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Preparing dichotic tapes using a digital music synthesizer

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Digital music synthesizers represent audio signals in the form of binary coded numbers. These binary coded numbers can be manipulated by the operator, thereby altering the audio signal in a variety of ways. The present article describes how these capabilities can be used to produce perfectly aligned dichotic tapes in which the stimulus items are matched on all extraneous (timbre, amplitude, duration) factors.

Over the past 10 years, several procedures using electromechanical devices to produce audio tapes for dichotic listening tasks have been developed (Leong, 1975; McDonnell & Perusse, 1978; Rubino, 1972; Yates, Smith, Burke, & Keane, 1969). Within the tolerances permitted by mechanical equipment, these techniques have probably achieved their maximum resolution in aligning two tracks. Unfortunately, electromechanical devices and the procedures developed around them are not able to equate stimuli on any other parameters (timbre, amplitude, duration). Researchers have tried to cope by matching stimuli with the aid of an oscilloscope. This approach is time consuming and not very satisfactory.

Two exceptions to the dominant electromechanical approach are the minicomputer procedures developed by Knight and Kantowitz (1973) and Treisman and Riley (1969). By recording digital facsimiles of spoken words, these experimenters were able to alter the characteristics of the stimuli. For example, Treisman and Riley (1969) were able to expand or compress their stimuli so that each had a duration of 250 msec.

The procedure described in the present article is an extension of the computer approach. It overcomes virtually all the difficulties involved in electromechanical approaches and offers even greater control of alignment and other stimulus parameters.

HARDWARE

The dichotic tapes are made with the Fairlight CMI (Computer Music Instrument) manufactured by Fairlight Instruments of Sydney, Australia, and sold around the world. (The Fairlight is distributed in the United States by Fairlight Instruments, West Los Angeles, California, and costs about $20,000.)

The Fairlight CMI consists of a piano-type keyboard, a video control console with light pen, eight digital sound modules, four microprocessors, 1 MB of floppy-disk storage, and 208 KB of random access memory.

The Fairlight CMI is a polyphonic system—up to eight different "voices" can be played simultaneously. Because it is a digital synthesizer, the Fairlight CMI is quite versatile. It can generate and reproduce music, speech, and sound effects without the characteristic "synthesizer" sound common to analog devices. A feature of the Fairlight that makes it particularly useful for making dichotic tapes is its ability to sample sounds (through a microphone) from external sources. Sounds (or words) input via the microphone can be manipulated, merged with other sounds, stored on floppy disk, or output to a tape. The Fairlight CMI divides words (or other sounds) input via the microphone into 128 segments and 32 harmonic envelopes. Once in the machine's memory, a word can be shortened or amplified, and its timbre and other characteristics may also be manipulated. The Fairlight also permits Fourier computations on each segment. Waveform characteristics such as duration, amplitude, and the shape of a sound's harmonic envelope can be altered merely by using a light pen. Up to 50,000 notes can be stored on floppy disks, and a special music-composition language can be used to sequence sounds and control timing.

A Revox B77, reel-to-reel tape deck is used to record the tapes.

PROCEDURE

Making dichotic tapes using the CMI involves three steps.

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Sampling

Words (or other stimuli) are entered individually into the CMI's memory through an external microphone. The sampling rate can be adjusted to suit the individual who is reading the words. It has been found that a sampling rate of 16,000 Hz provides adequate fidelity for human speech. (A sample rate as low as 3,000 samples/sec still provides intelligible speech output.)

Harmonic Profiles

After the stimulus entered into the CMI (Step 1) is digitized, it may be recalled from floppy disk and displayed in up to 32 sine-wave harmonic envelopes. Using the CMI's software, the operator controls the amplitude of each envelope. In addition, the duration envelope and the master volume envelope can be set. With these features, it is possible to make each word virtually equivalent to every other word. Such control is not possible with electromechanical devices.

Output

Once stimuli are equated for length, volume, etc., they are stored on floppy disk in digital form. A program written in the CMI's music-composition language then outputs the words to the Revox tape recorder through two of its eight possible outputs. One word goes to each channel of the deck, where they are recorded simultaneously. Timing can be controlled by the operator so that tapes with leading or trailing stimulus onsets or offsets can also be made. Alignment tolerance is limited only by the cycle time of the microprocessor (4 microsec). External synchronization facilities allow for accurate alignment of stimuli to other events and supply a means of accurate signal merging or overdubbing.

SUMMARY

Not only can dichotic tapes made with a digital synthesizer be aligned accurately, but also each stimulus item can be equated on characteristics such as timbre, duration, and amplitude. The procedure described in this paper begins with external sampling of a speaker's voice; there is, however, no reason why the entire voice cannot be synthesized and given any accent or inflection required. The synthesizer can be used to produce any sound stimulus a research program may require.

At present, digital synthesizers are expensive. The Fairlight CMI costs about $20,000, a low price considering its sophisticated capabilities. This price is certain to decrease along with the prices of all other computer products, but such synthesizers are unlikely to become common. For this reason, we would be pleased to make tapes for specialized purposes and would charge only for the costs involved, and we invite interested researchers to contact us with their inquiries.

REFERENCES

KNIGHT, J. L., & KANTOWITZ, B. H. A minicomputer method for generating dichotic word pairs. *Behavior Research Methods & Instrumentation*, 1973, **5**, 231-234.

LEONG, C. K. An efficient method for dichotic tape preparation. *Behavior Research Methods & Instrumentation*, 1975, **7**, 447-451.

MCDONNELL, P. M., & PERUSSE, S. A method for the preparation of audio tapes for dichotic listening research. *Behavior Research Methods & Instrumentation*, 1978, **10**, 15-17.

RUBINO, C. A. A simple procedure for constructing dichotic listening tapes. *Cortex*, 1972, **8**, 335-338.

TREISMAN, A., & RILEY, J. Is selective attention selective perception or selective response? A further test. *Journal of Experimental Psychology*, 1969, **79**, 27-34.

YATES, A. J., SMITH, P. J., BURKE, B. D., KEANE, M. A. A technique for the construction of discrete dichotic stimulation material. *Behavior Research Methods & Instrumentation*, 1969, **1**, 257-258.

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