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A SYSTEM FOR MONITORING AND CONDITIONING MODAL FUNDAMENTAL FREQUENCY OF SPEECH[1]

This report describes a prototype system for monitoring and conditioning fundamental frequency, the acoustic correlate of a speaker's perceived voice pitch. While deviant pitch may be the cause or effect of laryngeal pathology (Boone, 1971), many children and adults, including retardates and the emotionally disturbed, maintain deviant pitch levels unrelated to structural or physiological deficits (Perkins, 1971). A voice that is too high or low pitched for a person's age or sex may be defined as an appropriate target behavior for applied behavioral analysis; the system described treats vocal pitch as a response that can be controlled by its consequences. Moore and Holbrook (1971) described a system that is somewhat similar in principle and function, and the interested reader is encouraged to consult their report for a review of some experimental data.

Figure 1 shows a block diagram of the system. Essentially, a General Radio Wave Analyzer 1900A (General Radio Company, West Concord, Massachusetts) is used as a highly selective narrow band-pass filter network. The subject's speech is fed into this network, which can be tuned to a specified frequency, f_o. The output voltage, V_o, of the wave analyzer is proportional, at any instant, to how close the input frequency, f, is to f_o. If $f = f_o$, $V_o = 3$ volts; for $f < f_o - 1.5$ Hz or $f > f_o + 1.5$ Hz, V_o is approximately zero. Thus, the wave analyzer creates a "frequency window" of 3-Hz width centered at f_o. The output voltage of the wave analyzer is used to drive the electronic switch system described in Figure 2.[2] This system supplies 110 v to the elapsed time meter and frequency dependent light only when the subject's speaking frequency is within the chosen frequency window; when f_o is outside the window, the switch turns the time meter and frequency dependent light off. Thus, the elapsed time meter accumulates only during those periods when the subject's speech frequency is within the chosen window.

A timer is used to obtain speech-sample trials of uniform length from a subject. When the timer is started, it energizes a light in the soundproof room signalling the subject to begin reading aloud. Simultaneously, it completes the circuits for the elapsed-time meter and the frequency dependent light. At the end of the predetermined sampling interval, the timer shuts off the "read" light, the frequency dependent light, and the elapsed time meter. Also included in the experimental apparatus is a tape recorder used to record the subject's speech, and a means for the experimenter to communicate with the subject.

In preliminary studies the system has been found reliable and highly efficient in conditioning fundamental frequency with five normal-speaking adults. Figure 3 illustrates the performance of one subject. With the frequency contingent light non-operative, successive 30-sec samples of his speech were obtained from which the percentage of response time at 5-Hz steps from 95 to 140 Hz were obtained. The selected fundamental frequency for conditioning was 105 Hz, a frequency at which he averaged only 15% response time during seven baseline trials. Conditioning was instituted at Trial 8; the frequency contingent light was made operative and the subject was instructed to "try to keep the light on". He first attempted to increase speaking rate, but at the end of the ninth trial he began to speak in a low-pitched monotone, and for the tenth and eleventh trial he accumulated 87% response time at the selected fundamental frequency. Since these preliminary studies investigated conditioning with and without "awareness" of the operant contingency and this subject spontaneously verbalized awareness after the eleventh trial, no extinction trials were given.

Wave analyzers of the type used for the heart of this system are common equipment in communicative disorders laboratories and comparable systems may be suggested. Such systems, when used by a trained clinician with proper medical consultation, may allow highly efficient and effective clinical management of persons with deviant vocal pitch.

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[2]Mr. Leslie Meyers designed the switching circuit and provided the description.

