Signal Detection Experiment

Lab Report

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Introduction

Signal Detection Theory (SDT) is a framework used to understand decision-making in uncertain or ambiguous situations, often applied in fields like psychophysics, medical diagnosis, and memory recall. The theory explains how individuals make yes/no decisions when detecting a signal amidst noise, whether external (from variability in the stimulus) or internal (from neural responses).

SDT categorizes decisions into four outcomes: hit (correct detection), miss (missed signal), false alarm (incorrect detection of signal), and correct rejection (correctly identifying no signal). Key to SDT is the idea that decision-making involves setting a criterion along a continuum of internal responses. A low criterion increases hits and false alarms, while a high criterion decreases both.

Performance in SDT is often measured through receiver operating characteristic (ROC) curves, which show the relationship between hit and false alarm rates. Discriminability, or d', quantifies how well an individual can distinguish signal from noise, with higher d' values indicating better performance.

In experiments, SDT is applied to tasks like motion discrimination, where neural activity in response to stimuli is measured. For example, researchers have modeled how a simulated neuron’s firing rate changes with signal strength, creating neurometric functions that predict detection accuracy. Overall, SDT provides a powerful mathematical framework for analysing perceptual tasks and decision-making under uncertainty, offering insights into both sensory processing and strategic judgment.

Method

To quantify an individuals ability to discriminate between signal and noise to provide insights into their signal processing and decision making capabilities, we would be conducting an orientation discrimination task. This experiment was conducted on Psychopy which conducts psychophysics experiment using python. The participant’s consent was taken and was given a comfortable environment. There was an experiment conducted where the participant was advised to click up and down arrows according to the ‘no tilt’ or ‘tilt’ in the grating. Here, is the orientation of the gaussian surface is 0, which means that the lines of the surface are not tilted, the stimulus is present. If the lines are tilted and the orientation is not zero, then the stimulus is absent. The data was later on collected and later on we derived the d prime and criterion. This helps us to understand the accuracy of the reactions. In PsychoPy, layers are defined to create an instruction slide, followed by a 1-second fixation before presenting the stimulus—a visual grating. This visual grating has a Gaussian texture, a contrast of 0.3, a spatial frequency of 5, and a size of (0.3, 0.3). The orientation of the grating surface is determined by a tilt variable, which is calculated using custom code.

Result

The d’ value is calculated to be 1.366818 and the criterion is -1.16007. The result was derived after calculating the proportion of hit and proportion of false alarm.

Discussion

The d-prime (d') value quantifies the participant's ability to distinguish between signal and noise in a decision-making task. In this case, a d' value lesser than 2 indicates low sensitivity, meaning the participant is moderately skilled at discriminating between the signal. The criterion represents the participant’s bias or decision threshold for determining whether the stimulus is signal or noise. Here, the criterion is less than zero, suggesting the participant has adopted a conservative approach. This means they require stronger evidence to confirm whether the stimulus is signal or noise and are more likely to say "no" than "yes."

References

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