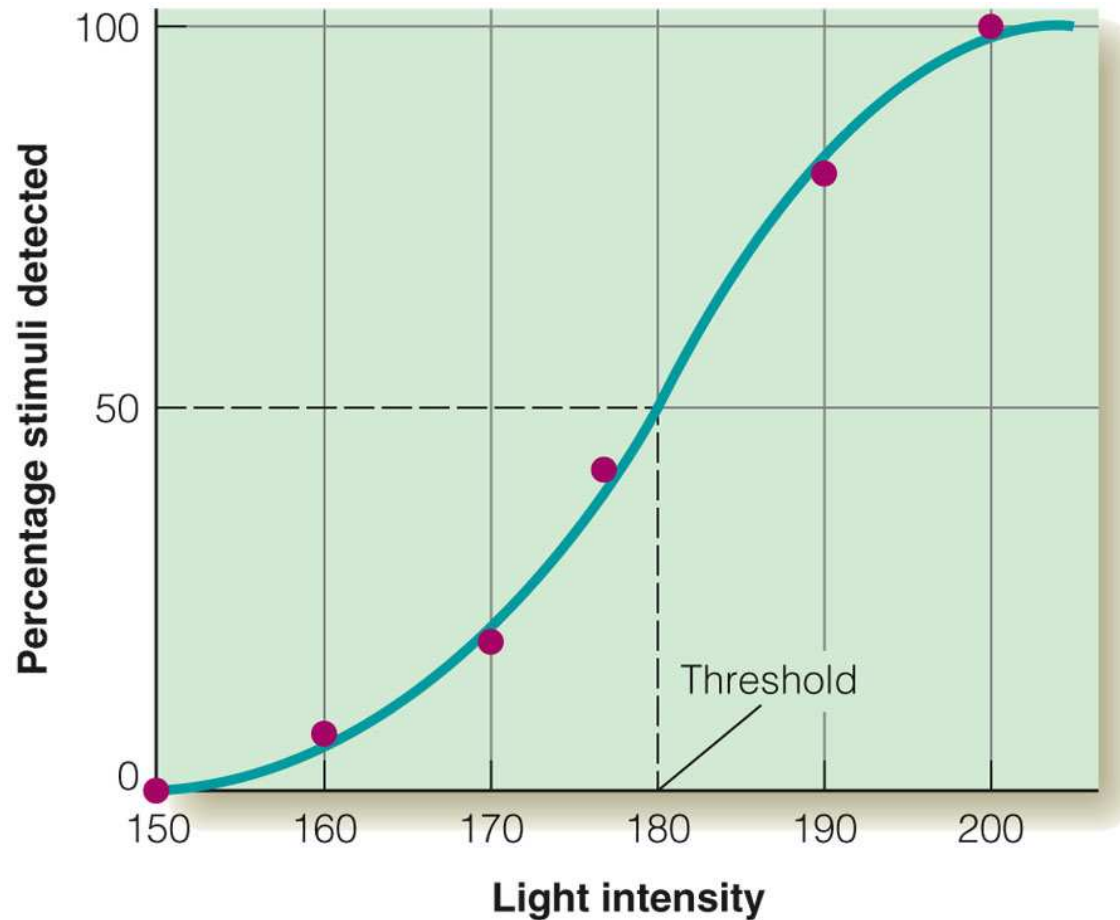


## Thresholds: two types

**ABSOLUTE THRESHOLD:** The minimum intensity of stimulation (brightness of a light; loudness of a tone) required to produce a detectable sensory experience

**DIFFERENCE THRESHOLD:** The minimum *change* in intensity required to produce a detectable change in sensory experience (this is also known as a Just Noticeable Difference or JND)

## *Psychometric function for absolute threshold*

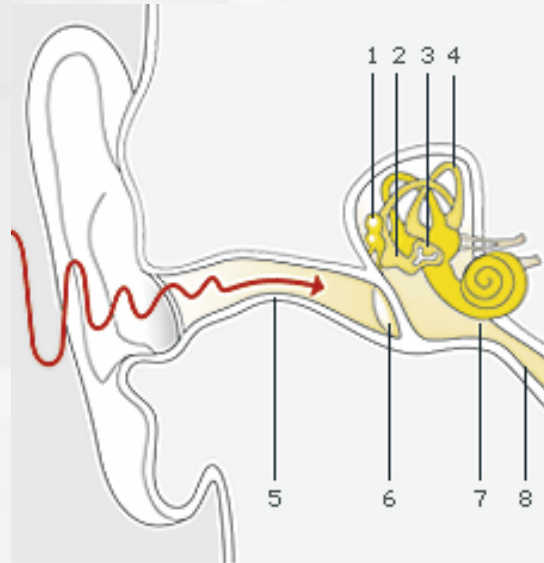


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Figure 1.11 Results of a hypothetical experiment in which the threshold for seeing a light is measured by the method of constant stimuli. The threshold - the intensity at which the light is seen on half of its presentations - is 180 in this experiment.

Example of a difference threshold:

