Methods for Studying Perception

- Perception and mental processes are not directly observable.
- Behavior and the activity of the brain are observable.
- The scientific study of perception involves reliable observation of behavior or brain activity and relating it to hypothetical mental events.
- For both humans and animals, behavior means actions of the organism and the speed with which these actions are performed.

Observing Behavior

I. Two approaches

There are two basic types of behavioral observations: Open ended descriptions and forced choice descriptions.

A. Open Ended Descriptions

Here, the observer describes the behavior of the organism. For humans, the observer could describe their own subjective experience.

This approach creates an inventory of what the organism does and when. For animals, this is often the first step in understanding their behavior and from their behavior, inferring brain function and/or mental processes.

Observing Behavior 2

In the study of perception, this approach is often used as a first step in humans to establish the range of subjective experience that our theories must explain.

In animals, this approach is used as a first step to understand how the animal interacts with its environment. The perceptual abilities of the animal will be a part of that adaptation.

Observing Behavior 3

B. Forced Choice

The forced choice methods allow an organism to respond with only one of a limited number of alternatives.

The advantage here is that it is possible to compare data across subjects since they will be using the same response alternatives.

The disadvantage is that the response alternatives may not be appropriate for the mental processes that we are trying to understand.

II. Forced Choice Methods

Fechner described the three basic methods used in measuring behavior in studies of sensation and perception. As originally developed, they were used to measure absolute thresholds and just noticeable differences.

The Absolute Threshold

The absolute threshold corresponds to the minimum quantity of some stimulus that can be reliably detected by an observer. To illustrate, consider an example of an experiment.

Sample Threshold Experiment

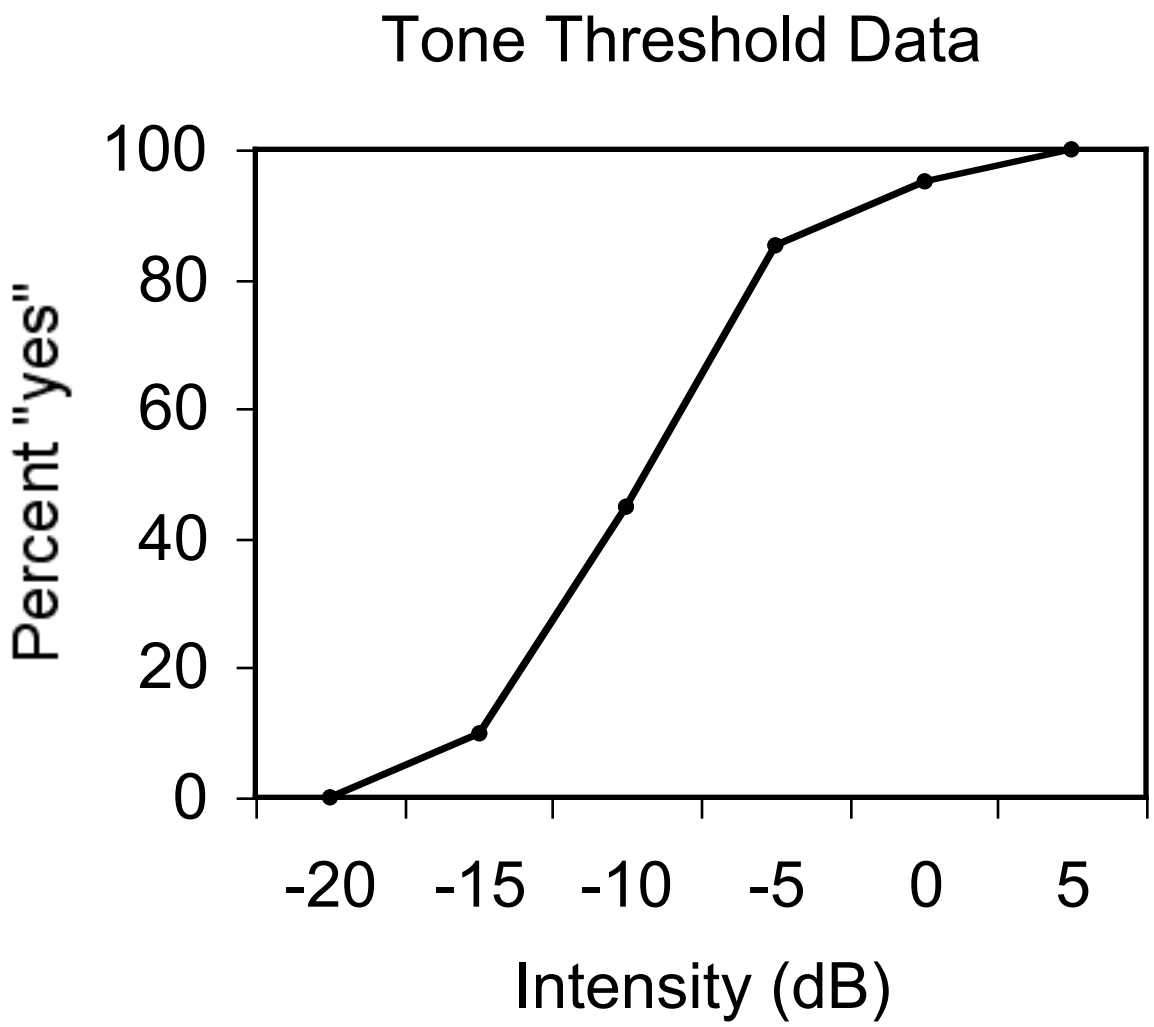
We want to know the minimum energy (intensity) sound that a listener can reliably detect (distinguish from no sound).

