A SPEECH RATE METER FOR VOCAL BEHAVIOR ANALYSIS¹

JOHN A. STARKWEATHER

UNIVERSITY OF CALIFORNIA SCHOOL OF MEDICINE

The inherent advantage of automatic recording is undoubtedly one factor which has increased attempts to apply operant methods to many kinds of human behavior. These have often been conscious attempts to produce analogies to the behavior of rats and pigeons; and with appropriate experimental controls and recording procedures, cumulative records have been obtained which are remarkably similar to records produced by animals under various reinforcement schedules. An early example of this method applied to human behavior is the work of Lindsley (1954), who has continued a program of operant experimentation with state hospital patients for some years. He has described the method in detail in a later report (Lindsley, 1956).

King, Merrell, Lovinger, and Denny (1957) have undertaken similar work with patients, using an operant motor task which involved pulling a plunger for rewards of candy and cigarettes. Other research which has produced human operant records is that of Holland (1957). His subjects pressed a key in order to illuminate the face of a dial, one which they were monitoring and attempting to maintain on a particular setting. Several different reinforcement schedules have been used with this technique and have produced data which compare closely with the effect of reinforcement schedules on animal responses.

Anyone who has watched humans respond to slot machines cannot doubt that key pressing or lever pulling can be an important kind of human behavior under certain circumstances. Lewis and Duncan (1956), for example, have demonstrated an inverse relationship between continued human lever pulling and the proportion of reward for this type of behavior. However, the operant pressing of a key or pulling of a lever is a relatively rare behavior for most people; and it should be worthwhile to look for operants which are not only amenable to study and recording, but which also form a part of our daily activities.

The verbal, vocal, and gestural components of human communication may all be amenable to behavioral analysis with operant methods. Krasner (1958) has recently reviewed studies on the influence of generalized reinforcers on specified classes of verbal material. The apparatus described here makes available a variable of vocal behavior, one which should be of particular interest because of its natural occurrence in human activity, and its relation both to the progress of thought and to the expression of emotion. In addition, there are clear indications of behavior on the part of listeners which has reinforcing properties and may have discriminant stimulus properties. The apparatus provides a measure of the rate of talking by detecting speech pulses which are in the frequency range of syllables or points of emphasis within words. The apparatus converts these speech pulses into a series of uniform output pulses which operate the stepper on a cumulative recorder.

Another circuit developed independently was presented by Irwin and Becklund (1953) for the purpose of indicating the maximum repetition rate of the production of specific repeated syllables and repetitive tapping movements. This instrument, called the Sylrater, has some similarities to the circuit presented here, but was arranged to give only a meter indication of repetition rate, and was not arranged to handle conversational speech. Developmental norms were presented from this instrument for maximum rates of consonant repetition and tapping sounds produced by boys and girls at selected ages from 6 to 15 years.

¹Supported by Research Grants M-2015 and MY-3375, U. S. Public Health Service.

to compensate for the wide dynamic range which one may find in recordings of voice. Following rectification and filtering of the signal in order to produce a wave envelope within the frequency range of syllables, differentiation allows the use of a threshold related to the rate of rise of such pulses. Rates of rise above the threshold then trigger a circuit which produces uniform output pulses. These pulses are fed to a meter indication of pulses per second, and they may be counted by means of an electromechanical counter. The output-relay closure, however, can operate a cumulative recorder to give a continuous-response graph. As in similar recording of other responses, the rate of speech is here indicated as the slope of the line.

OPERATION AND USE

In using the Speech Rate Meter it soon became evident that syllables, as one might count them from a written record, were not being detected in records of conversation. Syllables would be detected, of course, during repetition of a single consonant sound; but during speech the instrument was rather responding to major points of emphasis within words. Typescripts were obtained for samples of recorded speech, and a word count from these typescripts was compared with the number of steps from the cumulative records. The apparatus came close to giving a running record of word rate as one might count it from a typescript. For 30 samples, recorded during interviews which involved four different people, the steps measured from the cumulative graph at 5-minute intervals had a mean of 354.4 and σ of 210.3. Words counted from a typescript of the same time periods had a mean of 366.5 and σ of 219.1. The product-moment correlation was 0.988 between measured steps and counted words. A sample record of interview recording is shown in Fig. 3.

Reliability has generally been such that repeat records from the same recording may be superimposed with no obvious discrepancy. Because of the rate of response under study, a standard cumulative recorder was modified to have a time base of 2 centimeters per second. The records use 8 steps per millimeter. A recycling timer resets to base line at 5-minute intervals for convenient reference points.

Figure 3. Sample record for Speech Rate Meter: Successive 5-minute periods from an interview.

The example also shows a use of the recorder's reinforcement marker to indicate vocal activity of a conversational partner. If separate but simultaneous recordings of the two voices are available, as they were here, a voice key will appropriately operate the marker to give a record similar to that shown. This is an obvious aid if the hypothesis of reinforcement activity by a listener is being considered. A noise-operated relay, Model 320A, manufactured by the Hunter Company of Iowa City, Iowa, has worked well in this application with no modification beyond bypass of the microphone preamplifier stage.

SUMMARY

An apparatus, called the *Speech Rate Meter*, produces a graphic, cumulative record of pulses in speech which shows a high relationship with word counts from typescripts. Diagrams which show direct operation from an audio signal are presented. A method is also described for the indication of conversational interaction.

REFERENCES

- Holland, J. G. Technique for behavioral analysis of human observing. *Science*, 1957, **125**, 348-350.
- Irwin, J. V., and Becklund, O. Norms for maximum repetitive rates for certain sounds established with the sylrater. *J. speech hear. Dis.*, 1953, **18**, 149-160.
- King, G. F., Merrell, D. W., Lovinger, E., and Denny, M. R. Operant motor behavior in acute schizophrenics. *J. Pers.*, 1957, **25**, 317-326.
- Krasner, L. Studies of the conditioning of verbal behavior. *Psychol. Bull.*, 1958, **55**, 148-170.
- Lewis, D. J., and Duncan, C. P. Effect of different percentages of money reward on extinction of a lever-pulling response. *J. exp. Psychol.*, 1956, **52**, 23-27.
- Lindsley, O. R., and Skinner, B. F. A method for the experimental analysis of the behavior of psychotic patients. *Amer. Psychologist*, 1954, **9**, 419-420 (Abstract).
- Lindsley, O. R. Operant conditioning methods applied to research in chronic schizophrenia. *Psychiat. res. Rep.*, 1956, **5**, 118-139.

Received December 28, 1959