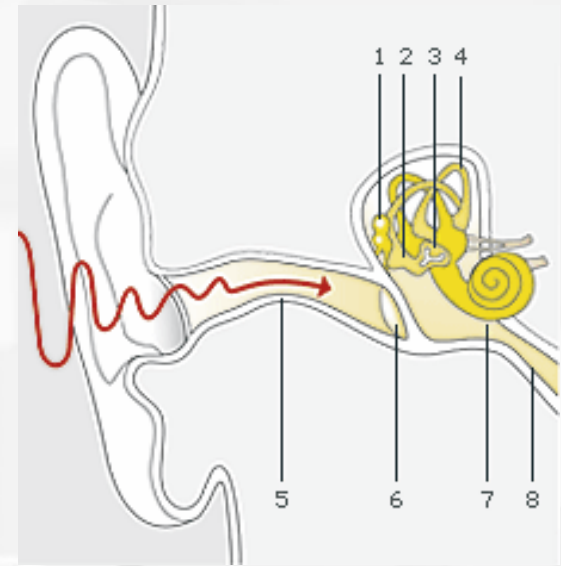
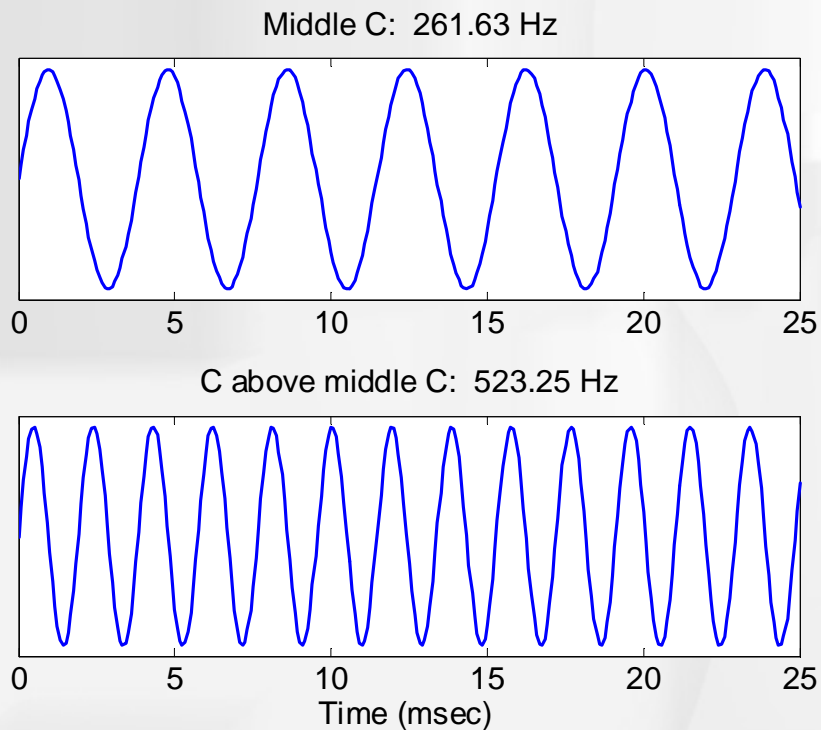
## Auditory frequency discrimination



What is the just noticeable difference between two auditory frequencies?

## A quick note about the auditory system: Frequency and Pitch

The psychological experience of *pitch* is related to the temporal *frequency* of vibrations of the air hitting the eardrum.



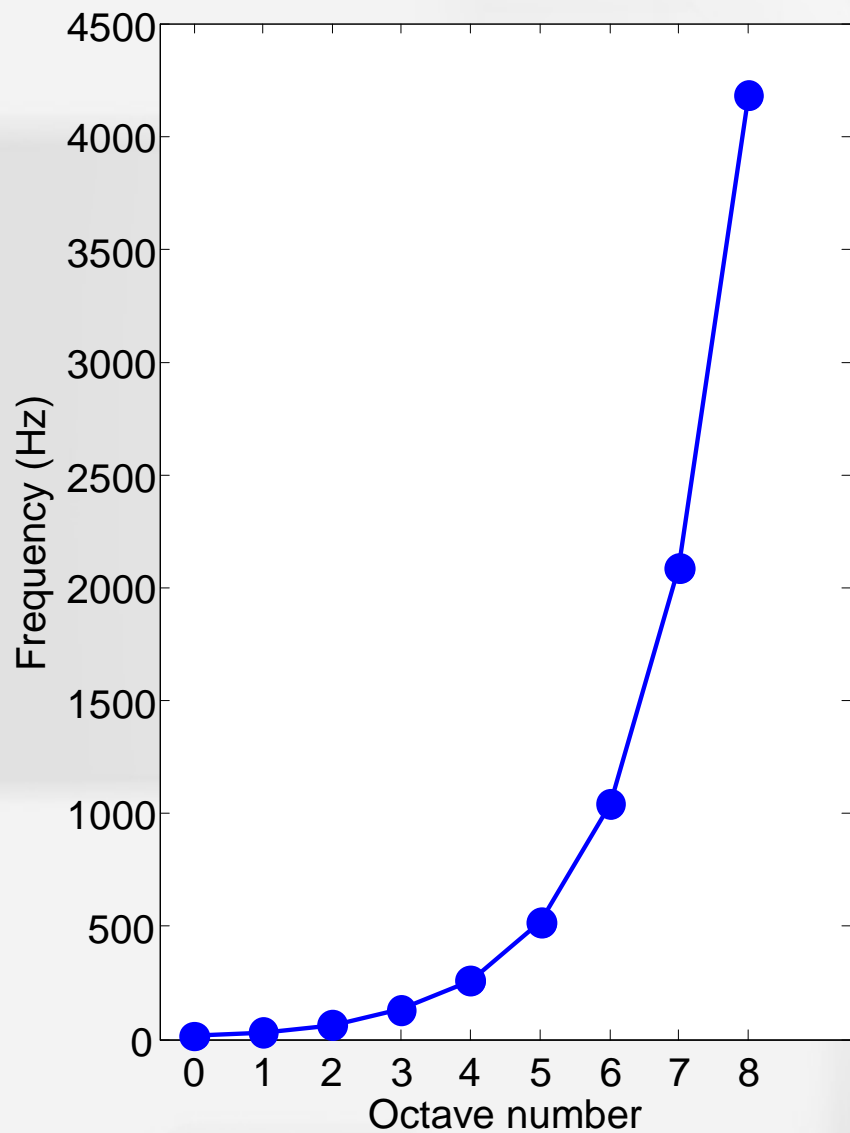
Doubling the frequency  
increases the pitch by one  
octave.