We will present a 1000 Hz tone at various intensities to our listener and, on each presentation, ask them to indicate either ”yes, I heard the tone” or “no, I did not hear the tone”.

The data, plotted as the percentage of “yes” responses for each intensity are shown in the accompanying figure.

The threshold might then be defined as the intensity that yields a 50% yes response.

Sample Threshold Data



Method of Limits

A. These data were collected using the **Method of Limits**.

In this method, the stimuli are presented in order from low to high or high to low.

If low to high, the subject starts by saying no to the low stimuli but at some point, as the stimuli increase, starts saying yes. The threshold is the point midway between the last no and the first yes response.

If high to low, the subject starts by saying yes to the high stimuli. At some point, as the stimuli decrease, the subject says no. The threshold is the point midway between the last yes response and the first no.

Sample Method of Limits Data

Intensity	1 down	2 up	3 down	4 up
5 dB	yes		yes	
0 dB	yes		yes	
-5 dB	yes	yes	yes	
-10 dB	yes	no	no	yes
-15 dB	no	no		no
-20 dB		no		no
threshold	-12.5 dB	-7.5 dB	-7.5 dB	-12.5 dB

Here are 4 runs through the Method of Limits. The average threshold would be -10 dB.

Method of Limits 2

Typically, the subject does multiple sequences of trials with both ascending and descending sequences intermixed.

Multiple sequences are run because our subjects do not respond exactly the same way each time a particular stimulus is presented. To deal with this variability, we collect multiple responses and average them.

The threshold is the average (mean) of the thresholds of each sequence. The psychophysical function (graph) is a plot of the percentage of time the "yes" response was given to each different stimulus.

Method Adjustment

B. An alternative to the method of Limits is the **Method of Adjustment**. In this task, the subject is given control over the stimulus and allowed to adjust it until they can just detect it. The stimulus at this point is the threshold.

A new starting point for the stimuli is then chosen and the subject repeats the process.

The threshold is the mean of the threshold values on each trial.

Method of Constant Stimuli

C. In this method, a set of stimuli are chosen. There are typically 5 to 9 items in the set. They are presented one at a time, in random order, and the subject responds “yes” or “no” to each one.

For example, if we had presented our six tones in random order, a plot of the data might have looked like the psychophysical function in the previous figure.

Comparison of Three Methods

Speed - The method of adjustment is the fastest (takes the least time for the observer). The Method of Constant Stimuli is the slowest, since every stimulus is presented an equal number of times.

Accuracy - The most accurate and consistent data come from the Method of Constant Stimuli and the least accurate from the Method of Adjustment.

Accuracy is influenced by knowing the order of presentation. In Constant Stimuli, observers do not know the order so that they can not anticipate the magnitude of the next stimulus. This results in greater consistently in the observers' responses.

Comparison of Methods 2

Regardless of the method, the observer is asked to do the task multiple times. The data are then averaged across trials.

The reason for this is *variability* in observer's responses. The response to any particular stimulus seems to be influenced by:

1. The stimulus on the previous trial and how they responded to it.

2. Alterations to the sensory system by previous stimuli.

3. Momentary changes in attention to the stimuli and the task (including fatigue).

Comparison of Methods 3

With practice, the data from these three methods provide very similar estimates of the threshold. In a hearing test where the threshold is being determined, Method of Limits is routinely used.

For situations where the whole psychophysical function is desired in addition to the threshold, the Method of Constant Stimuli is preferred since every stimulus in the set is presented to listeners an equal number of times.

Non-Threshold Tasks

III. Tasks for Examining Perception Above the Threshold

Suppose we wanted to know what wavelength of light yielded the best green.

We could take a set of different wavelengths (color chips) and let the subject pick among them. This is Method of Adjustment.

We could present wavelengths one at a time in random order and ask the subject to rate them for "greenness" on a 1 to 10 scale. This is the Method of Constant Stimuli.

We could present then in increasing or decreasing wavelength order and monitor ratings (1 to 10) until they stop increasing. This is the Method of Limits.

Non-Threshold Tasks 2

As these examples show, these three tasks can be used to measure our observer's responses for virtually any set of stimuli.

Most perceptual experiments use a variant of the Method of Constant Stimuli, but all three tasks are widely used.

