**Signal Detection Experiment**

PSY310: Lab in Psychology

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Github Link:

<https://github.com/SaanchiBhatt13/Psy310/tree/Signal_Detection_AU2220151>

**Introduction**

Signal Detection works to understand how humans make decisions based on the strength of a signal and their confidence in their hearing sensitivity. Scientists and experimenters primarily use it to measure the way individuals make decisions in the presence of uncertainty. There is an underlying assumption that noise (all other sensory stimuli other than the target signal) always exists when a stimulus signal is presented for detection. Signal Detection Theory quantifies the participant's sensitivity in detecting the signal accurately amidst this noise.

The trade-off between sensitivity—the capacity to recognize signals—and bias—the propensity to report a signal—is mathematically modeled by signal detection theory, demonstrating that signal detection is not an all-or-none situation.

It classifies results into four different categories: hits (identification of a signal correctly), misses (identification of a signal that is not present), false alarms (identification of a signal when none is present), and correct rejections (identification of the absence of a signal correctly). By analyzing these results, researchers can evaluate the perceptual sensitivity of participants under different stimulus intensities and noise levels.

However, the focus of the study is not on the nature of the response but rather on the characteristics of the signal detected, like signal strength (d’) and the criterion (c)

The application of this study extends to various important areas like memory recall, clinical diagnosis, sensitivity towards fire, and other safety hazards amongst security personnel.

**Method**

The participant, age 20, was an Ahmedabad University undergraduate majoring in psychology. Before the experiment began, she was informed about the aim and methodology of the study, and her consent was acquired. A 14.5" laptop screen and PsychoPy-2024.1.5 software were used to create the experimental setup. A vague shape (grating) with a sinusoid Gaussian mask of size (0.3, 0.3), spatial frequency of 5, and contrast of 0.3 was used in the experimental design.

There were 100 signal detection trials in this experiment. Preceding each Gaussian mask flash, a fixation takes the form of a polygon (a star in this case) and stays on the screen for 0.5 seconds.

After that, the grating is shown for just 0.3 seconds, tilting slightly (if at all) and changing every trial at random.

*(Fig 1. Image of grating used in orientation discrimination task: a sinusoidal shape with a Gaussian mask)*

The participant is asked to use the "up" and "down" arrow keys to indicate whether they can detect a perfectly vertical orientation or a slight tilt after the figure has flashed. The up arrow denotes the vertical position, and the down arrow indicates the tiltedness. Only pressing a key would end a single trial. Throughout the experiment, the tilt's presence or absence was determined randomly; no initial value was established.

Every trial's orientation and response accuracy data were recorded, downloaded in CSV format, and then transformed into an Excel file that was stored in the assigned folder on the aforementioned laptop.

**Results**

The d' obtained from the experiment was **1.279075**, and the criterion (c) was found to

be **-0.03495.**

**Discussion**

Here, the d’ value is indicative of the signal strength. A higher d’ value would represent a higher signal strength, indicating a greater proportion of hits to misses than vice-versa. In other words, it reports the ability of the participant to discriminate noise from the instance of noise plus signal.

The criterion is separate from d ′ and denotes the decision stage. It specifies the level of internal response required to discriminate a signal from noise. An internal reaction below the criterion (report "no") results in a correct rejection when the signal is absent, while an internal response above the criterion (report "yes") results in a false alarm. Similarly, an internal reaction above the criterion (report “yes”) in the presence of a signal is reported as a Hit trial, and an internal response below the criterion (report “no”) in the presence of a signal is reported to be a Miss trial. This bias in judgment is categorized in two ways- “Liberal,” which is the lower criterion or the response below the criterion, and “Conservative,” which is the higher criterion or the response above the criterion.

Hence, individuals with a “liberal bias” tend to report the presence of a signal more frequently (report “yes”), resulting in a higher proportion of false alarm trials than the individuals with a “conservative bias” who tend to report the absence of a trial, resulting in a higher proportion of miss trials in most cases.

Signal Detection Theory, since its introduction, provides a critical framework to analyze the signal detection of participants by calculating concrete quantities like the signal strength (d’) and criterion (c). It has a broad applicability across various fields like psychology and medicine - for purposes of diagnosis and academic research, as well as real-life applications in sensory tests. The theory’s heavy reliance on assumptions relating to defining stimulus and noise, calculating the abstract such as internal states, and risk of misinterpretation in case of violated assumptions make the theory one requiring careful designing and analysis of the experiment. Nonetheless, it remains a powerful tool for understanding decision-making in the presence of uncertainty.

**Citations**

1. Denison, R. N. (n.d.). Figure 9.2, [Signal detection theory (SDT) illustrated. . .]. - Neuroscience and Philosophy - NCBI Bookshelf. <https://www.ncbi.nlm.nih.gov/books/NBK583719/figure/visualphenom.F9.2/>
2. *Chapter 8 Signal Detection Theory, Advanced Statistics I & II*. (n.d.). <https://bookdown.org/danbarch/psy_207_advanced_stats_I/signal-detection-theory.html>