SE3910 – REAL TIME SYSTEMS

Response Time*

*Includes material from Dr. Larry Fennigkoh

OBJECTIVES

- Define Latency
- Construct a system diagram from a real world problem
- Experimentally determine the response time for a system
- Experimentally analyze the latency of various parts of a system.

Experimental Specimens

WHAT SEEMS WRONG WITH THIS WRITE-UP?

That's the minimum time the brain needs to register that your body's off-kilter and to do what it takes to avoid a tumble. "Anything less than 250 milliseconds—you're probably not going to catch yourself," says Daniel Ferris, a University of Michigan professor of kinesiology. In a recent study on balance, Ferris' team homed in on the left sensorimotor cortex, an area of the brain thought to be responsible for coordinating motion. When you realize you're falling, this region responds first, sending out the neural signals that set your body in motion to (ideally) restore stability—all within a quarter-second. Now that's what we call quick thinking.

250ms

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You have **250** milliseconds to catch a fall.

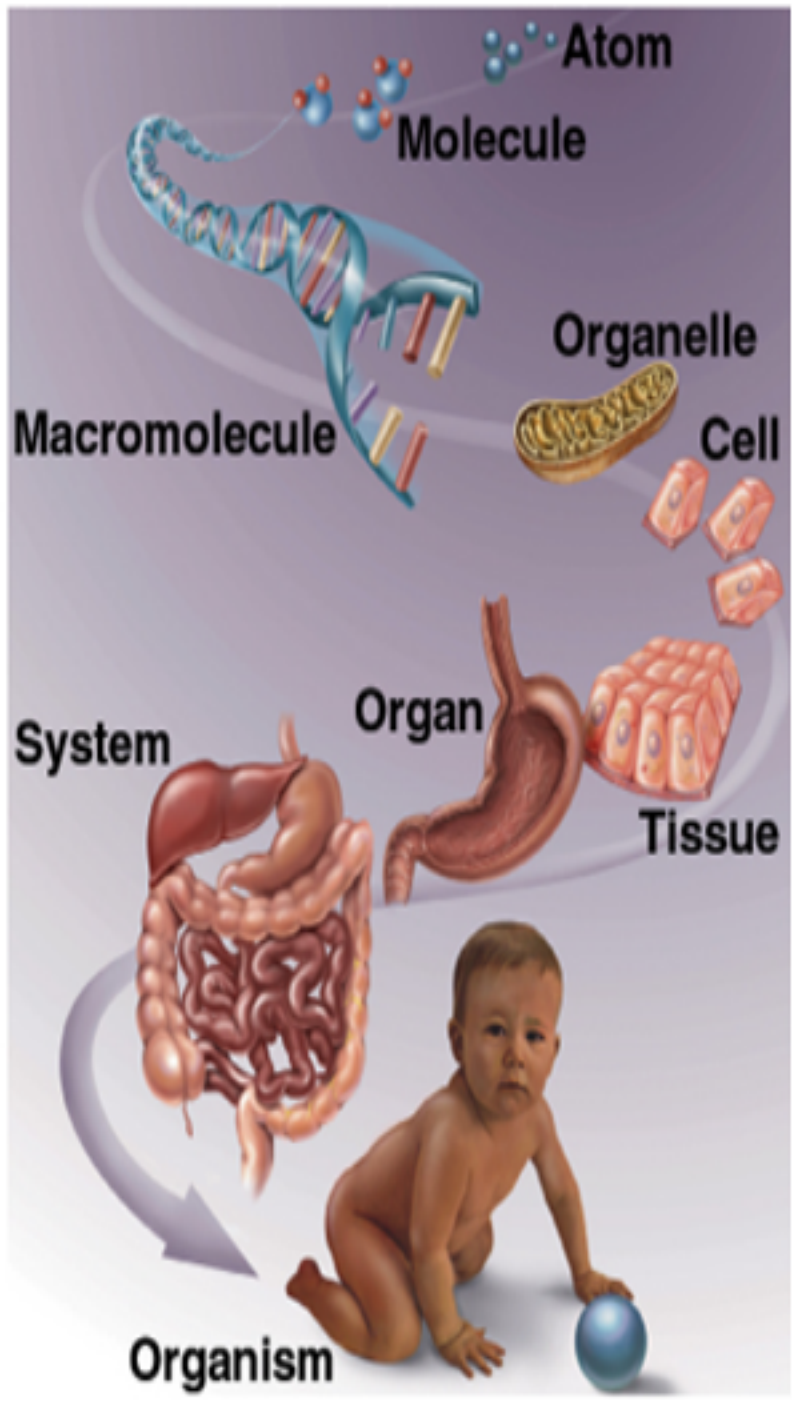
ACTIVE LEARNING EXERCISE

- Working with a partner, we are going to measure a person's response time

SPECIFIC INSTRUCTIONS

- Part 1
  - One partner should hold the stick while the other partner places their hands around the tape at the end of the stick. Hands should be approximately 1" from the stick.
  - At some point in the future, the partner drops the stick. Read the numbers off of the stick for response time and record them in the GoogleDoc.
  - Repeat the experiment 3 times
- Part 2
  - One partner should hold the stick while the other partner places their hands around the tape at the end of the stick. Hands should be approximately shoulder width apart.
  - At some point in the future, the partner drops the stick. Read the numbers off of the stick for response time and record them in the GoogleDoc.
  - Repeat the experiment 3 times
- Partners swap roles...

BUILDING A MODEL OF OUR SYSTEM



Adapted from K. Saladin, Anatomy & Physiology: The Unity of Form and Function, 3rd ed., McGraw-Hill, 2004, et al.