## Frequencies of notes on the 12 tone equal tempered scale

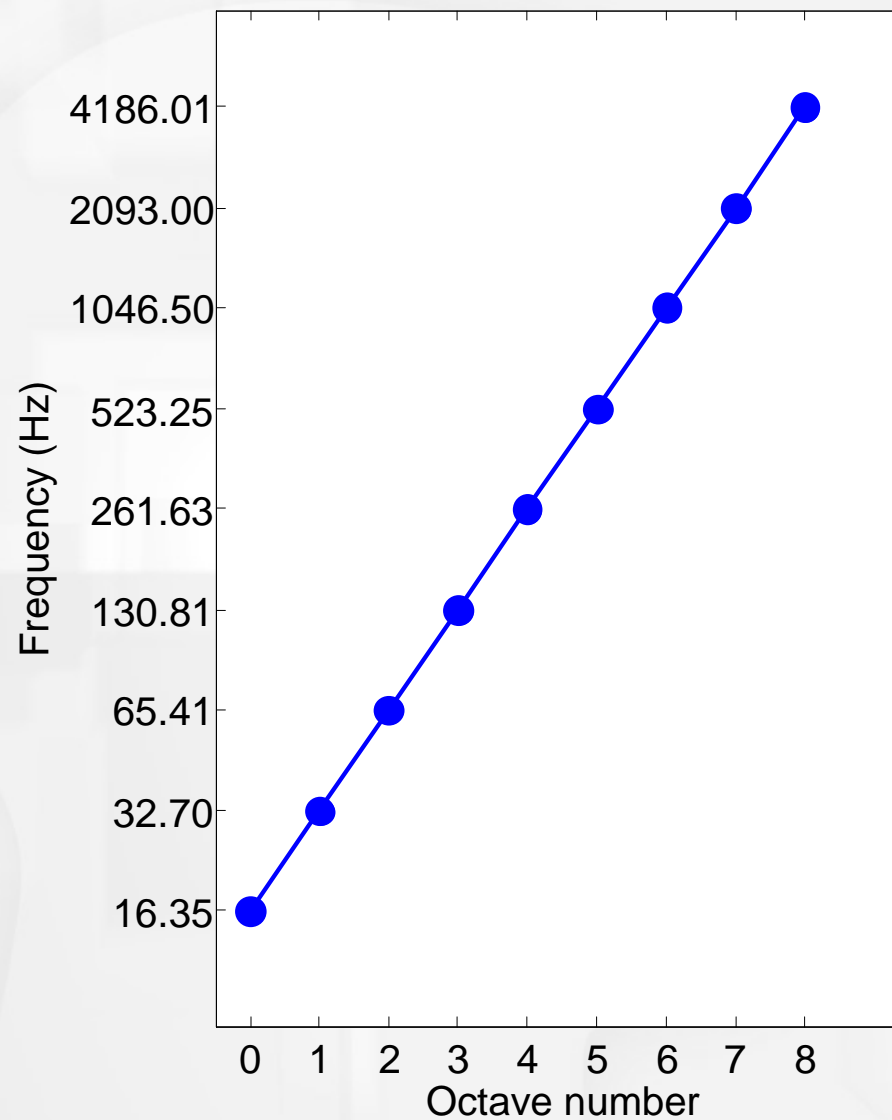
Octave	8	4186.0	4434.9	4698.6	4978.0	5274.0	5587.6	5919.9	6271.9	6644.9	7040.0	7458.6	7902.1
	7	2093.0	2217.5	2349.3	2489.0	2637.0	2793.8	2960.0	3136.0	3322.4	3520.0	3729.3	3951.1
	6	1046.5	1108.7	1174.7	1244.5	1318.5	1396.9	1480.0	1568.0	1661.2	1760.0	1864.7	1975.5
	5	523.3	554.4	587.3	622.3	659.3	698.5	740.0	784.0	830.6	880.0	932.3	987.8
	4	261.6	277.2	293.7	311.1	329.6	349.2	370.0	392.0	415.3	440.0	466.2	493.9
	3	130.8	138.6	146.8	155.6	164.8	174.6	185.0	196.0	207.7	220.0	233.1	246.9
	2	65.4	69.3	73.4	77.8	82.4	87.3	92.5	98.0	103.8	110.0	116.5	123.5
	1	32.7	34.6	36.7	38.9	41.2	43.6	46.3	49.0	51.9	55.0	58.3	61.7
	0	16.4	17.3	18.4	19.4	20.6	21.8	23.1	24.5	26.0	27.5	29.1	30.9
	C	C#	D	D#	E	F	F#	G	G#	A	A#	B	