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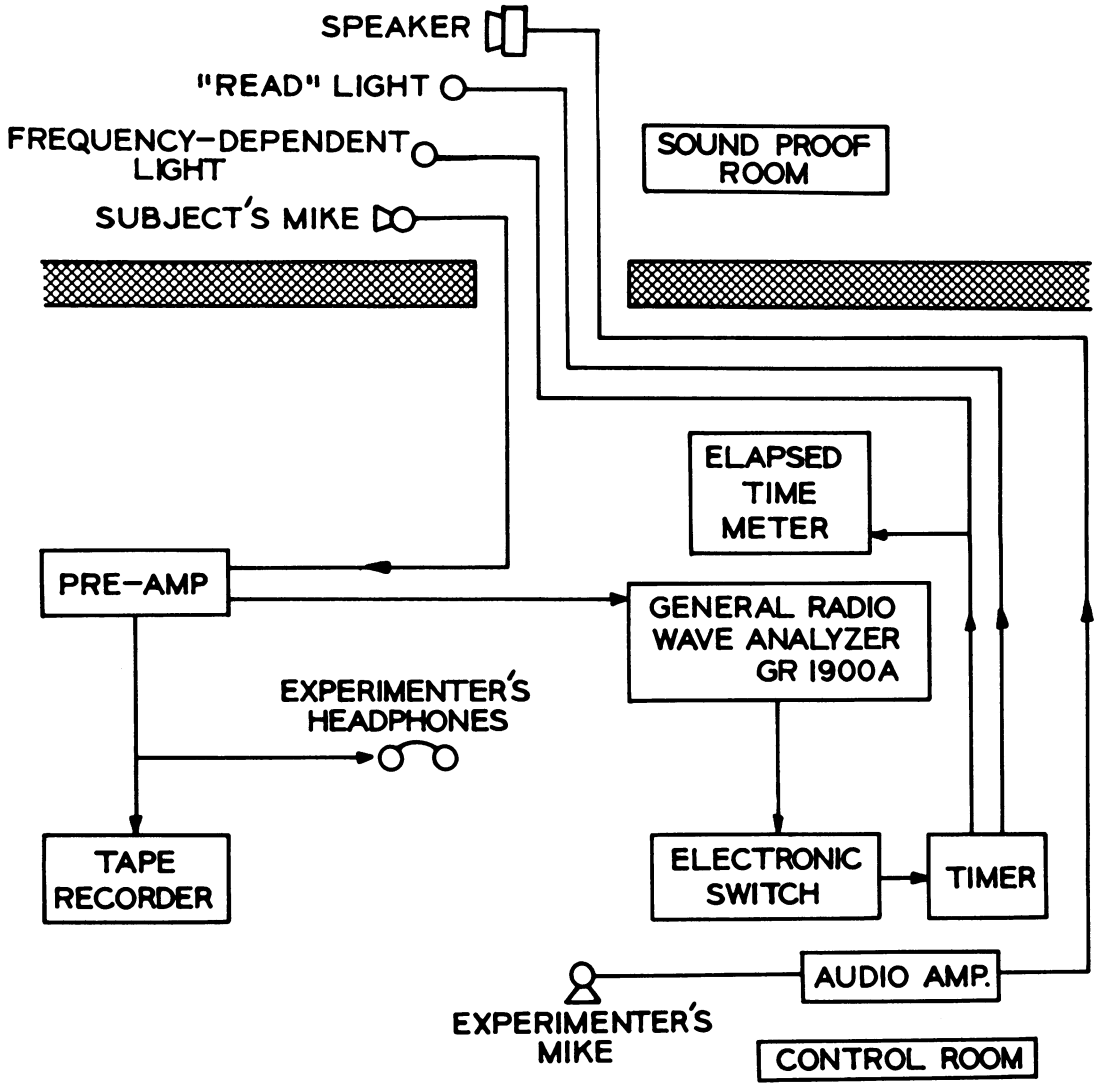

Fig. 1. Block diagram of a system for monitoring and conditioning fundamental frequency.

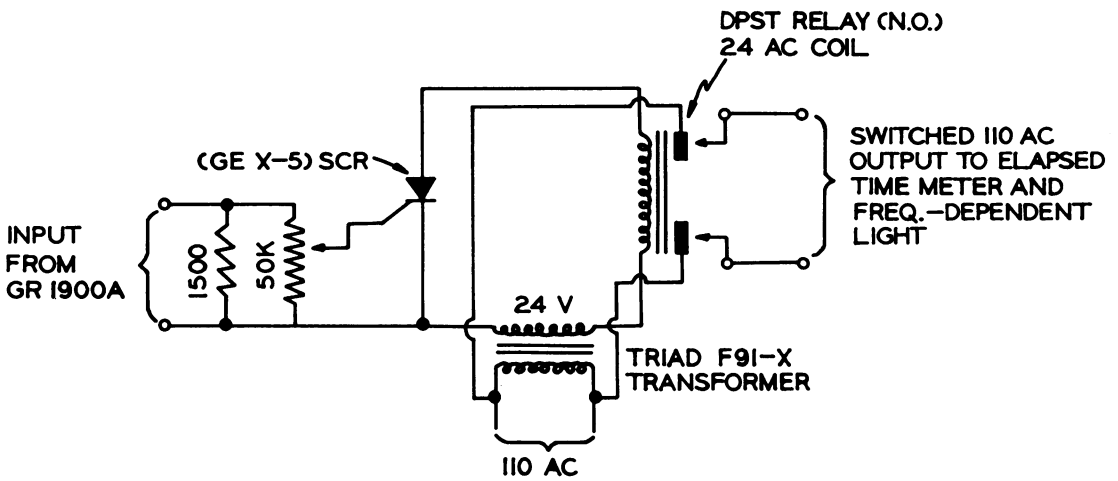

Fig. 2. Schematic diagram of the electronic switch.