- Epithelial
- Connective
- Muscle
- Nervous

THE NERVOUS SYSTEM

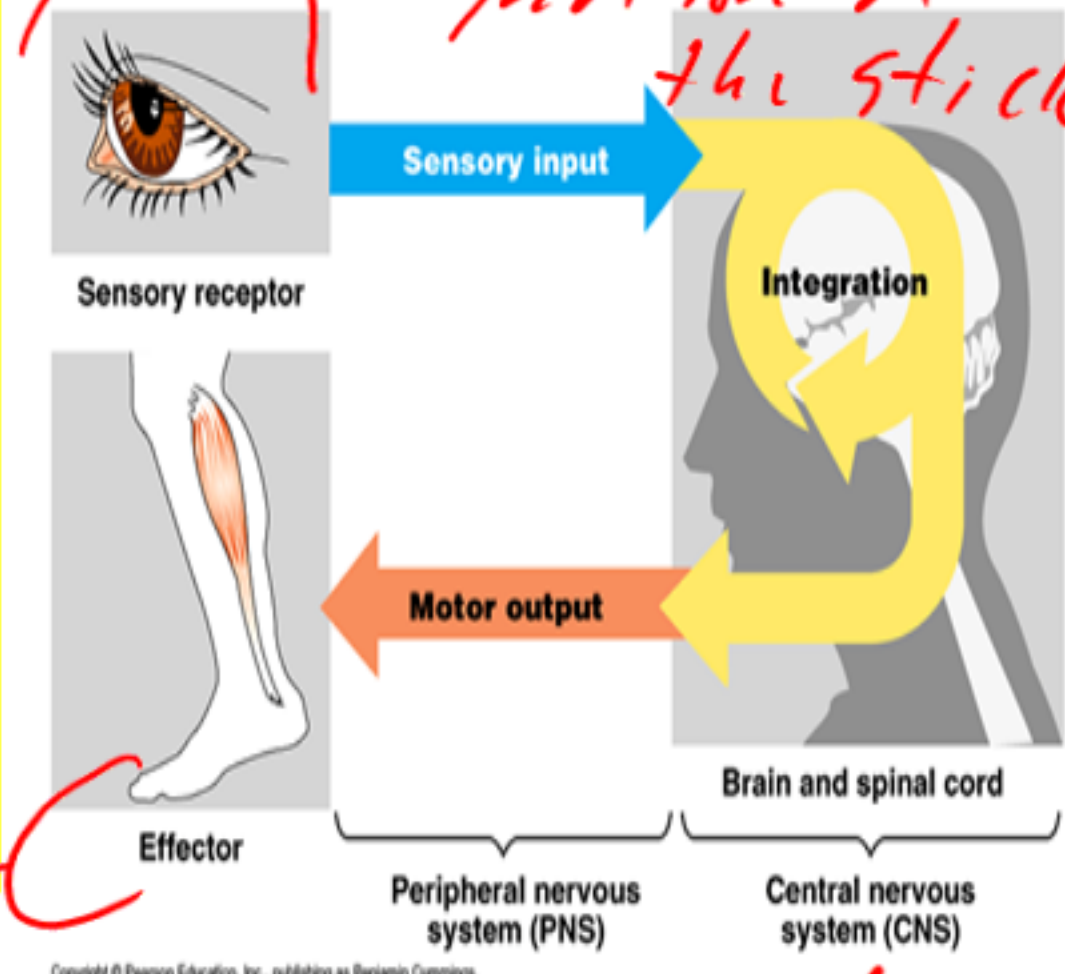
Basic Tasks of the Nervous System

Sensory Input: Monitor both external and internal environments.