12 Tone Equal Tempered Scale')

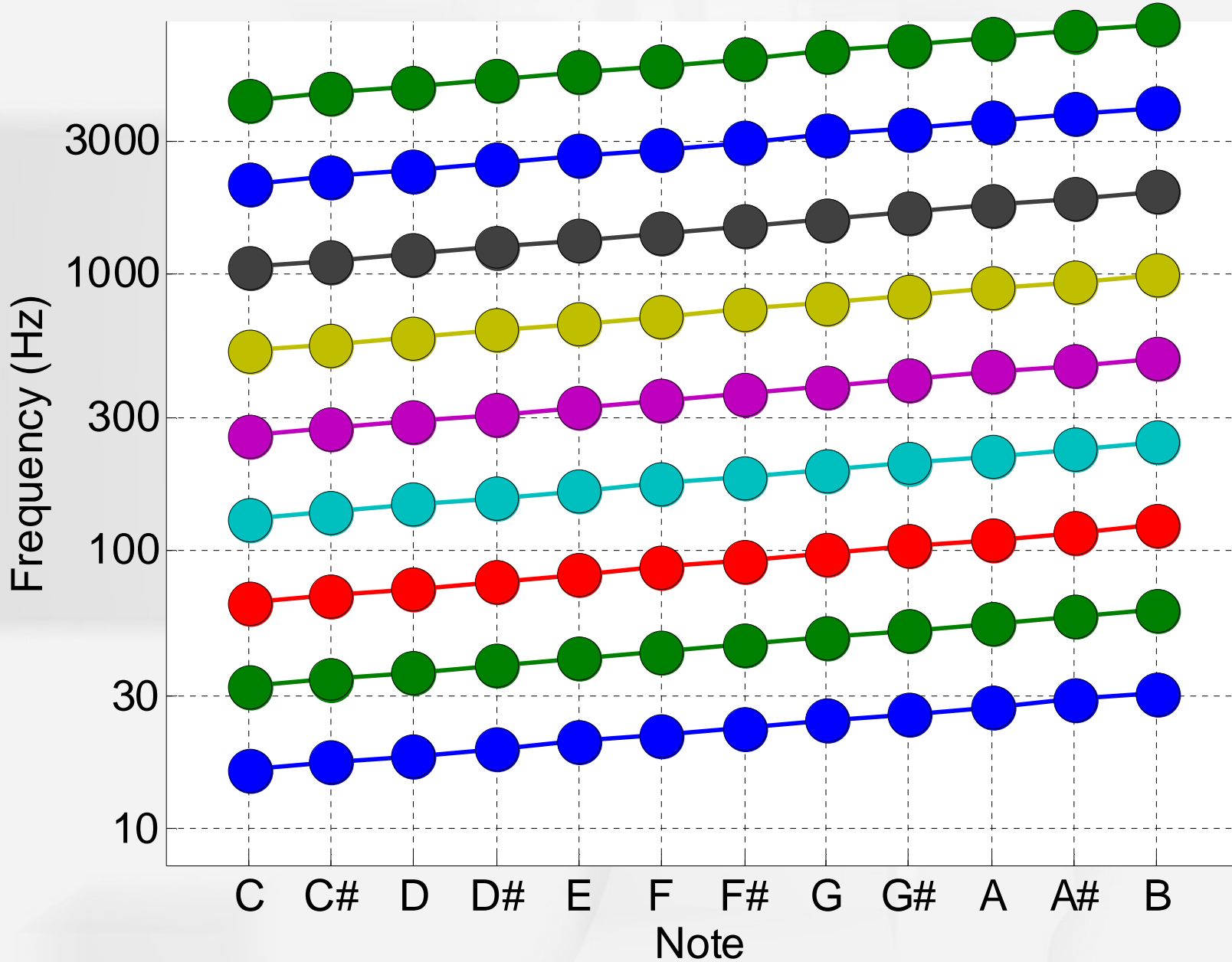
'C' notes on a linear axis



'C' notes on a logarithmic axis



Frequencies of notes on the 12 tone equal tempered scale



## 2) Behavioral measurements: 'psychophysics'

### Psychophysics - Quantitative Methods

**Difference Threshold:** Smallest difference that can be reported reliably (or just noticeable difference, JND)

Example: *Auditory frequency discrimination.*

Can you tell the difference between pure tones of 260 and 262 Hz?  
(261.6 Hz is middle C on the '12 Tone Equal Tempered Scale')



**260**

261

262

263

264

265

266

267

268

269

270

What about 440Hz? How much of an increment to you need to tell the difference?  
(440 Hz is the note A above middle C)



