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MONAURAL OR DIOTIC PERCEPTION OF DEGREE OF "REPETITION COLORATION" WITH FRONTAL OR LATERAL PRESENTATION IN FREE FIELD

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Introduction

A common complaint in many auditoria, even in modern concert halls, is poor tonal quality [1-3]. An extensive investigation of the phenomenon of "Repetition Coloration" has been carried out in order to find an appropriate solution of the undesirable aspects of this phenomenon, which appears often in room acoustics and electroacoustics [4]. It was found that the degree of repetition coloration for music is considerably different for different pieces of music, and moreover, it is different for the different sections of the same piece of music [4]. Therefore it was decided to determine first of all variations of the degree of repetition coloration for white noise with all possible factors and parameters.

The perception of repetition coloration is a result of the physical interference effect between an original sound (e.g., noise, speech or music) and its delayed coherent repetition(s) [1,3-5]. Repetition coloration for white noise is the perception of a tonal sound, "Repetition Tone" [4], associated with a certain pitch sensation, which, in general, corresponds inversely to the amount of time delay [5].

Experimental Techniques

The experimental set-up for determining the DRC-1 (see below) for frontal and lateral types of presentation are outlined in Figures 1 and 2, respectively. Thirty-six stimuli were recorded in random order according to a suitable changeover design of the subjective experiment [4]. The recorded stimuli were presented to the subject seated in the anechoic chamber facing the (Quad) loudspeaker radiating the direct sound at a distance of 3 metres. The SPL of the presentation was 60 dB(A) in the absence of time delay. Subjects who participated in the experiments had to satisfy specific auditory acuity and other requirements [4].

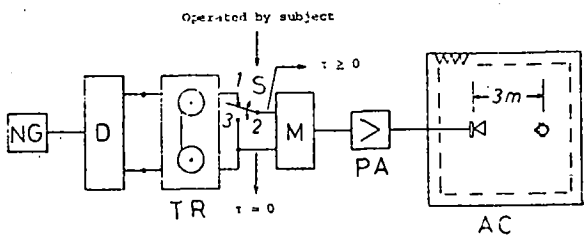

Fig. 1 Experimental set-up for a frontal presentation

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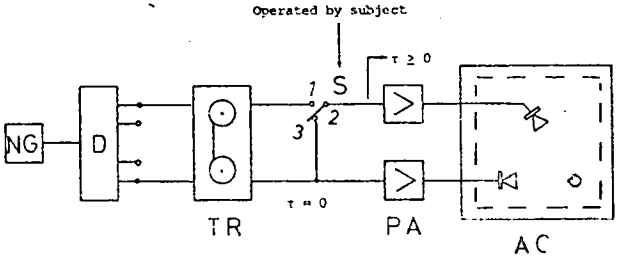


Fig. 2 Experimental set-up for a lateral presentation

(NG: noise generator, D: delay instrument, TR: tape recorder, S: switch, PA: pre- and power amplifiers, M: electronic signal mixer device, AC: anechoic chamber.)

Results and Conclusions

Repetition coloration for white noise, perceived monaurally and diotically for frontal presentation, or monaurally perceived for lateral types of presentation in an anechoic environment, occurs predominantly at time delays of 2 ms < τ < 15 ms, especially with τ = 5-10 ms. (Frontal and lateral types of presentations, FP and LP:α, mean that the direct sound is always radiated from straight ahead and the repetition is radiated from straight ahead (via one loudspeaker), FP, and laterally with the angle of azimuth α, LP:α.) The "repetition tone", perceived monaurally or diotically with τ = 5-10 ms, is relatively very loud and associated with a high pitch, which clearly and rapidly changes with the variation of the amount of time delay. At time delays of greater than 15 ms the change is slower, the loudness and pitch are much lower than those perceived with τ = 5-10 ms. The overall sound impression with τ = 5 ms is like that produced by blowing down a tube, whilst with τ = 15 ms it is then like the "drone" of a propeller aircraft. At time delay of τ = 20-30 ms, the overall sound has a "motorboating" character, with some "droning", both relatively faint, and both superposed on the white noise background.

