Stimuli for Dichotic Listening Experiments

Introduction. The preparation of test stimuli for dichotic listening experiments requires synchronizing two different signals on dual track magnetic tape. It is relatively easy to do this by subjective judgment if the experimenter cares little about the onset times of the two signals. Till recently, precise control usually required elaborate and laborious methods. A new computer facility at Haskins Laboratories now offers a degree of control and an ease of execution in advance of previous methods. The output from the speech synthesizer (of the parallel formant type) is triggered by a marker pulse on the magnetic tape; the tape is run through twice and different signals laid down on each track. Signals may be laid down exactly on the marker pulse or offset from it by multiples of 0.5 msec. The degree of control over the signal is the same as that normally obtained from the synthesizer. This facility has been used to prepare 8 dichotic experimental tapes. These fall into two categories: -- A. those dealing with non-speech sounds, B. those dealing with speech. The latter typically give a right ear preference whilst the former are thought to give, under certain circumstances, a left ear preference.

A. Non-speech.

1. Confirmation of temporal stagger effect.

Kimura (1964) reported that dichotically presented melodies showed a left ear preference in a recognition task. Some more recent unpublished experiments of my own have given some evidence that a similar preference holds for 4-note tonal patterns; these latter preferences were small and were disrupted by a slight (10 msec.) difference between the onset times of the individual notes within a phrase, so that the leading notes were reported more often than the lagging. This finding was unexpected -- at least for the small stagger employed -- and so a confirmatory experiment was prepared on the synthesizer. Similar 4-note phrases were used but four different values of stagger were employed: 0,5,10 and 25 msecs. The signals were made by exciting a single formant whose frequency was a simple multiple of the exciting pitch; this approximated a pure tone and was subjectively not speech-like.

2. 3-tone phrases.

Previous experiments with tonal patterns used 4-note phrases which were all permutations of the same 4 notes. Such phrases were used in an attempt to make melodic line (rather than the presence of a particular frequency) the main cue. Experiments using this material suffered from a low level of performance, making it difficult to obtain reliable laterality effects. An experiment was therefore constructed which used 3-note phrases, drawing each note without replacement from the seven notes of the major scale. These are expected to give a higher level of performance than the previous 4-note phrases. A low level of performance is objectionable not because the maximum possible laterality effect (calculated as the difference between percentage-correct scores) is low since this can be compensated for by an appropriate mathematical theory (e.g., Signal Detectability), but because subjects give inconsistent and unreliable results.

This experiment compared two types of waveform. In one type the amplitude falls to zero between each note for a few milliseconds, whilst in the other the amplitude is non-zero throughout the phrase. This variable was introduced for historical reasons to remove an ambiguity in a previous experiment. Two versions of the tape were prepared, one using notes of half the duration of the other.

3. Intonation versus melodic line.

This essentially exploratory experiment is an attempt to demonstrate a difference in tonal perception which is both detectable by naive listeners and clinically documented (albeit sparsely). Tone deafness (or more exactly melody deafness), though little documented, does not appear to carry with it any related speech impairment either in production or perception. A case is cited by Monrad-Krohn (1947) of a right-handed girl with left frontal damage who had grossly abnormal speech intonation but an unimpaired and sophisticated musical faculty. The possibility exists that the mechanisms responsible for the discrimination of patterns of pitch are two-fold, one associated with the speech mechanisms, typically in the left hemisphere, which deals with prosody, and another, possibly in the right hemisphere, which deals with musical patterns. The hypothetical speech-side mechanism typically would deal with continuous changes of pitch in a speech context, whereas the other mechanism would deal typically with discontinuous changes of pitch in a non-speech context. What little evidence there is would suggest that song would fall into the latter category (Monrad-Krohn's patient was able to sing her national anthem before she was able to recite the words).

