

Perceived Exertion

Learning objectives

- ⊕ **History**
- ⊕ **Methods**
- ⊕ **Mediators**
- ⊕ **Applications**

What is Perceived Exertion?

- ⊕ Perceived exertion is one's subjective feeling of strain or effort during physical work.
- ⊕ The perception of exertion represents an integration, or *gestalt*, of many different signals from many different physiological, psychological, and environmental sources.

Psychophysics & Perceived Exertion

- ⊕ **Psychophysics**: the psychological appraisal of the physical world.
- ⊕ **Sensation**: a passive process defined as the stimulation of sensory nerve fibers due to a physical stimulus.
- ⊕ **Perception**: an active process defined as the cognitive interpretation of sensations.

Active learning

Modern Psychophysics

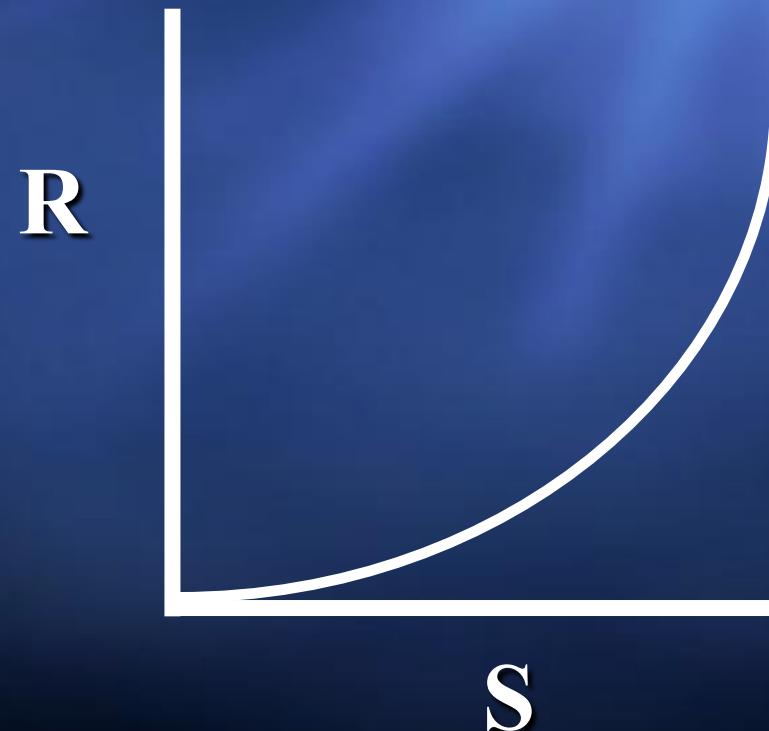
<u>Scale Type</u>	<u>Function</u>	<u>Example</u>
Nominal	Classification	ID #
Ordinal	Rank Order	To Do List
Interval	Distances	Thermometer
Ratio	Proportions	Meter Stick

