

# Psychophysical Tasks and Methods

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## I. Detection Task

The goal of a detection task is to determine the amount (energy, contrast, etc.) of a stimulus that makes it just detectable for some observer (subject).

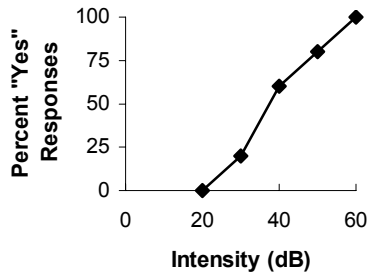
*Methods:*

A. *Method of adjustment.* The subject adjusts the stimulus magnitude (energy, contrast, etc.) until the stimulus is just at its absolute threshold. This method is fast and efficient but susceptible to large subject bias effects.

B. *Method of constant stimuli.* Different discrete values of the stimulus are presented randomly on different trials with the subject's task to respond "yes" or "no" as to whether the stimulus was perceived. Threshold is defined as the stimulus value leading to a "yes" judgment on 50 (or 60, or some other criterion) percent of the trials.

Stimulus Intensity  
dB SPL

20	N	N	N	N	N
30	N	N	Y	N	N
40	N	Y	Y	N	Y
50	Y	N	Y	Y	Y
60	Y	Y	Y	Y	Y



The method of constant stimuli is relatively bias free, although one can certainly have a bias to say "yes", but is inefficient and time-consuming.

C. *Double random staircase method.* On the one hand, this is like the method of constant stimuli, since a single value of the stimulus is presented on a given trial. On the other hand, it differs in that the value of the stimulus on a trial depends upon the subject's previous response in the same staircase sequence: if the subject says "yes", then the stimulus value is decreased on the next trial in the sequence, and if the subject says "no", it is increased. The method is fast and efficient. To minimize subject bias, one runs two staircase sequences concurrently and randomly alternates between them from one trial to the next, thus making it impossible for the subject to anticipate the value of the stimulus on the next trial.

		Trial																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Stimulus Intensity	Staircase 1	20	N																			
		30				N		N								N					N	
		40					Y			N				Y						Y		
		50									Y											
		60																				
	Staircase 2	20																				
		30											N						N			
		40							N			Y			N			Y				
		50			Y						Y						Y					
		60		Y																		

Instead of the “yes/no” judgment, which is essentially the subject’s verbal report of his/her internal state, one can employ the forced-choice judgment with either the staircase method or the method of constant stimuli. Typically, one has two (three, or four) observation intervals in temporal sequence during a given trial and the stimulus occurs in only one of these intervals. Alternatively, one can use spatial locations instead of temporal intervals for experiments involving vision. With this judgment, correctness of performance is used to assess threshold. In a two-alternative forced-choice task, typically the value corresponding to 75 percent correct is taken as the threshold (halfway between the guessing rate of 50% and perfect performance). In the staircase method, one chooses the next value in the staircase sequence according to whether the subject was correct or incorrect on the previous two or three trials.

## II. Discrimination Task

In a discrimination task, one is interested in the smallest difference along some physical dimension that permits a subject to reliably distinguish between two stimuli. Typically, one uses a fixed standard over a block of trials and varies the comparison stimulus. On each trial the subject receives both stimuli. The discrimination threshold or just-noticeable-difference (jnd) is the difference between the two stimuli along the physical dimension being varied (intensity, length, contrast, etc.) that corresponds to the criterion level of performance. The discrimination task can be performed using any of the three above methods and with either “yes/no” or forced-choice judgments.

## III. Matching Tasks

### A. Identity Matching Task

There are a few situations involving the human senses where physically different stimuli are perceptually identical. The most prominent example is that of metamerism from the area of color vision. It has long been known that any chromatic stimulus at photopic levels can be perceptually matched by a normal human observer using an additive mixture of three light primaries even though generally the mixture of primaries is physically quite different from the stimulus being matched. The amounts of primaries needed to match monochromatic lights from across the spectrum have proven immensely valuable in leading to an understanding of human color vision. It has been suggested that metamerism may also occur with the sense of smell. Aside from color vision and olfaction, it is unlikely that there are other interesting cases of complete metamerism in human perception.

### *B. Attribute Matching Task*

Much more common in the study of human perception is the task of having the subject adjust a stimulus along one or more physical dimensions until it matches another stimulus in terms of some perceptual attribute, even though one or more other attributes remain different. Some examples: adjusting the intensities of two lights of different color to appear equal in brightness, adjusting the intensities of two sounds of different frequency (and thus pitch) to appear equal in loudness, adjusting the physical sizes of two objects at different physical and perceived distances to appear equal in perceived size, and adjusting two line lengths in an illusion figure to appear equal in perceived length. In connection with illusion figures, the amount of physical disparity along some dimension required to make two stimuli appear equal in terms of the corresponding perceptual dimension can be taken as a measure of the illusion.

## **IV. Identification Tasks**

### *A. Absolute Judgment Task*

In the typical absolute judgment task, the experimenter assigns successive integers (1, 2, 3, etc.) to an ordered set of stimuli varying along just one physical dimension. After the subject is acquainted with the stimuli and the corresponding assigned values, the subject is then tested by being presented with each of the stimuli in random order. The subject's task is to identify the stimulus on each trial by responding with one of the assigned values. This method is useful in assessing the discriminability of the stimuli under different conditions of presentation. Performance is frequently measured using one or more of the following: rank-order correlation, product-moment correlation, and information-transmitted.

### *B. Recognition Task*

Another common perceptual task involves the recognition of multidimensional stimuli, such as letters, speech sounds, faces, common objects, etc. Frequently, the subject is already familiar with the stimuli and their labels. Commonly used measures of performance include response latency and percentage of stimuli correctly identified.

## **V. Direct Scaling Tasks**

The goal of a direct scaling experiment is to provide a scale of some perceptual magnitude (e.g., loudness, brightness, roughness, hardness) as a function of the corresponding physical dimension (or dimensions).

### *A. Magnitude Estimation Task*

Typically the subject is presented with a standard stimulus (some particular value along the physical dimension in question) and told to consider it as having some perceptual magnitude (e.g., 100). The subject is then instructed to assign values to all subsequent stimuli such that the reported values have the same ratios with respect to that of the standard as do the perceived magnitudes. From judgments of this sort, one can construct scales of perceived magnitude as a function of physical magnitude. The two are usually found to be related by a power function,  $P = kS^n$ , where  $P$  represents the perceptual magnitude,  $S$  the physical magnitude,  $k$  a constant, and  $n$  an exponent with a value typically different from 1.

### *B. Ratio Production Task*

This method is quite similar to magnitude estimation. However, rather than responding verbally with a number, the subject adjusts one of the stimuli so that its perceived magnitude bears some ratio to that of the standard, with the particular ratio on each trial being designated by the experiment. Though the response is

different, the scales constructed are much like those resulting from magnitude estimation. This method is sometimes called magnitude production.

### *C. Cross-Modality Matching Task*

In a cross-modality matching experiment, the subject's task is to adjust some stimulus until its perceptual magnitude is comparable to the perceptual magnitude of a stimulus along some altogether different dimension or even within a different sense modality. Thus, one might ask a subject to adjust a sound to appear as loud as some light is bright, or to squeeze a hand dynamometer so that the perceived grip force matches the pitch of a pure tone. Although this task might be thought to be so subjective as to lead to totally unreliable results, subjects readily adapt to the task and produce results that are both reliable and consistent with those of the other two direct scaling methods.