For this experiment the word "tea" was used as one carrier, since it is a monosyllable with an initial plosive and thus would be expected to give a right ear effect under conditions of dichotic competition. A single formant was used as the other carrier. Four pitch configurations were used, all varying between the same upper and lower bounds: rising, rising-falling, falling, and falling-rising. Each pattern was constructed on both carriers with both continuous and discrete pitch change.

B. Synthetic Speech.

1. Stagger in V-C syllables.

Shankweiler and Studdert-Kennedy (1967) found that the laterality effect for final consonants in spoken CVC syllables with only the final consonant contrasted was considerably less than for initial consonants in spoken CVC's with only the initials contrasted. This could be due to the greater amount of coarticulation between a consonant and the subsequent vowel than between a vowel and its subsequent consonant; an alternate explanation, as the authors suggested, is that the difference stems from the difficulty in aligning real speech sounds on dichotic tapes. For the final consonant contrast, alignment was on the burst. Since natural utterances were used, each spoken syllable was of a different length so that if the final consonants were aligned, the initial consonants would not be. A typical value of this offset is about 10 msecs. (for the initial contrast, of course, the onsets of the syllables were aligned). If the "capture" effect reported for staggered musical phrases is relevant here, then it might well constitute an additional source of variance for the final consonants but not for the initial, reducing the observed laterality effect for the former but not for the latter.

The present experiment is designed to allow any change in laterality effect with increasing stagger between the two syllables to be observed. The vowel /ɛ/ followed by one of the six plosives /b,d,g,p,t,k/ was used. The length of the vowel was changed over four conditions so that the onsets of the vowels were staggered by 0,5,10 or 25 msecs. whilst the plosives were always aligned. Final stops were released, as in the Shankweiler and Studdert-Kennedy experiment.

2. Direct comparison of initial and final consonants.

Whilst the last experiment should allow the effect of stagger on the laterality effect to be observed, it does not afford a direct comparison between initial and final consonants. For such a comparison another tape was prepared which had dichotic pairs consisting either of two syllables selected from /be,de,ge,pe,te, ke/ or from /eb,ed,eg,ep,et,ek/. The final stops were not released in these stimuli, to give a comparison between released and unreleased.

3. Short vowel experiment.

Shankweiler and Studdert-Kennedy have shown that the laterality effect for consonants in CV syllables is much stronger than for steady-state vowels of 300 msecs.[1] duration. The explanation which they favor is that steady-state vowels are somewhat akin to music (which can show a left ear effect) and are dealt with almost equally effectively by both hemispheres. Although this is a not unreasonable hypothesis, there are a number of simpler ones which are amenable to test. For instance, it is possible that the left hemisphere is better than the right at analyzing short sounds or rapidly changing sounds.

The present experiment is designed to test the latter hypothesis -- that the left hemisphere analyzes brief sounds better than the right. Plosive consonants are typically of 30-40 msecs. in duration; this is also about the threshold for recognition of vowels. Two durations of steady-state vowel were chosen: 40 and 150 msecs. The British vowels /I, ɛ, æ, ə, ʊ, i, a, ɔ, u, ɜ/ were used. Dichotic pairs were chosen such that each vowel was paired with every other vowel of the same duration.

4. Fricatives experiment.

The short vowel experiment attempts to determine whether length of signal per se is sufficient to alter the laterality effect. This experiment attempts to investigate whether the structure of the signal (i.e., steady-state versus rapidly changing frequency) affects laterality. The six fricatives /f, s, ʃ, v, z, ʒ/ are used, generally followed by /ep/. The cues for the recognition of fricatives are two-fold, the friction itself and the vowel transition. Typically the former is dominant. Four stimulus conditions are employed: (a) both friction and transition present (b) friction but no transition (c) no friction but with transition, and (d) friction alone. (a), (b), (d) sound like fricatives but (c) sounds like a plosive. Dichotic pairs were made up within each group so that each member of a group is paired with every other member of the same group.

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[This is a report of work done at Haskins Laboratories between 10 July and 14 September by C.J. Darwin, Cambridge University.]

References

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