**520**

521

522

523

524

525

526

527

528

529

530

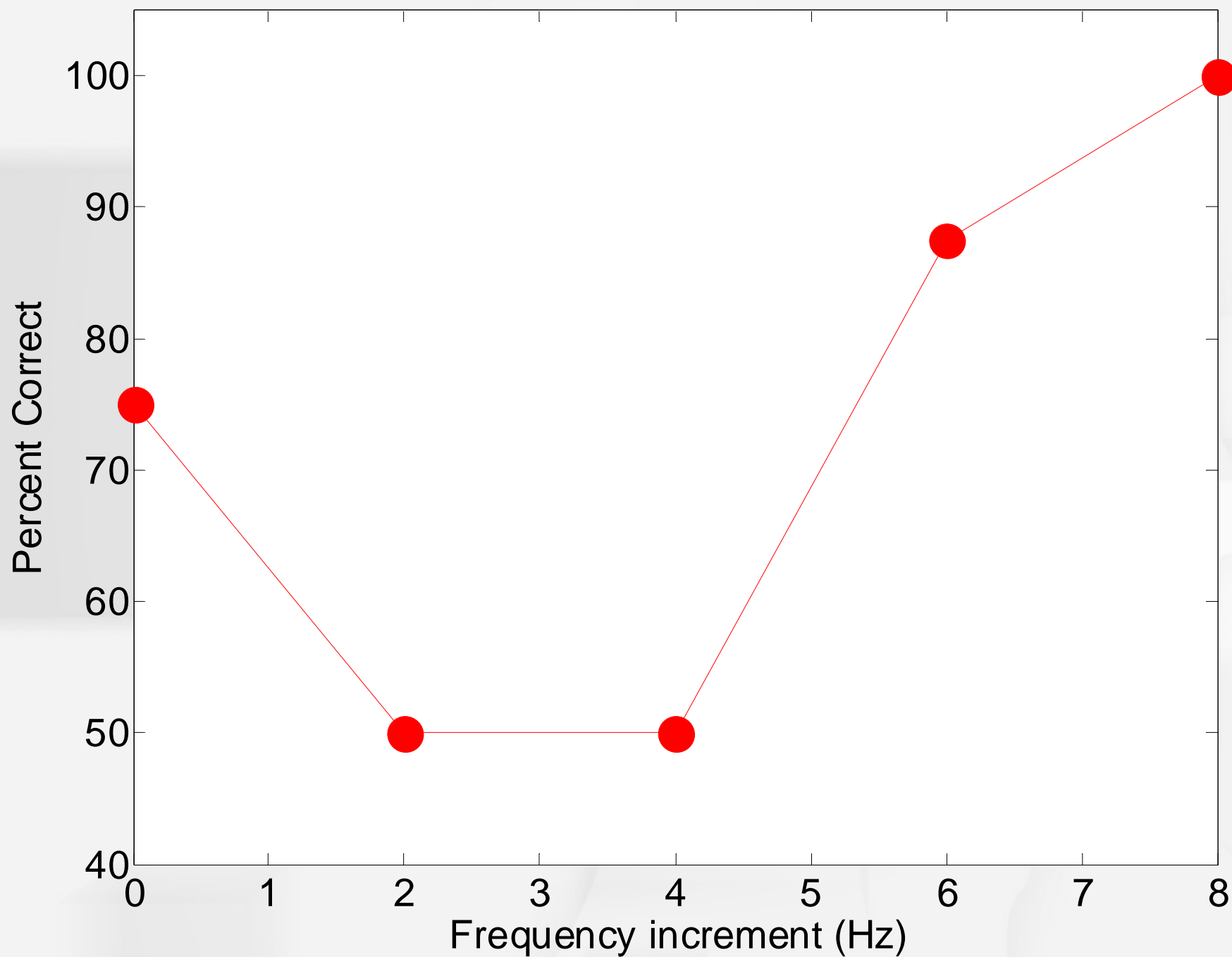


## How do we measure a person's difference threshold?

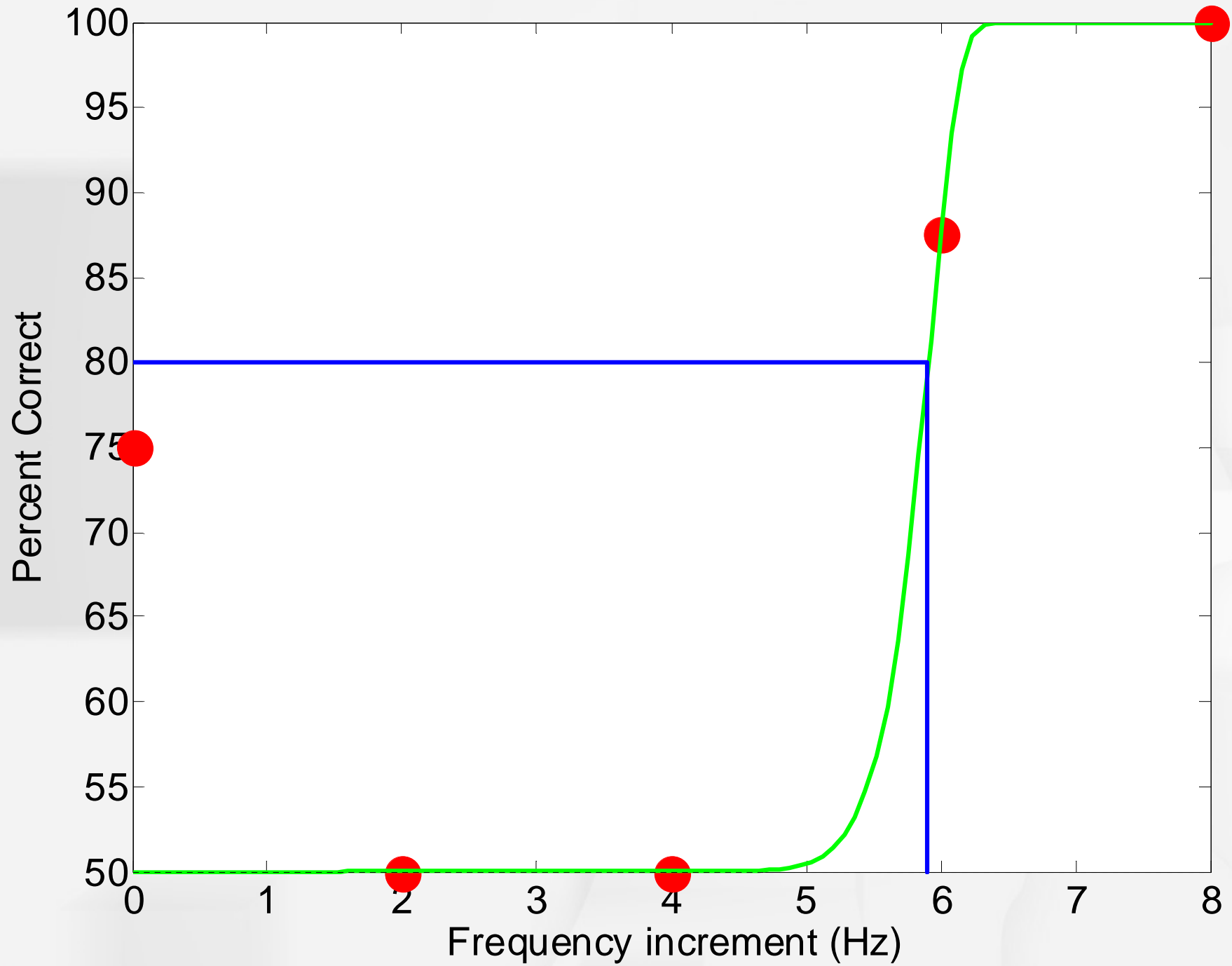
We'll use the method of constant stimuli again.

- 1) Pick a *baseline value* (e.g. 260 Hz)
- 2) Pick a set of *increments* (e.g. 0, 1, 2, 3, 4, 5 Hz)
- 3) Present the baseline and baseline+increment in pairs
- 4) Randomly choose which one comes first, and ask the subject which interval had the higher frequency.
- 5) Plot the resulting *psychometric function*
- 6) Fit the curve. The JND is the increment that gives 80% correct.