Ratio Scaling

- ⊕ Magnitude Estimation
- ⊕ Magnitude Production

Stevens' Power Law

$$R = k S^n$$



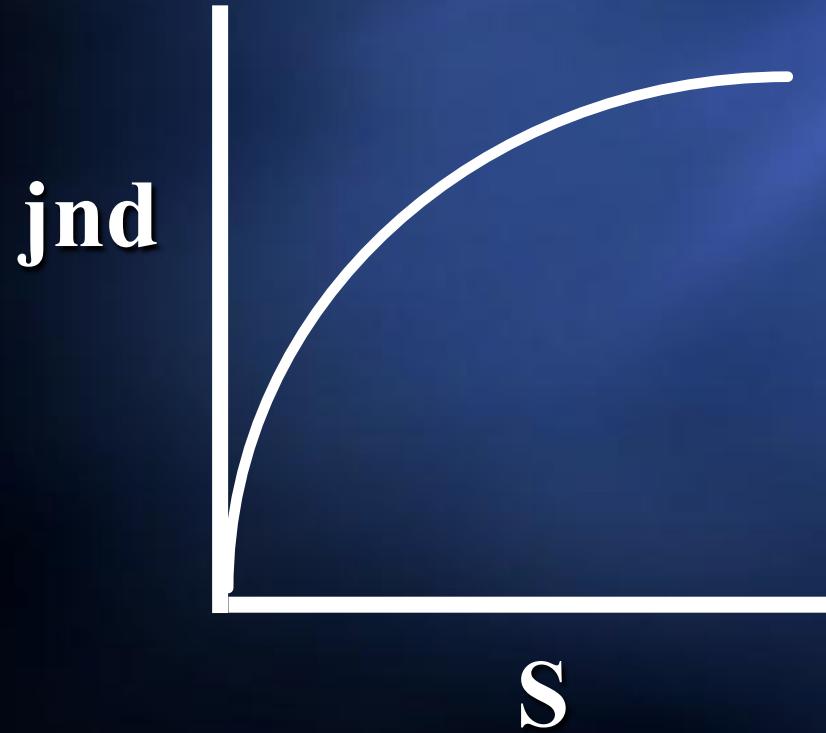
Stevens' Power Law

**What happens to the
jnd as intensity increases?**

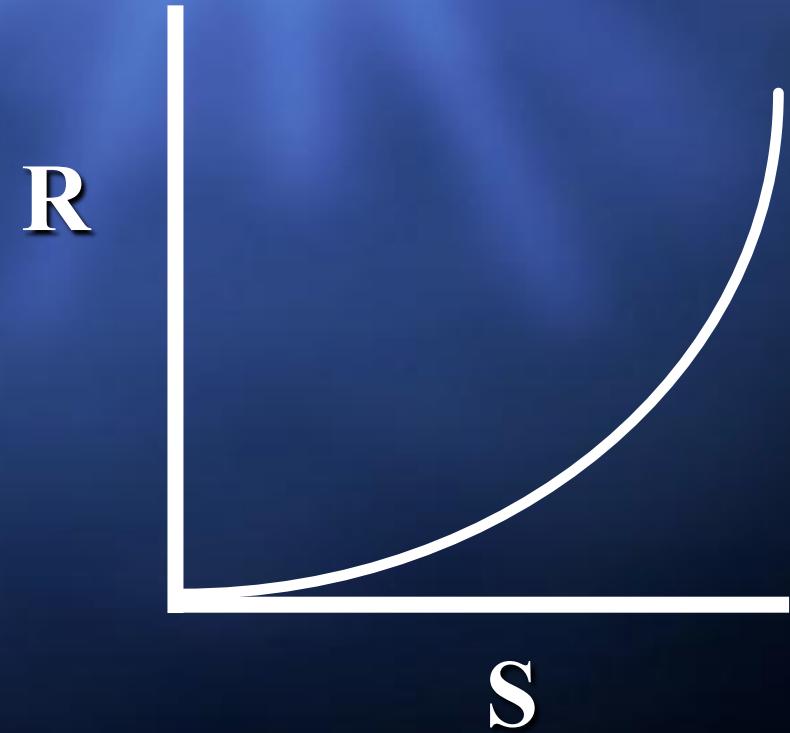
- ⊕ **the rate at which the jnd negatively accelerates with linear increases in power output.**

Stevens' Power Law

$$jnd = \log S$$



$$R = k S^n$$



Huh ?

Example: Continuously Graded Exercise Test

- ⊕ **As a person approaches their maximal capacity, work continues to increase linearly.**
- ⊕ **As each moment passes, the increase in power output required to elicit a *jnd* becomes exponentially smaller - thus the perceptions of force become exponentially larger.**

Stevens' Power Law: application to exercise

⊕ **As work increases linearly,
the perception of how hard
that work feels grows
exponentially.**