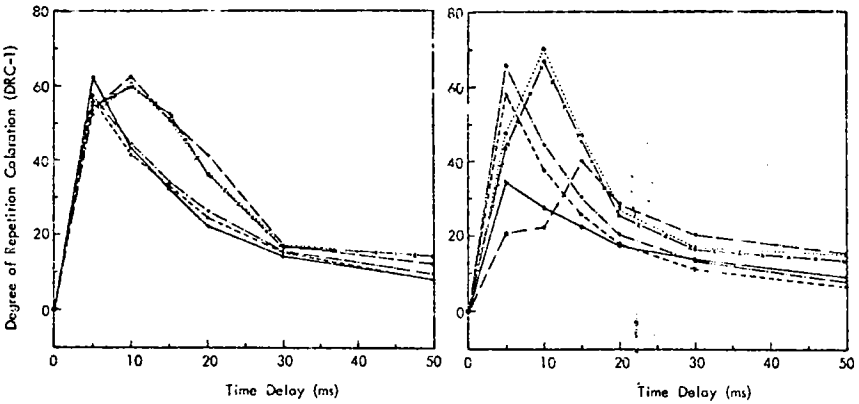
The coloration character (timbre and pitch) of the repetition tone perceived "diotically" with τ < 15 ms, especially with τ = 5-10 ms, for lateral presentation types, LP:45° - LP:135°, is scarcely distinguishable, the overall sound being not very much different from that of the original sound. This is entirely different from that perceived (i) monaurally for the same type of presentation, and (ii) monaurally and diotically for frontal presentation. Most of the subjects asked doubtfully whether the time delays were the same in the first case as in the latter two. This can occur only as a consequence of the different absolute interaural time delays of both the direct sound and its delayed repetition, which cause the neutralization and/or the distortion of perception of the repetition tone [4].

The degree of repetition coloration (first definition) for white noise, DRC-1,

indicates the percentage amount of the "repetition tone" subjectively perceived relative to the overall sound impression regardless of its apparent loudness, timbre and pitch. The subject had to give his judgement of the DRC-1 relative to the two extreme cases (A) the DRC-1 = 0% for the overall sound impression of white noise with the absence of a repetition tone, and (B) the DRC-1 = 100% for a pure tone.

Any value of the DRC-1 at any value of time delay in any of the following curves represents the mean value of the means of (six) judgements determined by every subject. Eight and six subjects performed the experiments for frontal and lateral presentation, respectively. Two groups of subjective responses were found. The maximum value of the DRC-1 or its relevant time delay, τ_m, depended upon the group of subjects, type of presentation and type of hearing.

The DRC-1 values determined monaurally and diotically by group (A) or (B) for frontal presentation are virtually the same (Fig. 3). The DRC-1 determined by groups (A) and (B) has maximum values at τ_m = 5 and 10 ms, respectively. Below τ_m the DRC-1 increase rapidly with the increase of time delay, whereas above τ_m the DRC-1 decreases less rapidly with the increase of time delay.



(a) Frontal presentation (b) Lateral presentation

Fig. 3 DRC-1 for white noise determined by groups (A) and (B) with monaural and diotic hearing. Group (A): ———, diotic hearing; -----, left ear occluded; — • — , right ear occluded. Group (B): — —, diotic hearing; —x—, left ear occluded; ....., right ear occluded.

The most interesting aspect of repetition coloration perceived for the lateral types of presentation, particularly with LP:60° and LP:90°, is that the character (timbre and pitch) of the repetition tone, with τ = 5 and 10 ms, perceived diotically, is entirely different from that perceived in cases (i) and (ii).

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It is not very much different from that of the white noise alone. This can be obviously noticed when listening monaurally, diotically and dichotically to the tape recording attached within the rear cover of Reference 4. The DRC-1 values, determined diotically with τ = 5 and 10 ms, are considerably less than those determined for the cases (i) and (ii) (see Fig. 3). On the other hand, those values determined for the cases (i) and (ii) at any value of time delay are virtually the same.

In room acoustics: the degree of repetition coloration perceived in an auditorium can be considerably diminished with the conversion of the strong frontal and overhead reflections into lateral, or with weakening the frontal and overhead reflections and enhancing the lateral, by means of a proper geometrical design of walls and ceiling shapes. (For further important suggestions for both electro- and room acoustics, see Chapter 15 of Reference 4.)

Acknowledgements

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References

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