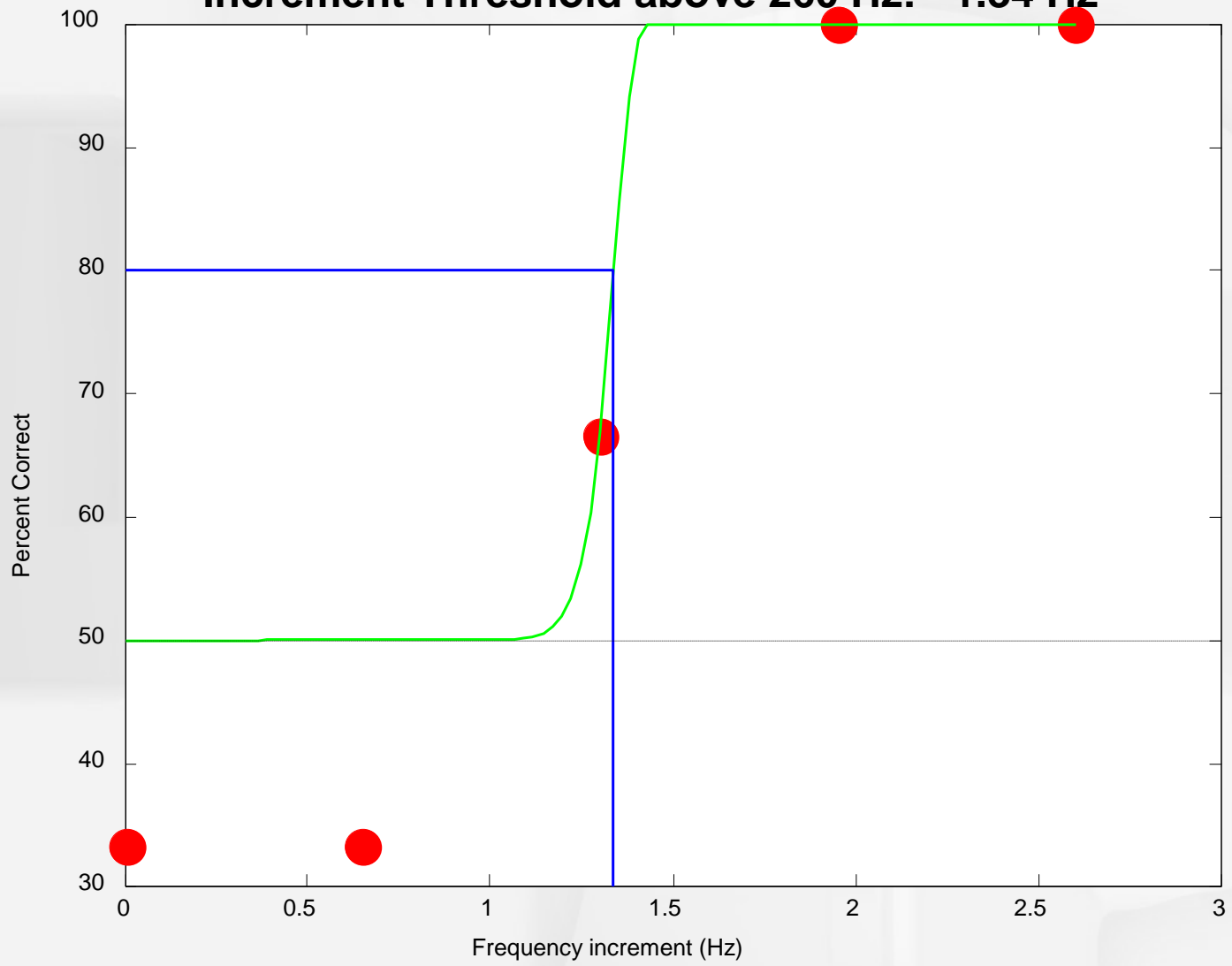
Base frequency: 260 Hz



Base Frequency 260 Hz: JND: 5.90 Hz

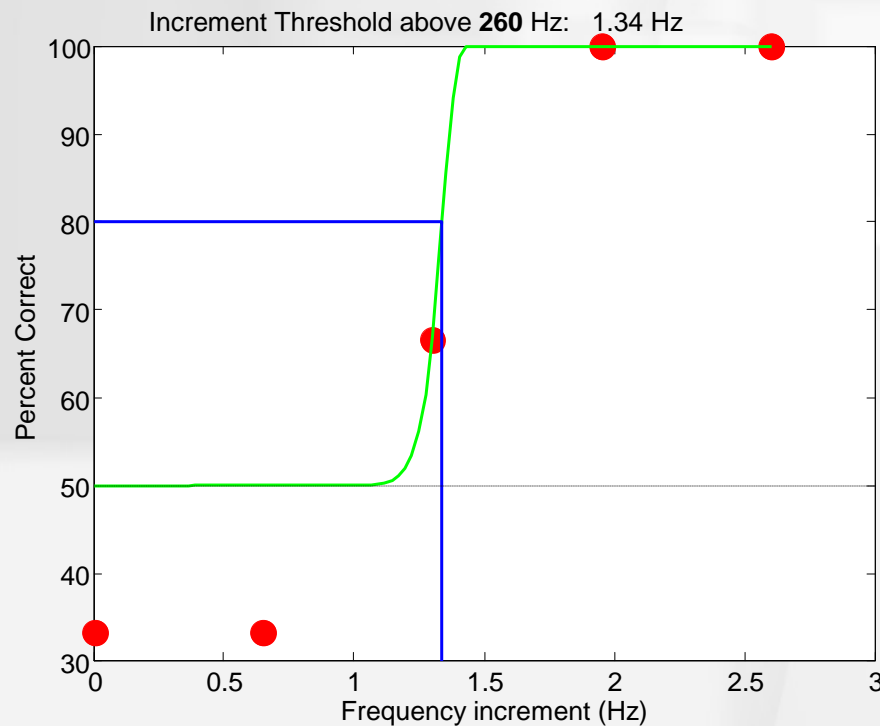


### Increment Threshold above 260 Hz: 1.34 Hz



The *Weber Fraction* is the fractional increase above a baseline value that can be reliably detected.

