SOURCES OF VARIANCE IN THE DETECTION OF AUDITORY SIGNALS WITH SPECIAL REFERENCE TO UNSTABLE DECISION CRITERIA

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ABSTRACT

Data from twelve auditory signal detection experiments show that a model general to all signal detection tasks explains results better than specific auditory models. This thesis examines models of the detection of sinusoids in Gaussian white noise, all predicting linear ROC-curves on normal-normal co-ordinates, but differing in their predictions for the ROC-curve slope.

Distinction is made between stimulus distributions, transducer distributions and response-inferred distributions. Response-inferred distributions include variance from stimuli, transducers and unstable criteria.

The first three experiments (rating) showed that slope increases with increases in p(sn) and in the number of categories available for describing the presence of the signal. An explanation for this data assumes that the 'yes-no' criterion has the least variance and other criteria have variances proportional to their distances from the 'yes-no' criterion. This explanation is developed into a model of selective attention in which the variance of all real criteria is a function of their distancesfrom an optimal criterion. Faulty memory is the assumed cause of criterion variance.

Predictions that follow from the model are

(i) there is a decline in criterion variance as signal strength increases;

(ii) there is a U- (or inverted U-) shaped function relating slope and signal strength;

(iii) criterion variance is less in forced-choice tasks than in 'yes-no' tasks; and

(iv) slope is partially determined by task design and any other factor which affects the subject's memory for signal or noise.

Experiments 4-6 establish that the concept of criterion variance also applies to yes-no procedures, and Experiments 7-11 substantiate predictions made by the model of selective attention. Data from Experiments 5, 7, 8, 9 and 10 are analysed in terms of models of sinusoidal burst and gap detection. None of the probabilistic models is adequate, but Zwislocki's (1969) deterministic model of temporal summation accounts for the data.

A model of response-inferred distributions is presented in which the mathematical relationships of the variances and locations of criteria, of signal strength and of stimulus variances to the slope of the ROC-curve are described. Equations for the optimal criterion, the variance of individual criteria and a measure of sensitivity uncontaminated by criterion variance are derived. Re-analysis of data using the model of response-inferred distributions supports the predictions of the model of selective attention.

The model of response-inferred distributions predicts 'peaked' rating ROC-curves which are similar to two-state functions and commonly observed in the literature. However, both two-state and high-threshold theories are unable to explain the data.

Experiment 12 compares the model of response-inferred distributions with Pike's (1973) multiple observations model for latency data and finds the latter model inferior.

Criterion variance is shown to account for at least half of the variance of the response-inferred distributions, and consequently, it is argued that TSD results should be viewed more in terms of the general processes which produce criterion variance than modality-specific models of signal processing.

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