Integration: Process the information and often integrate it with stored information.

Motor output: If necessary, signal effector organs to make an appropriate response.

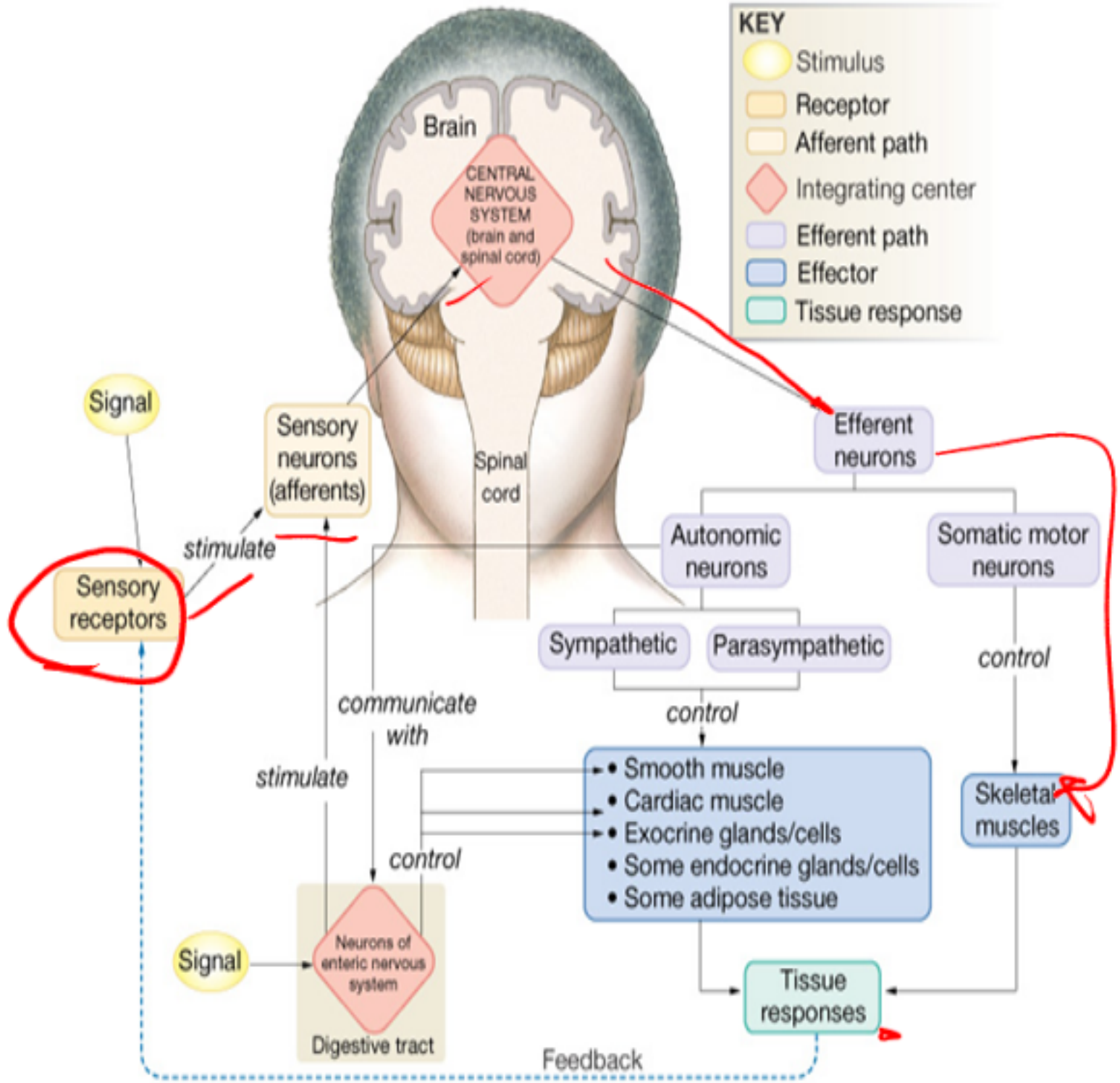
Eye detects motion of the stick.