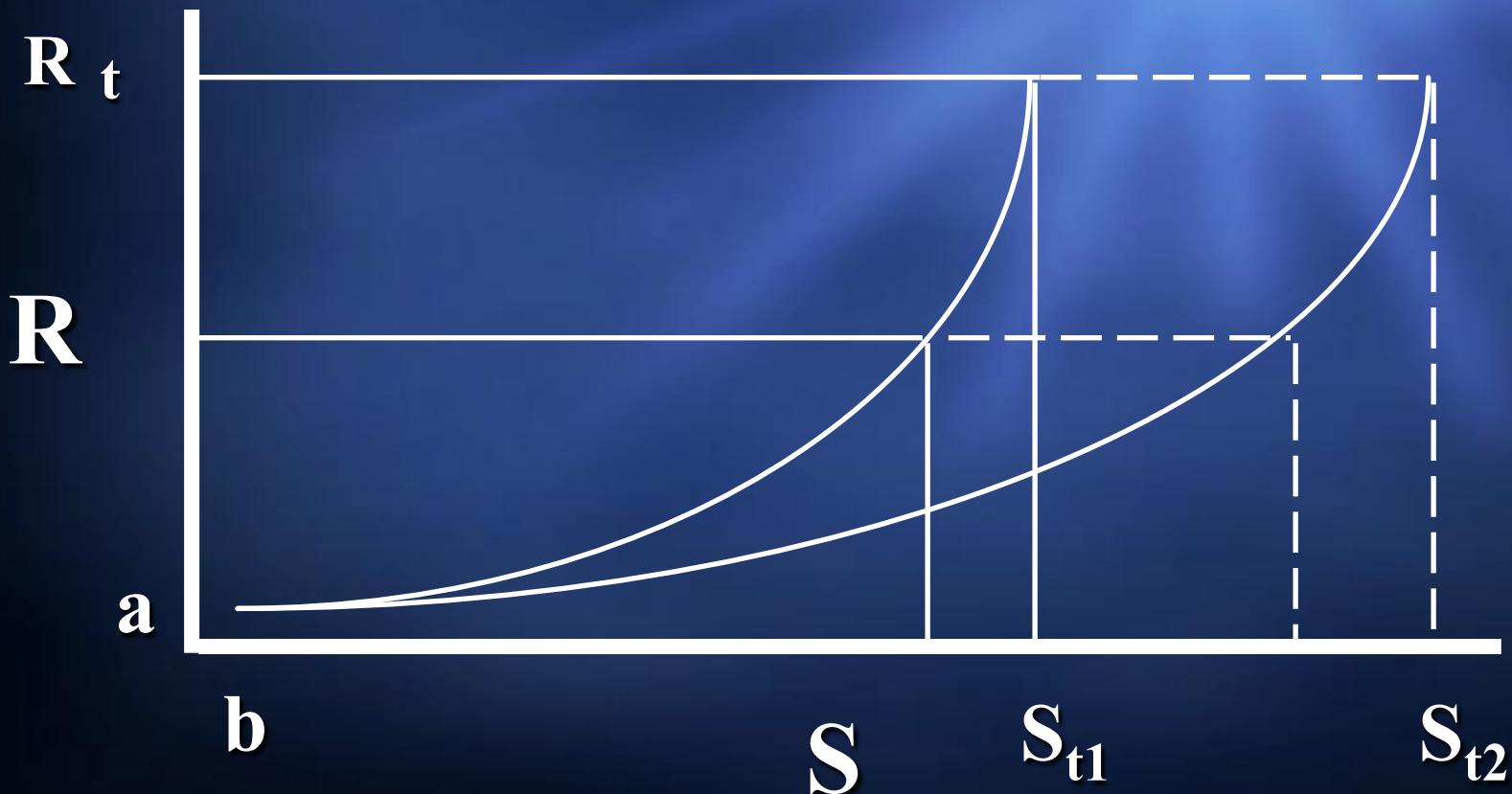
Borg's Modified Power Law

$$R = a + c(S - b)^n$$

- ⊕ **a** represents the tonic level of perceived exertion at complete rest, when no work is being performed.
- ⊕ **b** represents the stimulus threshold.

Borg's Range Principle

$$R = a + c (S - b)^n$$



Borg's Range Principle

- ⊕ All people have the same perceptual range for feelings of exertion.
- ⊕ All people have similar experiences and memories of physical exertion, from feelings of “no exertion at all” to feelings of “maximal exertion”.
- ⊕ Subjective feelings of “no exertion” and feelings of “maximal exertion” are perceptually the same for all people.

Instructions for the RPE Scales

- ⊕ **Define perceived exertion**
- ⊕ **Describe the scale**
- ⊕ **Anchor the perceptual range**
- ⊕ **Specify overall or differentiated ratings**
- ⊕ **Encourage accurate and honest responses**

Active learning, pt 2

What Signals Contribute to Perceptions of Exertion?

- ⊕ **Respiratory-Metabolic Mediators**
- ⊕ **Peripheral Mediators**
- ⊕ **Psychological Mediators**

Respiratory-Metabolic Signals

- ✓ Ventilatory Drive
- ✓ Respiratory Rate

⊕ Indicators:

- V_E / VO_2
- % VO_{2MAX}

Respiratory-Metabolic Signals that are not mediators of RPE

- x Rate of Oxygen Uptake**
- x Rate of Carbon Dioxide Excretion**
- x Tidal Volume**
- x Heart Rate**
- x Blood Pressure**

The Problem With HR

⊕ Borg Proposed:

$$X \text{ HR} = \text{RPE} \times 10$$

⊕ **Error:**

$$\oplus \text{HR} = \text{RPE} \times 10 + 20-30 \text{ bpm}$$

The Problem With BP

- ⊕ During Exercise:
 - ⊕ SBP may increase
 - ⊕ DBP remains stable or decreases slightly
 - ⊕ MAP remains stable

- ⊕ Since MAP does not change much with increased exercise intensity, it is unrelated to ratings of perceived exertion.

Peripheral Mediators

- ✓ Force or Torque
- ✓ Proprioception
- ✓ Hydrogen Ion Accumulation (\downarrow pH)
- ⊕ Indicators
 - # IEMG (related to fiber type & M.U. recruitment pattern)
 - * Blood Lactate Concentration

Peripheral Mediators

- Temperature
- ✓ Skin Temperature
- But NOT Core Body Temperature
- ✓ Catecholamines
- ✓ Nociception (Substance P or Prostaglandin or ?)