It is the ratio of the difference threshold over the baseline value

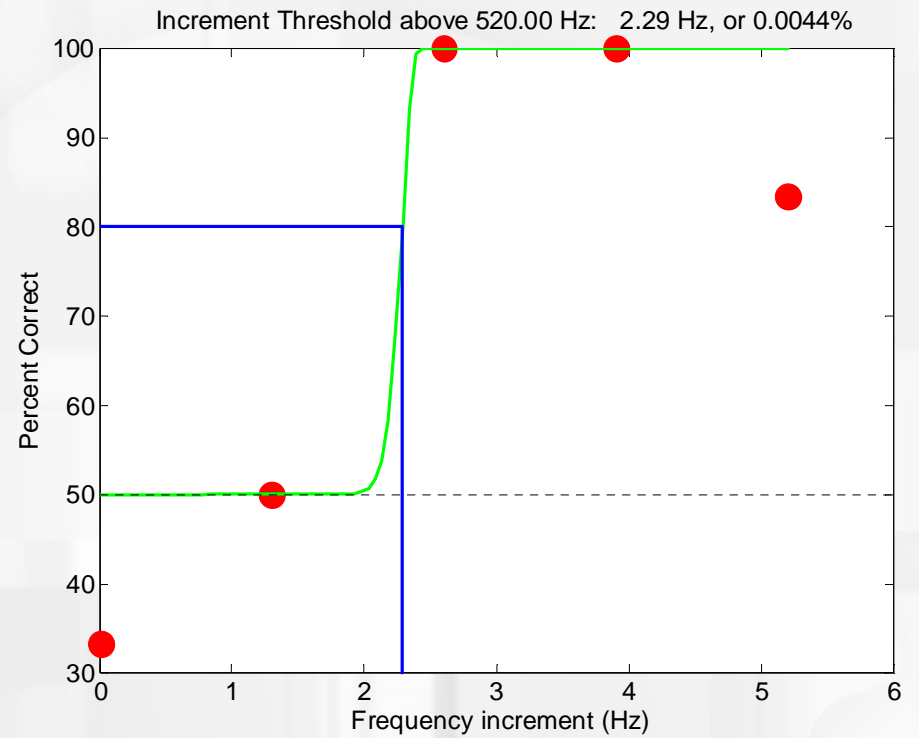
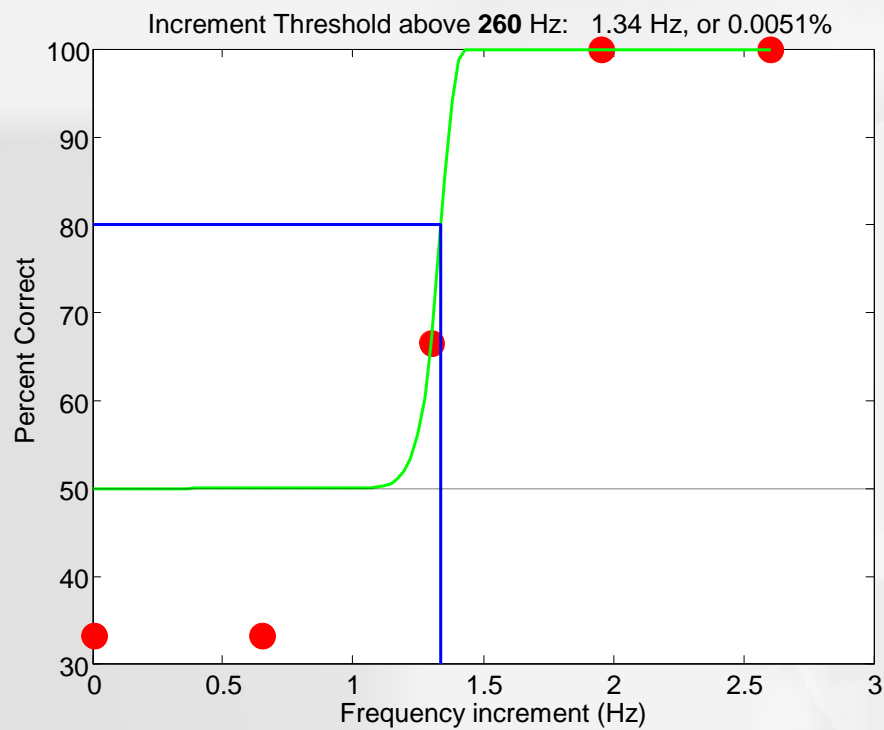


In our example:

