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Individual Loudness and Evoked Response

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Much effort has been concentrated over a period of more than 40 years, into the investigation of the subjective experience of the loudness of sounds. The earlier portion of this work (see[1] Robinson 1953 for a review) showed that, in general observers had some ability to assign numerical values to loudness, but the magnitude of the differences between the results of different workers suggested that these results were extremely susceptible to details of the experimental techniques employed. More recent work has produced somewhat more consistent data, although it is not clear whether this is due so much to a real advance in technique or merely to a reduction in the variety of procedures employed.

A study of the literature suggests that in one important respect work on loudness has not progressed in the same way as research into subjective responses in some other modalities. This is in the significance of individual differences in scaling performance. It is found that, although a number of workers[2] in the 1930's noted that considerable inter-individual differences existed, and in some cases that these differences appeared to be consistently maintained, they did not pursue this matter, and always presented their data in the form of group means, with the (implicit) assumption that the group performance was representative of the individual.

More recently, [3] McGill (1960), [4] Stevens and Guirao(1964), [5] Reason (1968) and Barbenza et al((6),(7),(1970)) have shown much more convincingly that there are significant differences between individuals in loudness scaling performance, and that the differences are statistically significant and reproducible. The work by Barbenza et al (1970) on 15 normal observers showed that the slope of the loudness function (relating $\log_{10}$ of observers estimate to decibels of intensity) had a range from 0.012 to 0.070 for different individuals.

This large range in the values of the slope of the loudness function naturally poses the question of the origin of these inter-individual differences, and as a first step the data was examined for evidence of any correlation between loudness slope and the threshold of hearing, since it seemed remotely possible that the differences might be an end-organ effect. No correlation was found, a result which was confirmed by the re-examination of some earlier data ([8]McRobert 1964) which similarly showed no correlation over a group of 12 observers.

A more likely explanation of the interindividual differences is what [9]Ekman et al (1968) have described as 'response bias', which would appear to suggest some bias in the attachment of numbers to the loudness sensation. With this in mind the MMPI (Minnesota Multiphasic Personality Inventory) was used to assess any personality factors which might be related to the loudness scaling performance. The results of the MMPI test were used to derive a measure of the degree of individual 'excitability' for each of the 15 observers, and an interesting correspondence between excitability and loudness slope was found, the more excitable individuals demonstrating the steeper loudness functions.

The experimental conclusion, that interindividual differences in loudness scaling performance seem to be related to personality factors rather than end-organ differences, led to speculation as to where, in the perceptive process, the differences might be arising.

Work in the field of individual AER (Averaged Evoked Responses) to visual stimuli has provided one possible approach to this problem. Buchsbaum and Silverman[10] (1968) using light flashes, and Spilker and Callaway[11] (1969) using a sinusoidally modulated light source, have looked for evidence of individual differences in evoked response which can be related to other measures of perceptive processes or personality.

Spilker and Callaway used a kinaesthetic test, based on one originally described by[12]Petrie (1967), which involved repeated judgements of the width of a wooden bar. The test classified the observers on a scale of kinaesthetic "augmentation" or "reduction" according to their individual performances, providing a numerical measure of this characteristic. They showed a highly significant rank correlation ($P<0.01$) between the slope of the AER(visual stimulus) and the scores in the bar test. This work, and that of Buchsbaum and Silverman, suggest that the pattern of the evoked response, and in particular the way in which the evoked response varies with the stimulus magnitude, might be more generally related to other features of the perceptive processes. An experiment was therefore designed to investigate this possibility in the auditory modality.

Experimental procedure As a first step a groupof 75 observers (all with normal audiograms) took part in a loudness estimation experiment which provided, for each individual, a loudness function slope. Each observer also completed the MMPI personality inventory. From the initial group of 75 two sub-groups of 12 were selected, one consisting of individuals with particularly high loudness slopes and the other with low slopes. Work is now in progress to measure the slope of the auditory evoked response function (i.e. the slope of the evoked potential vs sound pressure level in dB) in the 40-90dB range for 1000Hz tones. The tones are presented binaurally, and in the first experiments a tone duration of 0.25 seconds has been used together with an inter-tone interval of 2.5 seconds.

At the time of writing (January 1971) this final stage of the work is incomplete, and insufficient data has been obtained to undertake a statistical analysis of the results, however, it is hoped that the experimental results will be complete by the beginning of April 1971, and that they will be available for presentation at the Birmingham meeting. Figures 1 to 5 show, respectively, a typical averaged evoked response and four examples of individual evoked response functions.

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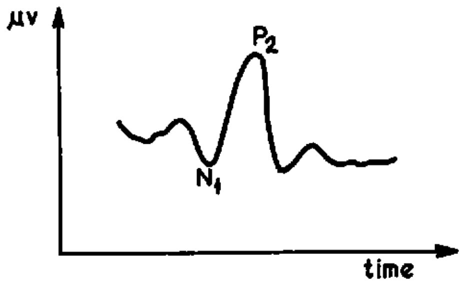
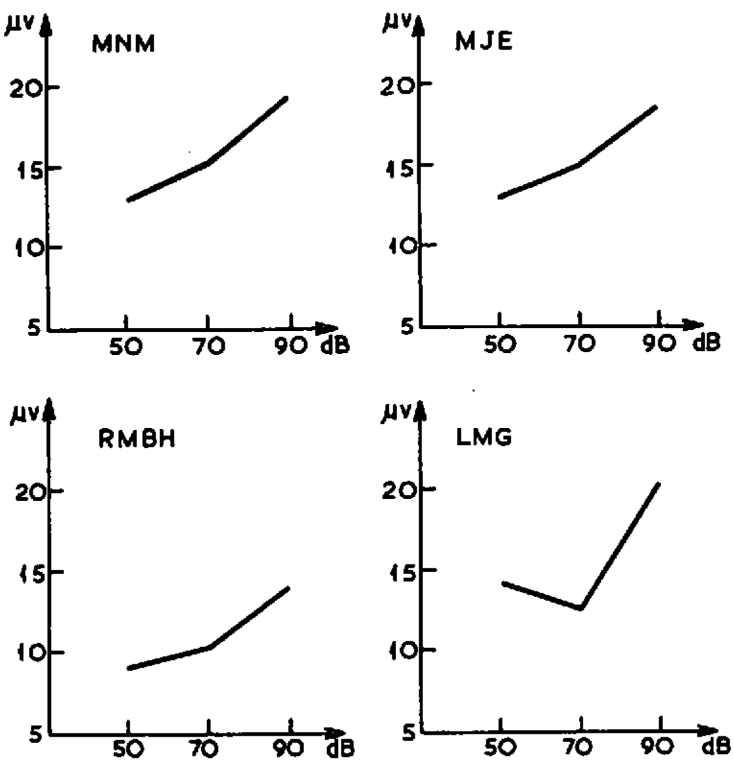


Typical average evoked response to 90dB stimulus.



Individual evoked response functions.