F. Receiver-Operated Characteristics

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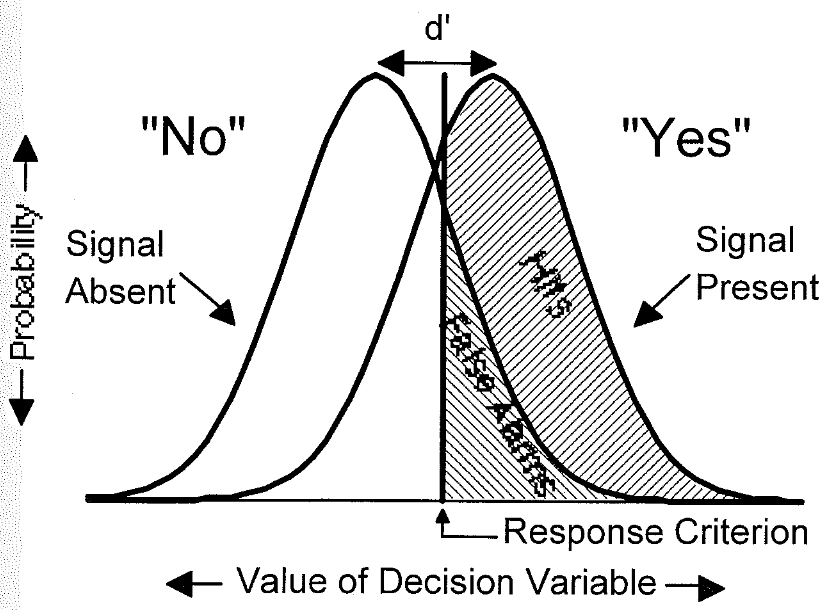
***NB!** This manual is not for the Friday practical, but for "psychophysical evening entertainment" to be carried out whenever you like. PRIZES for the best!*

Duration 0.5 hr per person

Determining the receiver-operated characteristics of a student with SDU's 'computer game'. This practical is available off-hours so that students can go and play with it when getting exhausted with the other measurements.

Introduction.
In many measurements of behavioral or neural thresholds it is assumed that the threshold can be determined with an arbitrary precision. This assumption only holds if the receiver does not have any internal noise that may lead to spurious detection. All biological systems have internal noise, and therefore the detection of a signal can be compared to a statistical test of the two conditions: 1) response to the internal noise alone 2) response to signal and noise with the zero hypothesis that the two distributions are similar. Clearly, the further apart the two distribution means are the easier the detection task is. The distance is called d' or the signal-to-noise ratio.



(from Buus 2002)

Like in other statistical tests, there are four outcomes of the decision ('Is there a signal')

1. Decision is 'Yes' and the signal is on. This is a **correct** decision or '**hit**'
2. Decision is 'Yes' and the signal is off. This is an **incorrect** '**false alarm**'
3. Decision is 'No' and the signal is off. This is a **correct** decision '**reject**'
4. Decision is 'No' and the signal is on. This is an incorrect '**miss**'.

The decision can be manipulated by moving the response criterion. If it is moved to higher values of the decision variable, evidently the probability of false alarms will decrease. However, inevitably,

the probability of the other type of errors – misses- will increase. Where the animal will place its response criterion depends on the costs and benefits of the four decision outcomes (also called the pay-off matrix). If, for example, the outcome of a miss is fatal (detection of a predator) the response criterion can be expected to be positioned so that a relatively high proportion of false alarms is produced.
Experimentally, the response criterion can be manipulated by selectively punishing one of the types of errors (or rewarding one of the types of correct responses). If false alarms are punished, for example, it will lead to a 'cautious' strategy, where the animal will produce more misses. Different pay-off matrices may produce threshold differences of up to 6-10 dB.

The present practical is a small computer game. The test subject (you) must decide whether the signal (a 1200 Hz tone burst) is on or not. The subject is rewarded/punished by receiving a small sum (in virtual DKR) or fined by an amount, according to the pay-off matrix of the experiment. Each experiment consists of 200 trials, where the sound is on (on average) 50% of the trials. In each experiment, 5 different sound pressures are presented, positioned around the subject's threshold. There are four experiments, each with a different pay-off matrix.

First, load the program (SDT). The program is now playing a 1200 Hz tone in noise, and you are required to set the threshold for the 1200 Hz tone by adjusting the scroll bar until you (just) cannot hear the tone. Press OK when done.
The next screen is loaded. You start each trial by pressing 'Go' (or 'g') and you now (for the rest of the practical) just have to indicate whether the tone is on (Yes or press 'y') or not (No or press 'n'). You will have to guess much of the time.
The final score of each subject is saved together with the results of each experiment, broken up by the four decision categories. The five columns in the (text) data file are sound pressure (dB attenuation re 80 dB SPL), number of hits (CH), false alarms (FP), rejections (CR) and Miss (M). There are four tables, one for each experiment (i.e. for each pay-off matrix). Note that the program calculates one false-alarm-category for each attenuation; you will have to combine these false alarm rates and calculate one FA-rate (%) for each experiment (100*false alarms/(false alarms + rejections). The hit-rate is calculated as 100* hits/(hits+misses). Ideally each experiment would give a different FA-rate. The ROC curve is produced by plotting percent hits against false alarm rate. One experiment produces four points on a vertical line. Connect points measured at the same sound pressure (same attenuation).
The student having the highest score will reap a princely reward, to be delivered at an official ceremony during the course.

Suggested reading:

Au WWL (1993) The sonar of dolphins, p- 13-21. New York: Springer-Verlag

Buus S (2002) Psychophysical methods and other factors that affect the outcome of psychoacoustic measurements. In: Tranebjærg L, Christensen-Dalsgaard J, Andersen T, Poulsen T (eds) Genetics and the function of the auditory system. Proceedings of the 19th Danavox symposium.