Reaction Time – Designing an Experiment to Measuring A "System" Response
(Based on Reaction Time Lab @ http://www.radford.edu/jkell/Reaction%20Times.pdf and @ http://www.biologycorner.com/worksheets/response_time.html)

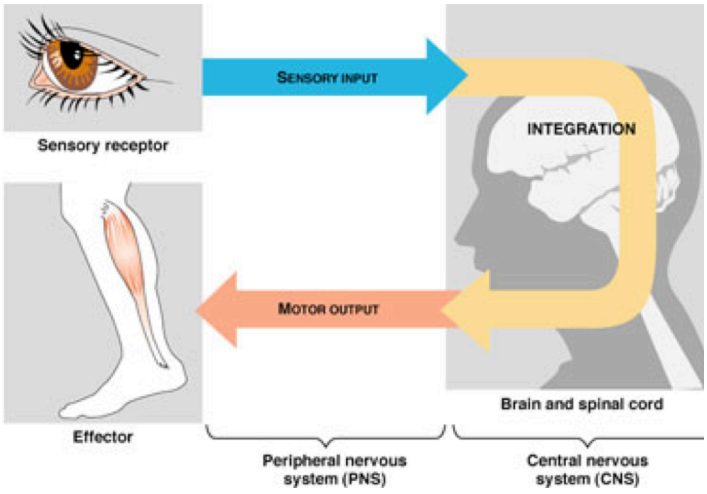
Introduction: "Reaction time is a measure of how quickly an organism can respond to a particular stimulus. Reaction time has been widely studied, as its practical implications may be of great consequence, e.g. a slower than normal reaction time while driving can have grave results. Many factors have been shown to affect reaction times, including age, gender, physical fitness, fatigue, distraction, alcohol, personality type, and whether the stimulus is auditory or visual.

The model for information flow within an organism can be represented in this way:

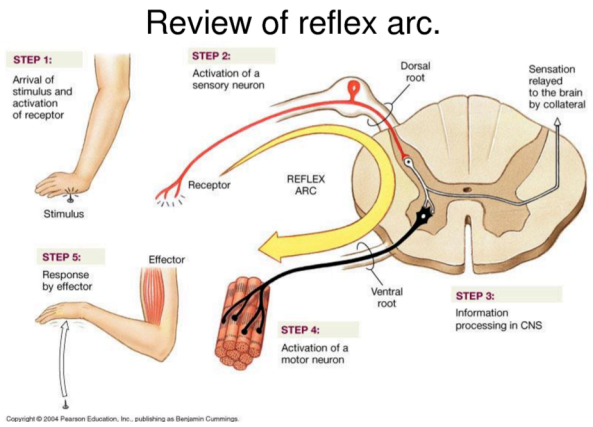
Stimulus→Receptor→Integrator→Effector→Response

More specifically, in vertebrates, information flow can be represented in this way:

Stimulus→Sensory Neuron→Spinal Cord or Brain
Motor Neuron Response



Sensory neurons convert a stimulus into an electro-chemical signal, which flows the length of the sensory neuron(s), then through a neuron or neurons of the central nervous system, and then through the length of the motor neuron(s). Generally, motor neurons will cause a muscle to contract or a gland to secrete a substance. Reactions that involve only the receptor, the spinal cord, and the effector, are faster than those which involve processing in the brain. Reactions which only travel to, through, and from the spinal cord are often called spinal reflexes or cord- mediated reflexes; withdrawing one's hand from a hot stove is an example of such a reflex.



Reaction Time and influences on reaction times can be measured in a number of ways. In 'simple reaction time' experiments, there is only one stimulus and one response. Catching a dropped stick, or hitting a button when a light changes are examples.

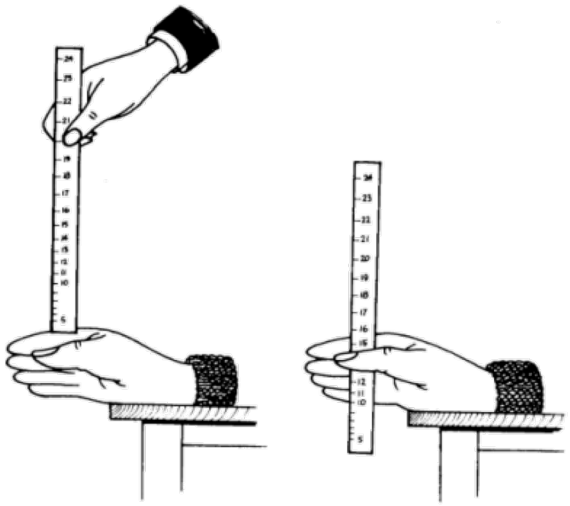
In 'recognition reaction time' experiments, there are symbols to respond to and symbols to be ignored. There is still only one correct stimulus and one response. An example would be catching a dropped stick with a word cue, while having to ignore other spoken words which are not cues.

