Reaction Times

Objectives:
1. Formulate and test hypotheses regarding reaction times.

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.

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.

Methods:
There are many methods to test reaction times; several tests are discussed here. Three involve catching a dropped ruler; the other is computer based and involves moving and clicking a mouse in response to a particular stimulus. You will design an experiment using one of the methods or comparing two of the methods.

Ruler Catching Methods: One way we can test reaction time in lab is by measuring the time it takes to catch a ruler dropped by an accomplice.

Method 1 -- Simple Reaction Time
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.
5. Record the number at the subject's fingertips, i.e. distance the ruler fell through the subject's fingers.
6. 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. Distance (d) fallen can be converted to time (t) passed with the following formula:

$d \text{ (in cm)} = (1/2)(980 \text{ cm/sec}^2)t^2$

$t^2 = d/(490 \text{ cm/sec}^2)$

$t = \sqrt{d}/(490 \text{ cm/sec}^2)$

[980 cm/sec^2 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.]

Methods 2: Reaction Times with a Word Cue: This method will once again calculate reaction time by calculating the time it takes to catch a dropped ruler, but in this method a final word cue is given, as well, after other words are spoken that should be ignored.

1 and 2. Exactly the same as in Method 1.
3. Determine a particular word as a signal to catch the dropped ruler.
4. Use a variety of words before dropping the ruler; disregard ruler catches on wrong word.
5. Record the number at the subject's fingertips, i.e. distance the ruler fell through the subject's fingers,
6. Calculate reaction time in seconds as in #6 above.

Method 3 – Reaction Time with Word Association
1 and 2: Exactly the same as in Method 1 and 2.
3. Say a stimulus word as a signal to catch the dropped ruler. Do not predetermine the stimulus word. The subject will catch the ruler with any word as a cue. This time, however, the subject

must also respond with a word. Keep a record of catches that do no count because of the lack of a word association.
4. Subject responds with a word and catches the ruler while responding. If unable to make a word association, the catch does not count.
5. Record the number at the subject's fingertips, i.e. distance the ruler fell through the subject's fingers.
6. Calculate reaction time in seconds as before.

A computer-based test of reaction times appear below. Go to the web site and follow the instructions.

Method 4: This is a 'choice reaction time test' which tests how fast you can respond to the random appearance of dots in a grid over the course of 30 seconds. It's available at: http://mindbluff.com/reaction.htm

With these tests and the population of subjects you have available, ask some questions about reaction time you can test in your lab today.

Design an experiment to help answer one of your questions. You may discuss this within your group and as a class as a whole.

In your experimental plan, describe each of the aspects below. You can do this on a separate sheet of paper.

1. Justification for your questions: why is it interesting or what makes it applicable to a real problem ?
2. State the hypothesis you are testing.
3. What is your Independent variable (a.k.a. explanatory variable) ?
4. What is your dependent variable (a.k.a. response variable) ?
5. What type of data will you be collecting?
6. What type of statistical analysis will you use?
7. What type of graph will you use to present the results ?
8. How many replicates will you use?
9. What is the predicted outcome if your hypothesis is true ?
10. How will you control your independent variable?

Results:
Describe your data and descriptive statistics here. Any graphs can be included here as well. Describe anything that is particularly interesting or noteworthy about the data here, but do not make any interpretations or conclusions.

Conclusions:
Interpret your results here, and address the following questions.
Were you able to answer your question with the data you collected?
Does the data support or refute your hypothesis?

What are some possible problems in your experimental design or the manner in which it was carried out?
How much confidence do you have in your conclusions?
How well did you control your explanatory variable?
Are there other variables that might affect your independent variable that you were unable to control?

Discussion questions:
Do you think one's reaction time can be improved? Did your reaction times improve in the tests you performed?

Do you think reaction time is more heavily influenced by genetics or the environment?

How are reaction times involved in maintaining homeostasis?

Bibliography:

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