Hand / shoulder muscles

MSOE UNIVERSITY

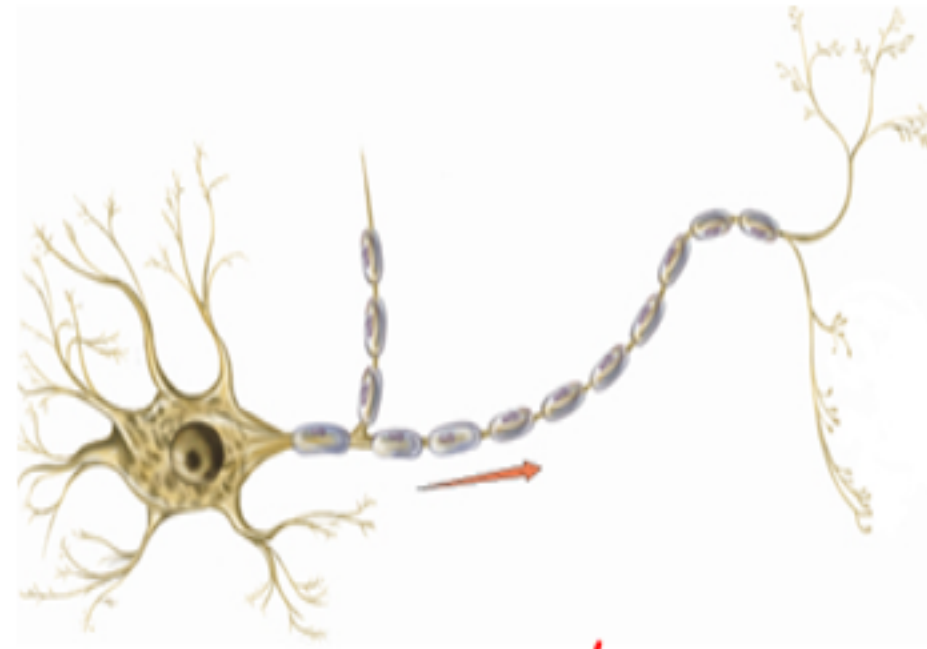
OUR NERVOUS SYSTEM



From D. Silverthorn, Human Physiology, 4th ed. 2007. Pearson Benjamin Cummings

SPEED OF NERVE SIGNAL

- Speed of signal transmission along nerve fibers
  - depends on diameter of fiber & presence of myelin
  - large fibers have more surface area for signals
- Speeds
  - small, unmyelinated fibers = 0.5 - 2.0 m/sec
  - small, myelinated fibers = 3 - 15.0 m/sec
  - large, myelinated fibers = up to 120 m/sec
- Functions
  - slow signals supply the stomach & dilate pupil
  - fast signals supply skeletal muscles & transport sensory signals for vision & balance