In 'choice reaction time' experiments, there are multiple stimuli and multiple responses. The reaction must correspond to the correct stimulus. Typing a letter which matches a printed letter prompt is an example of this type of experiment." (Biology 104, Radford University: http://www.radford.edu/jkell/Reaction%20Times.pdf)

Measuring reaction time is an excellent opportunity to not only investigate the nervous system but also to practice science through experimentation and analysis. In this exercise you will first measure your reaction time as a baseline. Once you have measured your reaction time, then you and your partner will ask a "question" about your reaction time (such as, "How is reaction time affected by auditory stimuli-cues and distractions?," "Are there age differences in reaction time?," "How is reaction time affected by closing one eye?," "How does using your 'non-preferred'/'non-dominant' hand affect reaction time?" etc....) and design a protocol to test your question.

Reaction Time Methodologies

Ruler Catching Method



1. Subject should hold out the chosen hand and extend the thumb and index finger so they are 8 cm apart.
2. Accomplice hold a metric ruler with its end exactly even with the subject's extended thumb and index finger. The ruler should be vertical with lowest numbers near the subject's hand.
3. The ruler is dropped, and the subject grasps it between the thumb and index finger.
4. Record the number at the subject's fingertips, i.e. distance the ruler fell through the subject's fingers.
5. Calculate the time it took for the subject to react and catch the falling ruler. The time (t) it took for the ruler to fall can be calculated from the distance it fell.

$$t = \sqrt{d}/(490 \text{ cm/sec2})$$

[980 cm/sec2 is the acceleration of a falling mass on Earth. Since we know how fast an object falls, we can figure out how long it took to fall a measured distance.]

Some Online Reaction Time Resources:

Sheep Dash Game: http://www.bbc.co.uk/science/humanbody/sleep/sheep/reaction_version5.swf
Human Benchmark: http://www.humanbenchmark.com
Stoplight Reaction Time Test: http://getyourwebsitehere.com/jswb/rttest01.html
Dot Reaction Time Test: http://www.mathsisfun.com/games/reaction-time.html
"Healthy Sleep" Reaction Time Test: http://healthysleep.med.harvard.edu/railroad-sleep/read-your-signals/game-reaction-time
Multitask Reaction Time Test: http://open-site.org/blog/the-multitask-test/

"**BASELINE**" Reaction Time – Repeat the reaction time test at least 10 times and record your reaction times below. After 10 trials, calculate your average reaction time.

Dominant Hand:_____

Trial #	1	2	3	4	5	6	7	8	9	10	Average
Reaction Time											

"**EXPERIMENT**" – Now, what are you interested in knowing in relation to your reaction time? What question will you try and how will you do the experiment? Complete the information below and get it approved by your teacher before you begin.

QUESTION (check with your teacher before designing):

INDEPENDENT VARIABLE:

DEPENDENT VARIABLE:

ALTERNATIVE HYPOTHESIS:

NULL HYPOTHESIS:

EXPERIMENTAL DESIGN: (1. Identify the reaction time method you will use to measure reaction time. 2. Describe what you will do differently in these tests before? Or during reaction time testing that might have an effect? Be specific enough that anyone who reads the protocol would be able to "replicate" your procedure, e.g. how long will you place your hand in ice before running test? How will you add auditory signals? Will they be distractors? How will you have the subject "multitasking?" etc...)

DATA COLLECTION: Draw your data table in the space below. Run at least 10 trials of your experiment and calculate your averages.

DATA ANALYSIS (what statistical test(s) will you use to determine if the difference between your average "BASELINE" reaction time and your average "EXPERIMENTAL" reaction time is significant? Explain why this is an appropriate test to use.) Show your calculations below.

ANALYSIS & CONCLUSION

CER: Claim w/Evidence & Reason – Use your data above to make a claim that answers the question below.

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<tr><td colspan="2">Question:</td></tr>
<tr><td rowspan="8">Claim:</td><td>Evidence:</td></tr>
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Conclusion/Discussion Questions

1. Using YOUR experimental method explain the how your sensory, nervous and muscular systems worked together to perform the actions. Draw a diagram that shows the "stimulus," afferent pathway, the integration and the efferent pathway involved.

2. Describe how your "independent" variable might have "interacted" and/or "interfered" with the "pathway" that you drew and explained above to change your reaction time.

3. What are some possible problems in your experimental design or the manner in which it was carried out? How would these problems affect your results (are your reactions times overestimated or underestimated?)

4. How are reaction times involved in maintaining homeostasis?

5. Discuss how these results might inform your decisions about the environment in which you study? What you should be doing (or not doing) when you are operating a car? Etc...

6. Did your reaction times improve during the testing? Why to you think that is?

7. Do you think one's reaction time can be improved? What would need to be done to improve reaction time? What changes might be occurring in the pathway that improves the reaction time?

8. Do you think reaction time is more heavily influenced by genetics or the environment? Explain your answer.

Bibliography:

Kosinski, Robert J. 2005. A Literature Review of Reaction Time. Accessed March 17, 2005. <http://biae.clemson.edu/bpc/bp/Lab/110/reaction.htm#Arousal>

Marieb, Elaine N., Exercise 22 Human Reflex Physiology, Activity 9: Testing Reaction Time for Basic and Acquired Reflexes, pp. 232-233, *Human Anatomy and Physiology Laboratory Manual* (Cat Version), 2003,7th Ed.- Update, Benjamin Cummings, San Francisco, California.