The Sensory Pathways for Exertion

- ⊕ Dorsal-Column Medial Lemniscal System
 - ⊕ **Type Ia (muscle spindle), Type Ib (Golgi tendon organ), Type II, & Type III Afferents**
 - ⊕ **Force, Proprioception, Respiratory Work**
- ⊕ Anterolateral System
 - ⊕ **Type III & Type IV Afferent Fibers**
 - ⊕ **Nociception (Pain) & Temperature**

Physiological Correlates of Perceived Exertion

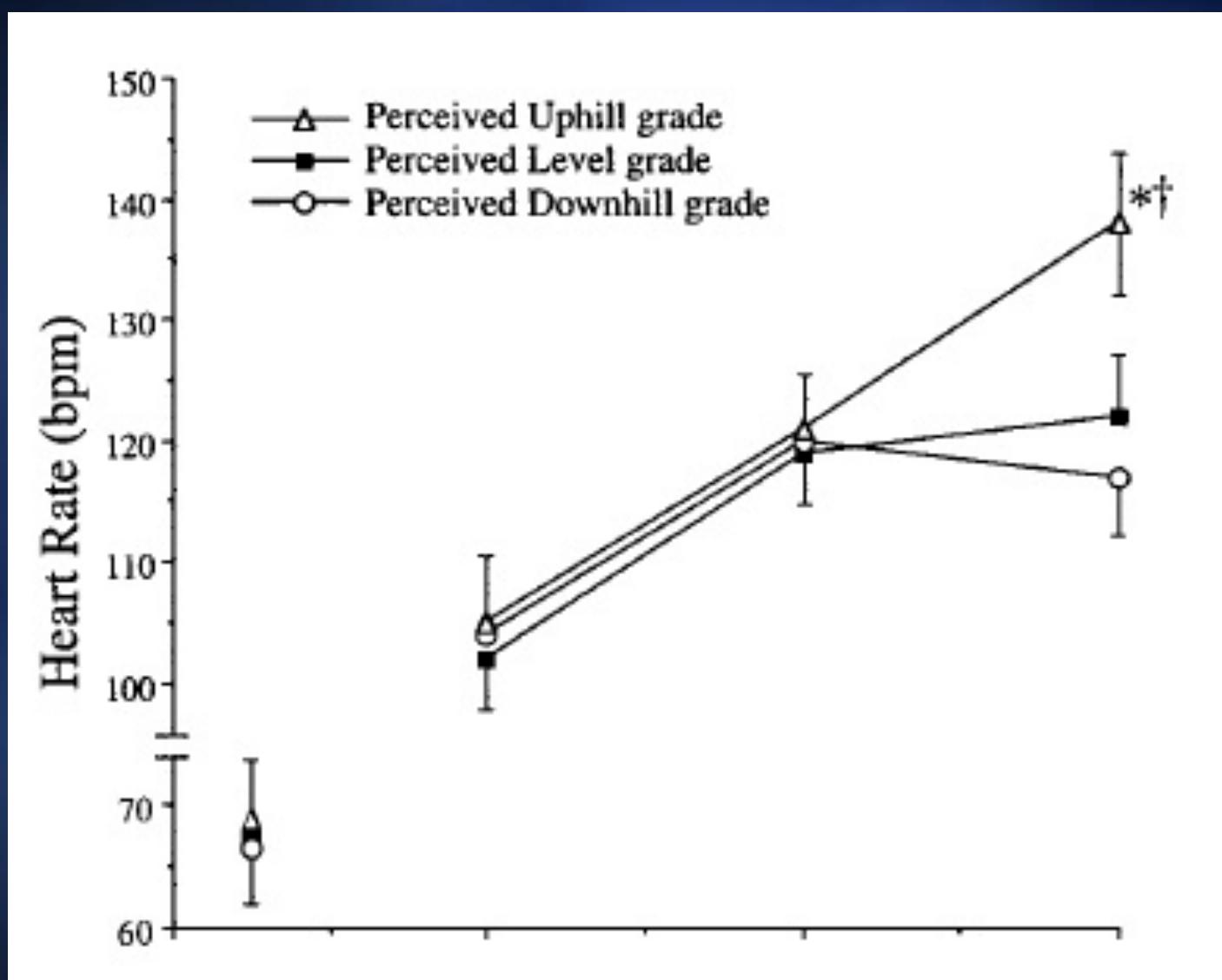
Metabolic Intensity