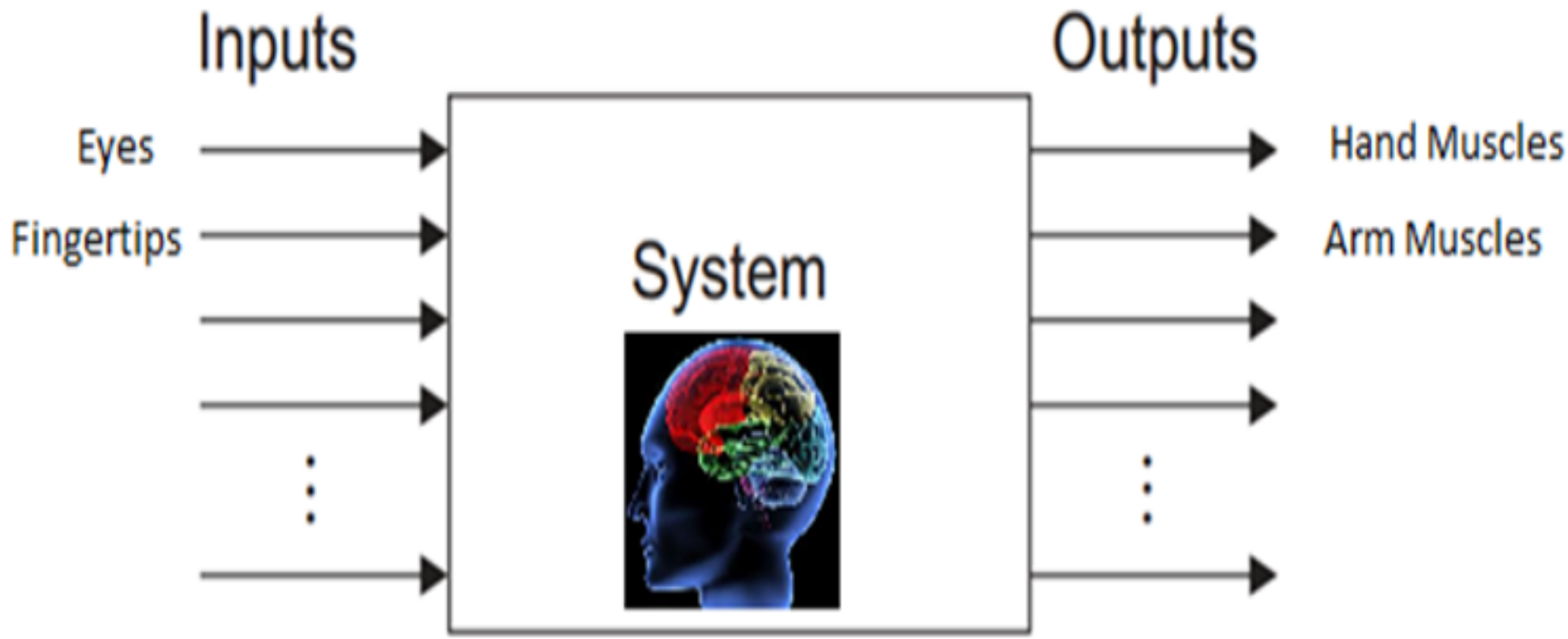
100 m/s → 10,000

OUR MODEL

- Delays
  - Distance from stick to eyes
    - Speed of light
  - Neuron distance between eyes and brain stem
    - .1 metre
  - Neuron distance between brain and hands
    - 1 metre
  - Time for hands to close
    - Hands can move up to 100 mph (44 metres per second)
  - Rest of time will be latency in the brain

DEFINITION: OUR SYSTEM

- A system is a mapping of a set of inputs into a set of outputs



- See if the data makes sense

Bulk of time spent processing.

- What response time can we guarantee with our system?
  - What is epsilon?

Response time

⇒ Average Time ± epsilon

Difficult in times