Signal Detection Experiment

PSY310: Lab in Psychology
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GitHub Link: [AahnaS/Signal-Detection-Experiment: Signal Detection Experiment]

Introduction:

Signal Detection Theory is a part of psychophysics and was developed by engineers to become a framework of the field of psychology. The concept involves analysing how individuals perceive sensory stimuli in the presence of noise or ambiguity. SDT assumes that variability in sensory representations and noise affect perception. If the internal representations of two stimuli overlap, errors occur, and the extent of this overlap determines the frequency and magnitude of errors.

For example, SDT is used by health professionals to detect cancerous cells present or not present in an individual. If the threshold is low, that is liberal bias, then the positivity rate would be high, and so the false alarms. Conversely, if the threshold is too high, then conservative bias creeps in, and chances of correct rejection increase, as do the events of miss-detection.

Method:

The experiment of Signal Detection included only a single participant (self). The number of trials run is 200.

The experiment is run on PsychPy Software. The first step is to create a polygon as a fixation, which would stay in the shape of a triangle for one second, with the size unit of (10,10) and the spatial units changed to pixel (pix). The stimuli of grating follow this for a time of 1.0 seconds and a duration of 0.3 seconds. The orientation is fixed to $tilt and set on every repeat, as there are 200 trials to be conducted. The mask is set to gauss, and the key response, which the participant is responsible for, is assigned to “up” and “down” (the two arrow keys); the correct answer would be stored as $CorrAns.

Certain codes are updated in the custom to make the experiment run effectively as desired. The codes are as follows-

Under begin experiment:

```
if random() > 0.5:
  tilt = 0
corrAns = 'up'
else:
 tilt = int(randint(-5,5))
   x = 0
```

```
 corrAns = 'down'
```

Under end routine:

```
trials.addData('tilt',tilt)
if random() > 0.5:
    tilt = 0;
    corrAns = 'up'
else:
    tilt = int(randint(-5,5))
    corrAns = 'down'
```

Following this, a loop is inserted with the trials mentioned to 200 in nreps. Now, the experiment is ready to run, and answers will be stored as data in the folder where the PsychoPy folder is saved in an Excel sheet.

The subject's task was to either press the up arrow key or the down arrow key based on the tilt of the grating- If the tilt is vertical, then the up arrow key and, if not so, then the down arrow key. The data obtained post the participant completion of trials (200) included the following- number of trials, fixation started and stopped, key response started and stopped, key response keys and corr., key response duration, tilt, participant, session, date, experiment name, PsychoPy version and frame rate.

To analyse efficiently, only data necessary for computation of the actual results were considered, and after data cleaning, the remaining data includes- Trials(n), key_resp, key_resp.corr and tilt. The calculation involved first identifying the Hit, Miss, False Alarm and Correct Rejection. The sum of each is calculated. Following which proportion hit (hit/hit+miss) and prop false alarm (fa/fa+corr rejection) were calculated. Based on these values, d prime and c are calculated.

Results:

The results obtained are as follows:

	Respond YES	**Respond NO**	**prop hit = hit/hit+miss**	0.769230769
Signal Present	HIT	Miss	**prop fa = fa/fa+corr rejection**	0.510416667
Signal Absent	False Alarm	Correct Rejection		
			d-prime = z(prop hit)-z(prop fa)	0.710202239
	Respond YES	**Respond NO**	**c = -z(prop hit)+z(prop fa)/2**	-0.381214798
Signal Present	80	24		
Signal Absent	49	47		

There are 80 hits, 49 false alarms, 24 miss and 47 correct rejections. Hence, the d prime value reported based on the collected data is 0.7102, and the criterion is -0.3812.

Discussion:

The d prime value reported is 0.7102, and the criterion is -0.3812. A d prime of 0.7102 indicates moderate sensitivity in recognising the signal from noise but is not highly sensitive in this case. As the criterion is negative, the participant stated a liberal bias, a tendency to respond YES to a signal, which increased the chances of a Hit and a False Alarm.

The signal detection has certain advantages like flexibility, considering its diversity in application across various fields, and it is quantifiable in the calculations mentioned above. The limitation is response bias depending on an individual's ability and the binary format of either yes or no, one or zero.

References:

Sumner, C. J., & Sumner, S. (2020). Signal detection: Applying analysis methods from psychology to animal behaviour. Philosophical Transactions of the Royal Society B: Biological Sciences, 375(1802), 20190480. https://doi.org/10.1098/rstb.2019.0480