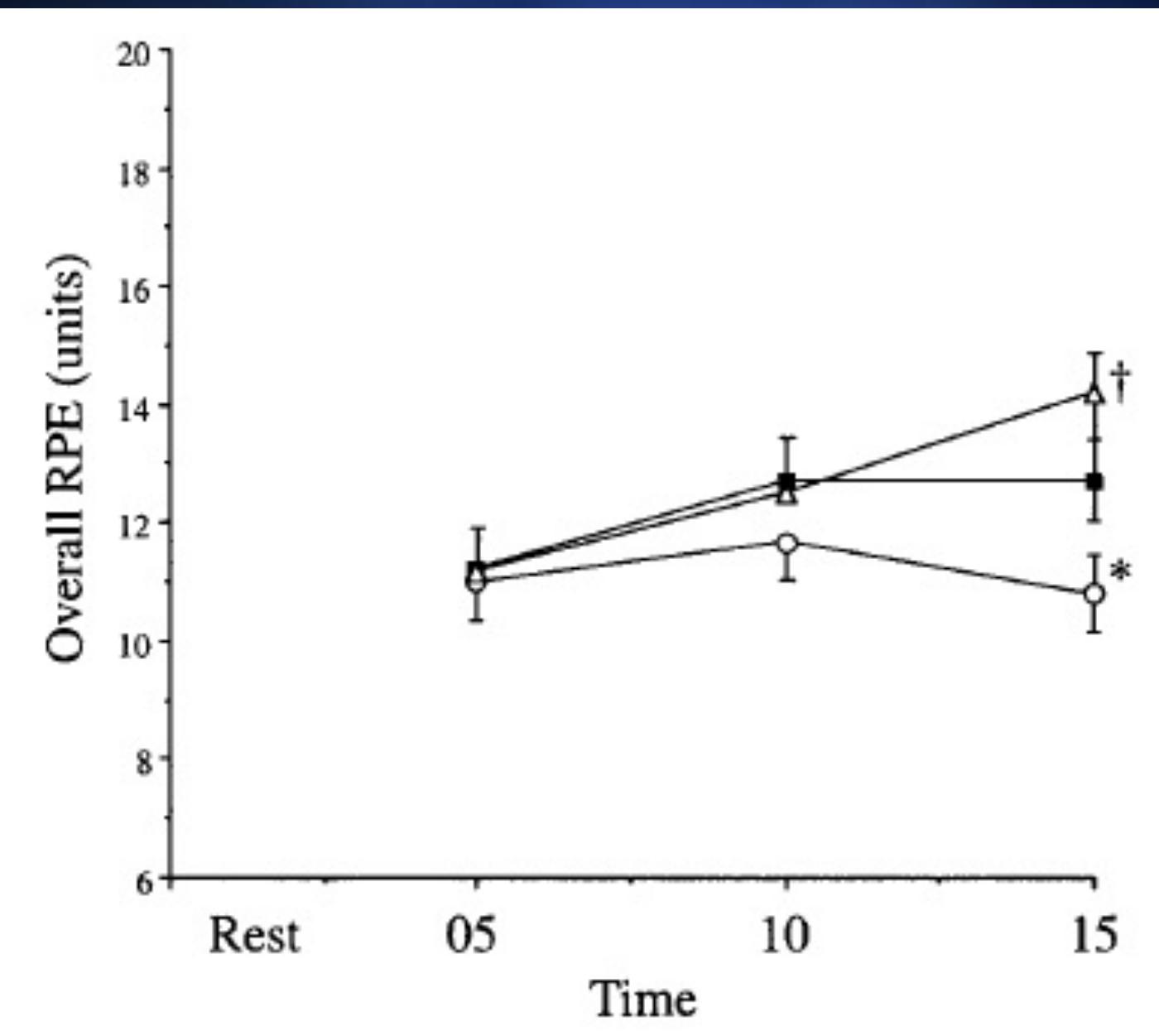
<u>%VO_{2MAX}</u>	<u>Respiratory</u>	<u>Metabolic</u>	<u>Peripheral</u>
<50%	Limited	Proportional	Dominant
50-70%	Moderate	Proportional	Dominant
>70%	Significant	Proportional	Dominant

Source: Robertson (1982)

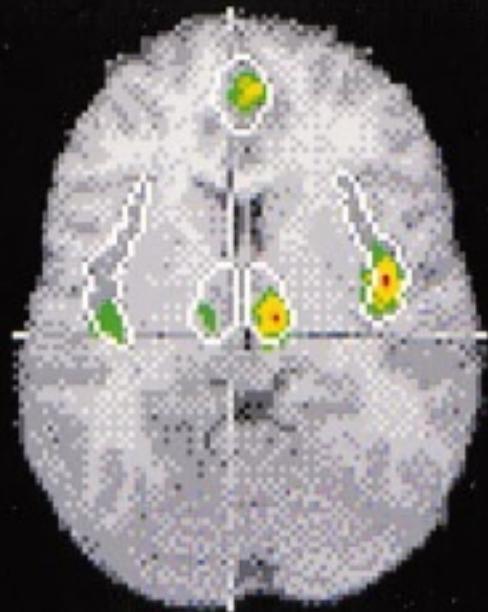
Psychological Mediators

- ⊕ **Attentional Focus?**
- ⊕ **Hypnosis?**
- ⊕ **Extroversion Vs. Introversion?**
- ⊕ **Social Desirability ?**
- ⊕ **Psychiatric Disorders ?**