Baseline value = 260 Hz

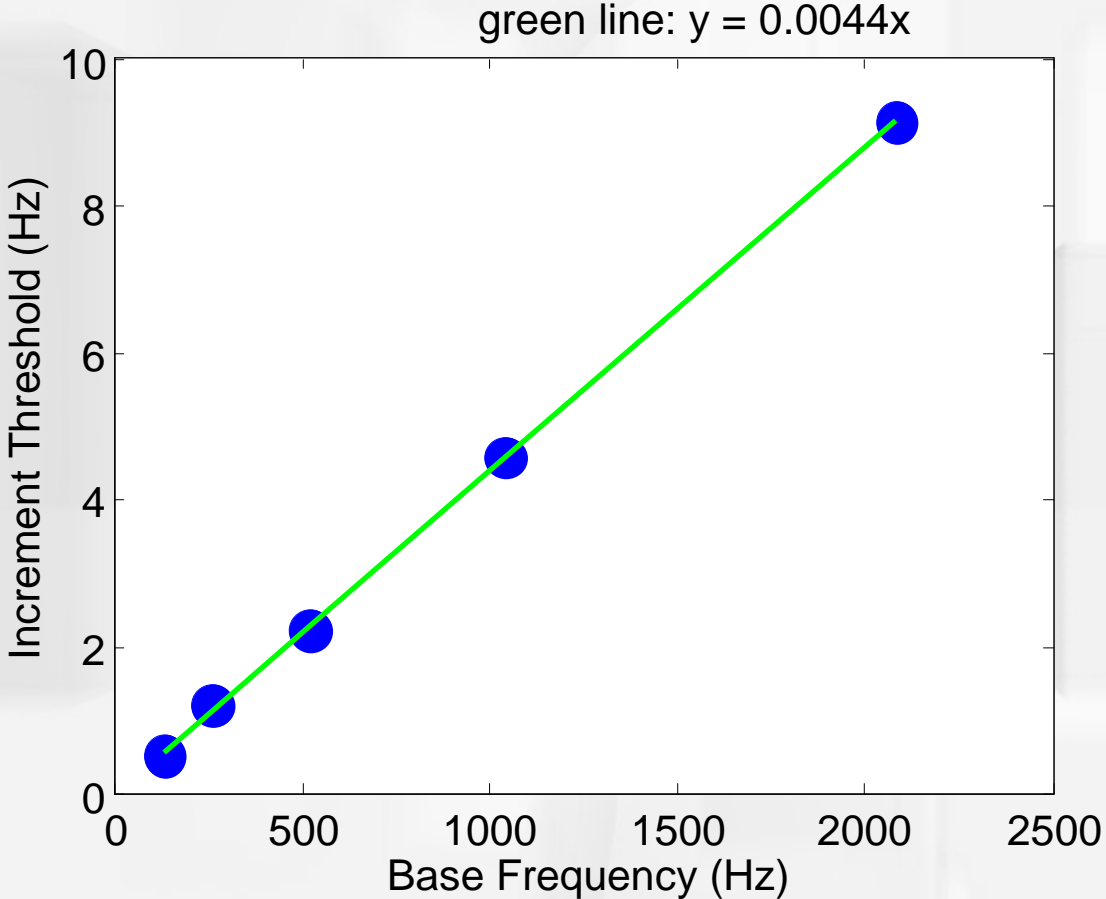
Difference threshold = 1.34 Hz

Weber fraction =  $1.34/260 = .0051$

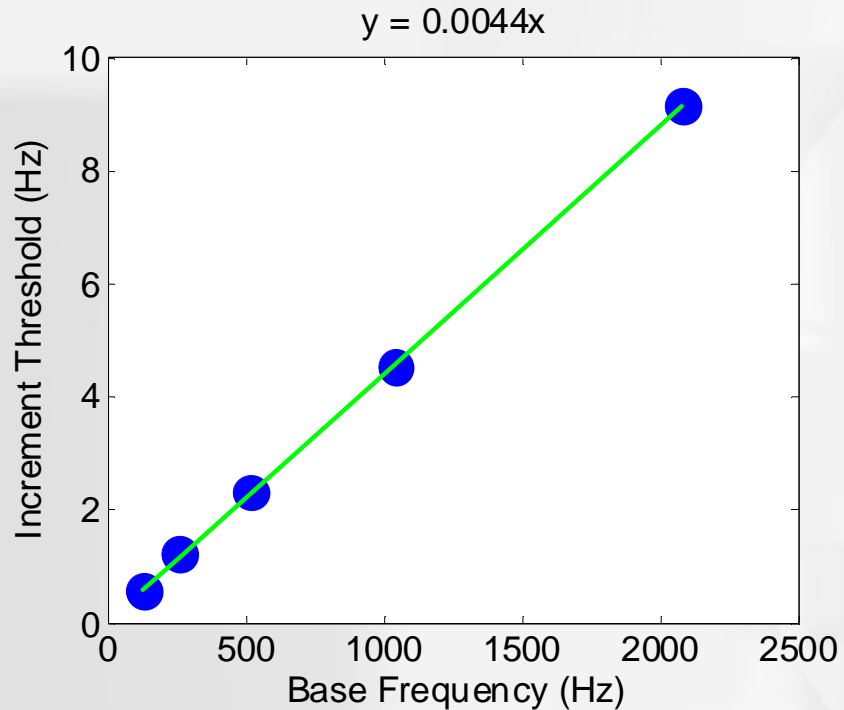


Base frequency	JND (Hz)	Weber fraction
260	1.34	0.0051
520	2.29	0.0044

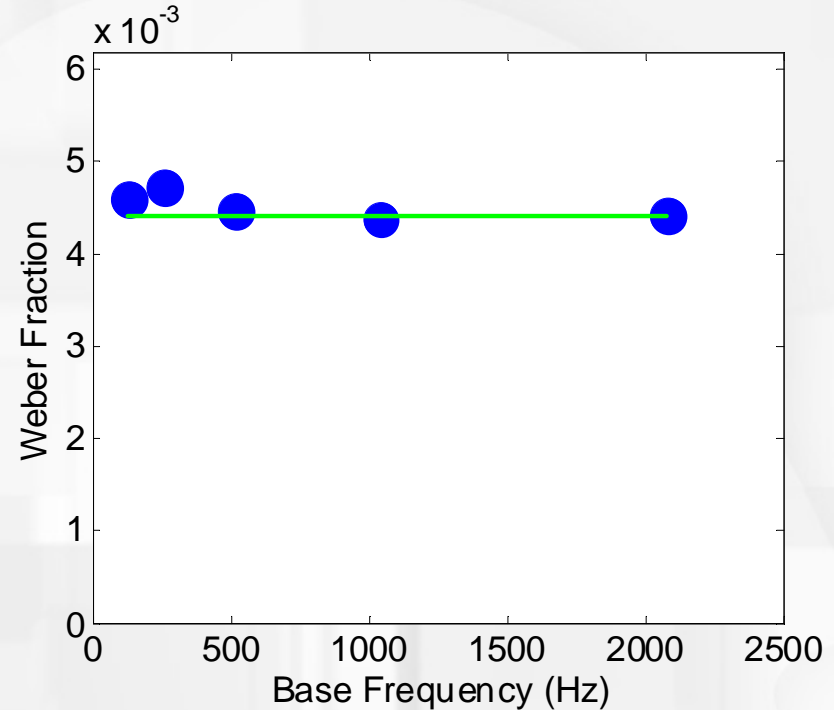
How does the Weber fraction change with baseline values?



## Difference thresholds for 5 baseline frequencies



## Weber fractions



**Weber's Law:** Difference thresholds are proportional to the baseline value

$I$  = baseline value

$\Delta I$  = difference threshold

$$\frac{\Delta I}{I} = k \quad \Delta I = kI$$

For this example of  
frequency discrimination,  $k = .0044$



## Hot off the press (sort of)

*Perception & Psychophysics*  
2002, 64 (2), 169-179

### Auditory frequency discrimination in adult developmental dyslexics

S. J. FRANCE, B. S. ROSNER, P. C. HANSEN, C. CALVIN,  
J. B. TALCOTT, A. J. RICHARDSON, and J. F. STEIN  
*University of Oxford, Oxford, England*

**Table 2**  
**Median Just Noticeable Differences  $\Delta F$  and Weber Fractions  $\Delta F/F$  for Controls ( $n = 20$ ) and Dyslexics ( $n = 16$ )**

Interstimulus Interval (msec)	$\Delta F$ (Hz)		$\Delta F/F$	
	Controls	Dyslexics	Controls	Dyslexics
	Condition 2I_1A_X			
0	6.8	16.5	0.014	0.033
10	7.1	19.1	0.014	0.038
400	7.0	23.6	0.014	0.047
1,000	7.5	15.9	0.015	0.032

(500 Hz tone)

**Table 1.3** ■ *Weber fractions for a number of different sensory dimensions*

Electric shock	0.01
Lifted weight	0.02
Sound intensity	0.04
Light intensity	0.08
Taste (salty)	0.08

*Source:* From Teghtsoonian (1971).

A Weber fraction of 0.01 means that subjects can reliably detect a 1% change in stimulus intensity.