Potential Problems

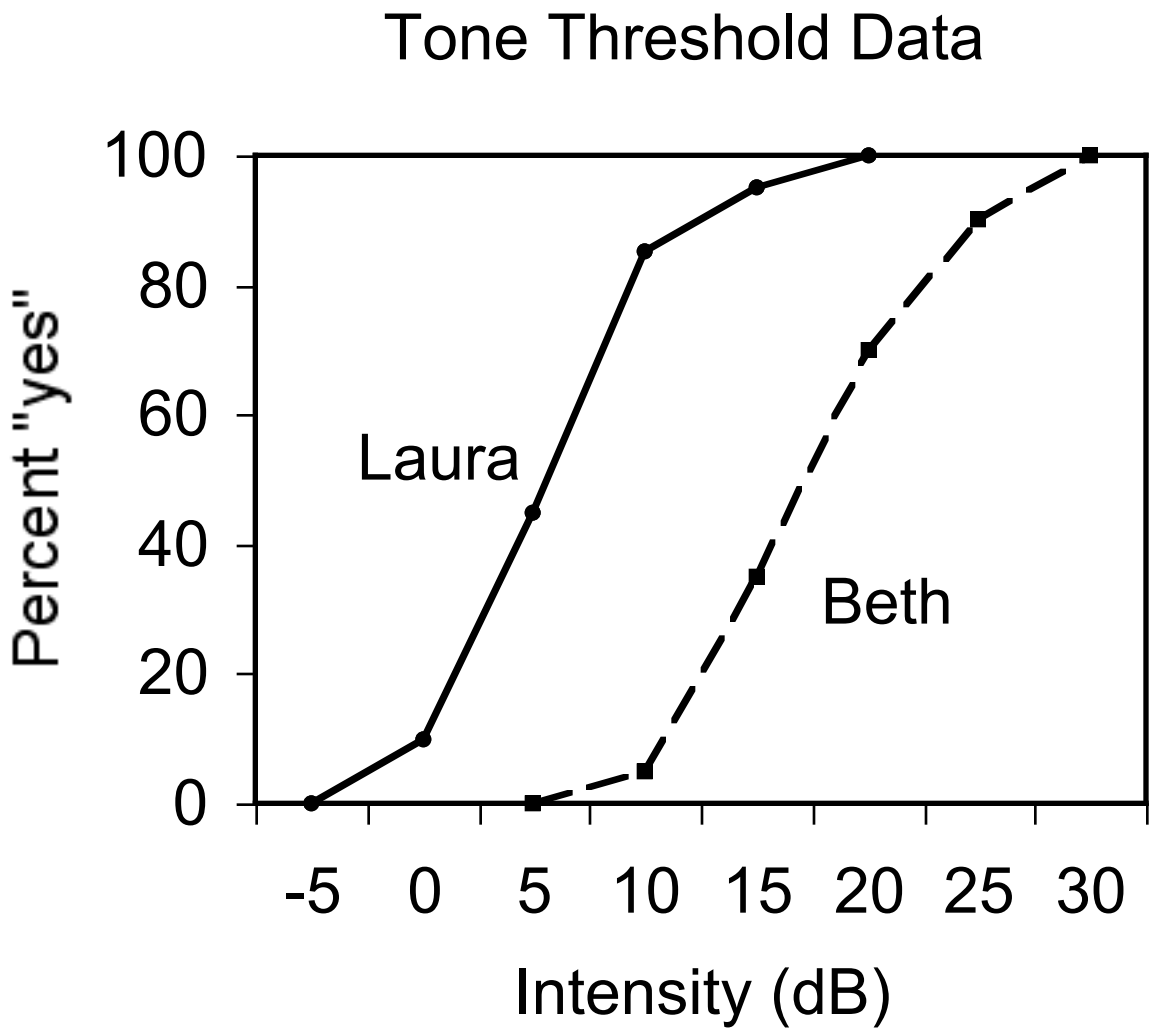
These methods do have some potential problems.

First, because a stimulus is present on each trial, and the observer knows this, we have no objective way of knowing whether their response is an accurate reflection of their perception of the stimulus.

Second, we have no way of knowing precisely how each observer interpreted our instructions. One listener may interpret them to mean "respond yes if there is any possibility that you heard the tone" while another listener interpreted them as "respond yes only if you are certain that you heard the tone".

These two interpretations could yield very different data.

Data for Two Listeners



Two Listeners

In the example, Laura and Beth seem to have different psychophysical functions and different thresholds.

But, do they really differ in their perception?

-or-

Do they differ in their interpretation of the instructions?

Two Listeners - 2

Suppose Laura interpreted the instructions **liberally**. If you think that you heard the tone at all, respond yes. She would respond yes even for presentations where she was unsure, so her threshold would occur at a low intensity.

Suppose Beth interpreted the instructions **conservatively**. She would respond yes only when she was sure that she heard the tone, so her threshold would occur at a higher intensity.

The data are consistent with both a difference in perception and a difference in interpreting the instructions. So, how do we know which is correct?

(see Appendix on Signal Detection Theory)