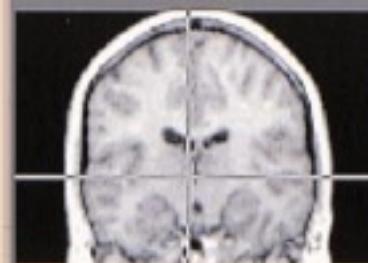


Uphill Cycling vs. Baseline Cycling



A

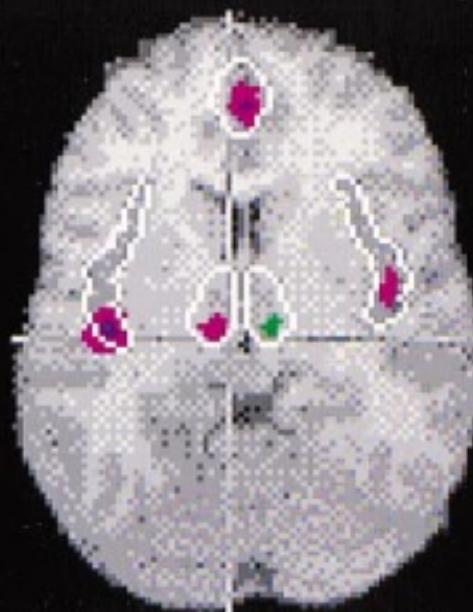
Oblique coronal



Parasagittal



Downhill Cycling vs. Baseline Cycling



B

Not Psychological Mediators

- ✗ Type A Behavior Pattern**
- ✗ State Anxiety**
(in low trait anxious)

Other Important Mediators

- ⊕ **Training Status**
- ⊕ **Exercise Duration**
- ⊕ **Exercise Mode**
- ⊕ **External Environment**

RPE Applications

⊕ RPE During Exercise Testing

⊕ Exercise Prescription Using
RPE

The Problem Using HR in the Prescription of Exercise Intensity

Karvonen Formula:

-  **Heart Rate Reserve = Max HR - Resting HR**
-  **Standard Deviation for Max HR is ± 11 bpm**
-  **Assumes linear relation between %HR_{reserve} & %VO_{2max}**

Take Home Message

- ⊕ Never rely on heart rate alone.
- ⊕ Always measure perception of effort and heart rate.
- ⊕ Most of the time, RPE will be the best indicator of relative exercise intensity.

Extras – Background info

Psychophysical Methods

⊕ **Classical Psychophysics**

E.H. Weber & G.T. Fechner

⊕ **Modern Psychophysics**

S.S. Stevens

Classical Psychophysics

- ⊕ **Method of Limits**
- ⊕ **Method of Adjustment**
- ⊕ **Method of Constant Stimuli**

Method of Limits

- ⊕ A series of stimuli are presented across a range of intensities in ascending and descending orders.
- ⊕ Goal : to determine the absolute threshold for perception.

Method of Limits

- ⊕ **Stimulus threshold** - the intensity of the stimulus that is perceived as *just noticeable*.
- ⊕ **Terminal threshold** - the maximal intensity of the stimulus that is perceivable.

Method of Adjustment

⊕ After the presentation of a standard stimulus, a comparison stimulus is adjusted until it is perceived to be of the same magnitude as the standard stimulus.

Method of Constant Stimuli

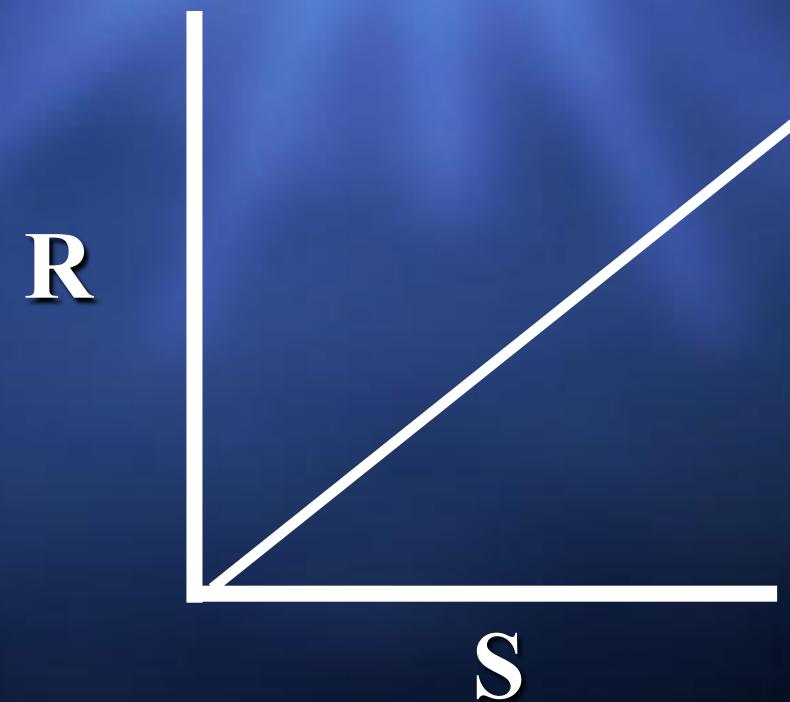
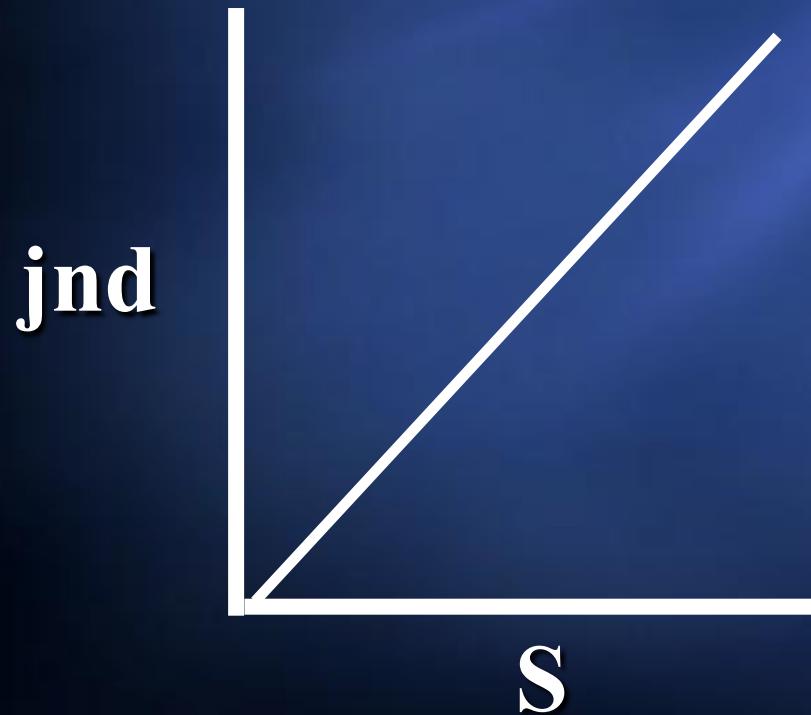
- ⊕ The task is to indicate: 1) if the comparison stimulus (CS) is perceived, and if so, 2) is different from the standard stimulus (SS).
- ⊕ The CS that is perceived to be different from the SS 50% of the time is referred to as the just noticeable difference (jnd).