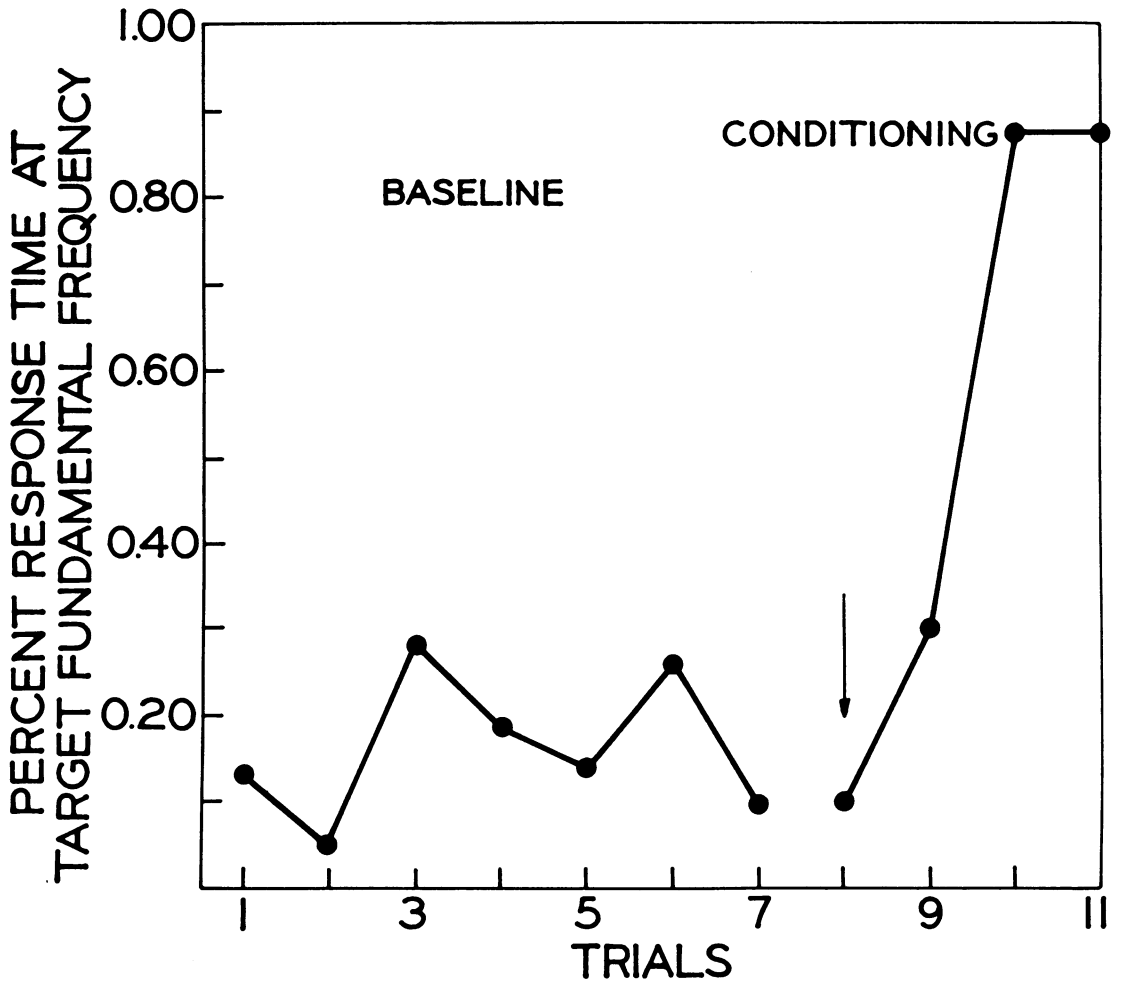

Fig. 3. Percentage of a subject's response time at a selected fundamental frequency (105 Hz) during baseline and conditioning trials.