topographies. The IRTs comprising the second mode (at approximately 0.4 sec) were produced when the Ss pecked the key with a gross movement that involved both head and neck, their heads usually traveling at least 2 in. with each response. In contrast, the Ss often kept their heads within approximately 1/2 in. of the key, pecking it with short rapid movements that involved the neck only slightly. These latter responses were respon-

³Such a shift must occur when small enough class intervals are used, since there is a physical lower limit to the IRT of any organism.

⁴In a recent paper (Blough, 1963, page 241) the following observation is made, "... the peak [IRTs] at 0.4 sec remains. Another peak of very short IRTs—about 0.1 sec—becomes noticeable."

Fig. 2. IRT distributions for each of three pigeons. Data from Bird 69—distribution A—are from a single session, while data from Bird 96 are shown for two different sessions—distributions B and C. Bird 97 also has data from two sessions—distribution D and E. Birds 96 and 97 were being maintained on variable-ratio 100 while Bird 69 was on random-ratio 100.

sible for the IRTs in the first mode (at approximately 0.08 sec). It is not likely that key "chatter" or "bounce" contributed to the distributions. The microswitch incorporated in the response key produced "bounce" that was well under 2 msec in duration. This period is not only 20 times smaller than the shortest class interval used, but is well below the operating time necessary for the recording pens to function. The thin plexiglass disk, which is coupled to this microswitch, has insufficient mass to activate the microswitch through a return "bounce".

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