Just Noticeable Difference

⊕ The *amount of change* in the intensity of the stimulus necessary for it to be subjectively perceived as just noticeably different.

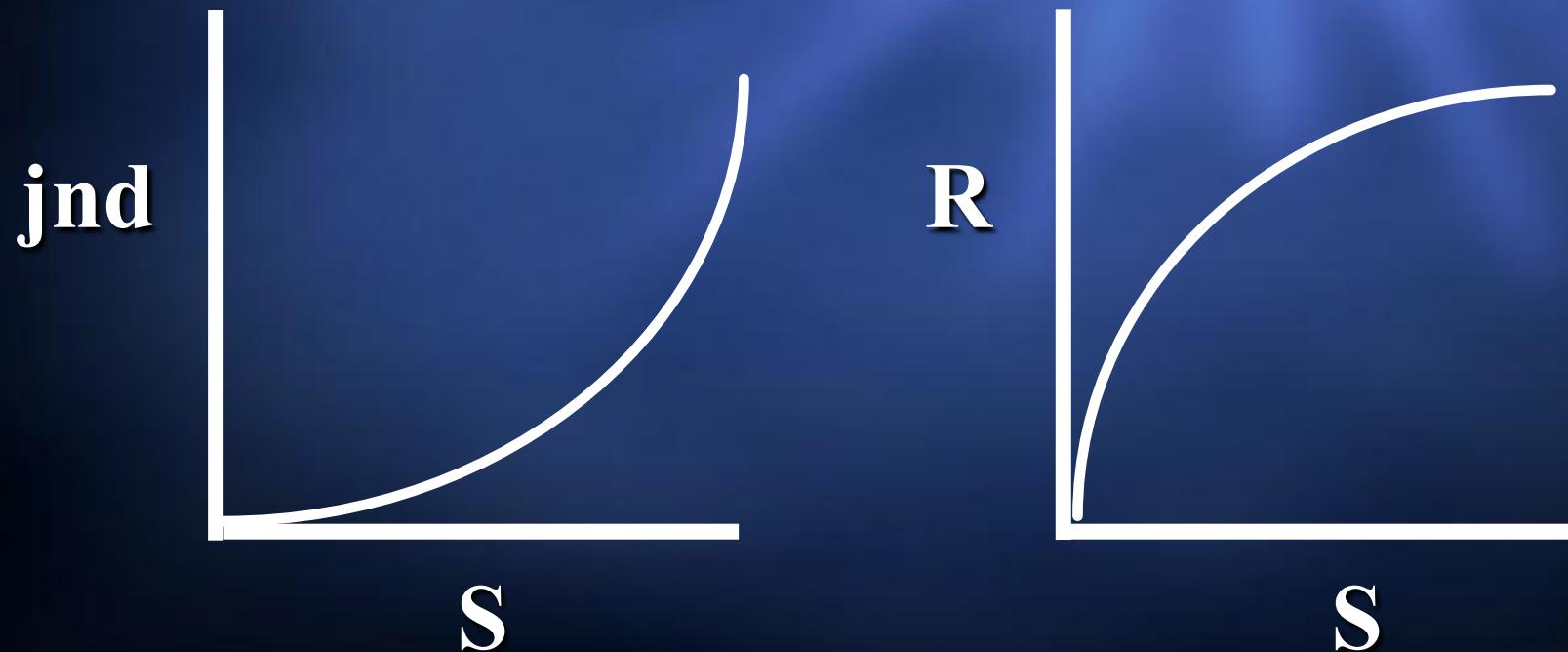
Weber's Law

$$jnd = k S$$



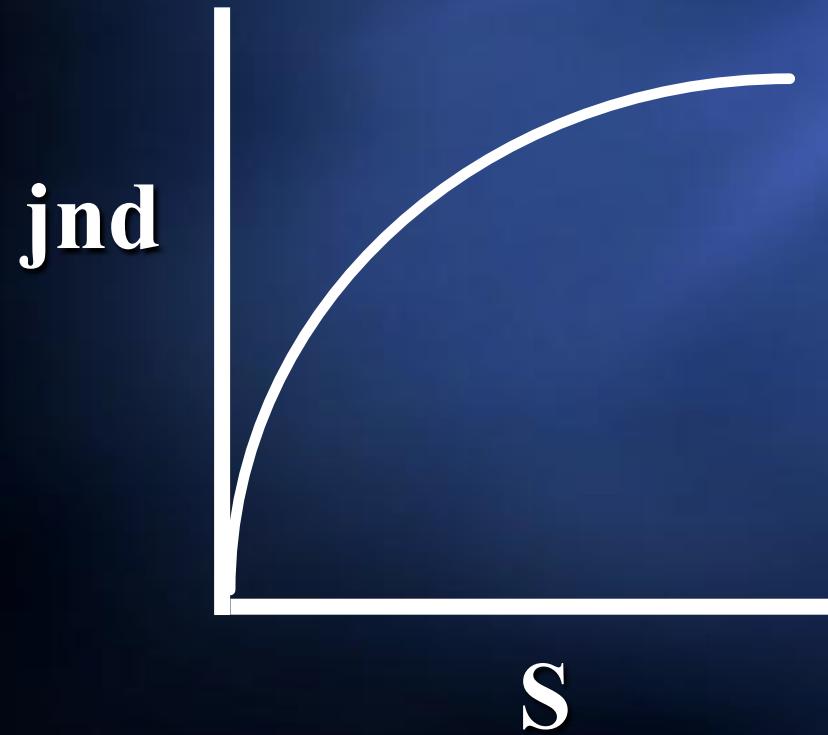
Weber-Fechner Law

$$jnd = k \log S$$

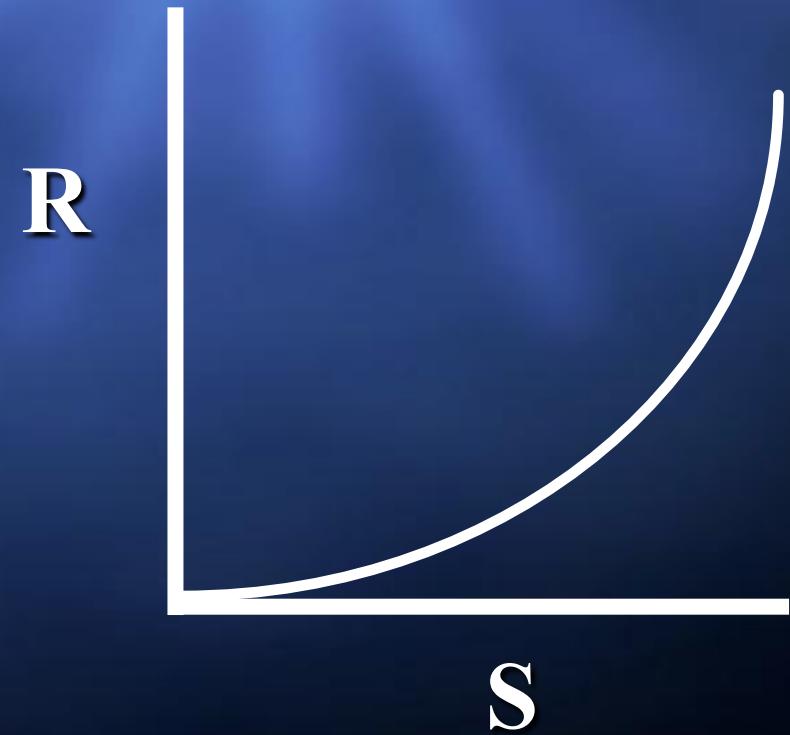


Stevens' Power Law

$$jnd = \log S$$



$$R = k S^n$$



Borg's Scales of Perceived Exertion

- ✓ 15-graded RPE Scale (6 - 20)
- ✓ CR-10 Scale
- ✗ Borg's 21-graded Scale (0 - 20)
- ✗ Univ. of Pittsburgh's 1 - 9 Scale