Introduction to Medical Science Laboratory Exercise 5

Reaction time measurements

I. Introduction

Elements of the nervous and muscular systems are anatomically and physiologically organized so as to provide for a proper response to a change in the body's relatively stable internal environment or a change in its external environment. The change that elicits a response is called a *stimulus*. The body's reaction to the stimulus may be that of an *involuntary reflex response*, or it may take the form of a *voluntary reaction*

A reflex is an involuntary or automatic, programmed response to a sensory stimulus. Reflexes allow the body to react automatically and involuntarily to a variety of internal and external stimuli so as to maintain homeostasis. For example, touching a hot object elicits an automatic withdrawal of the hand followed by a sensation of pain (Fig. 1). The reflex withdrawal requires no forethought or volition, and even occurs before the brain has been informed of the event.

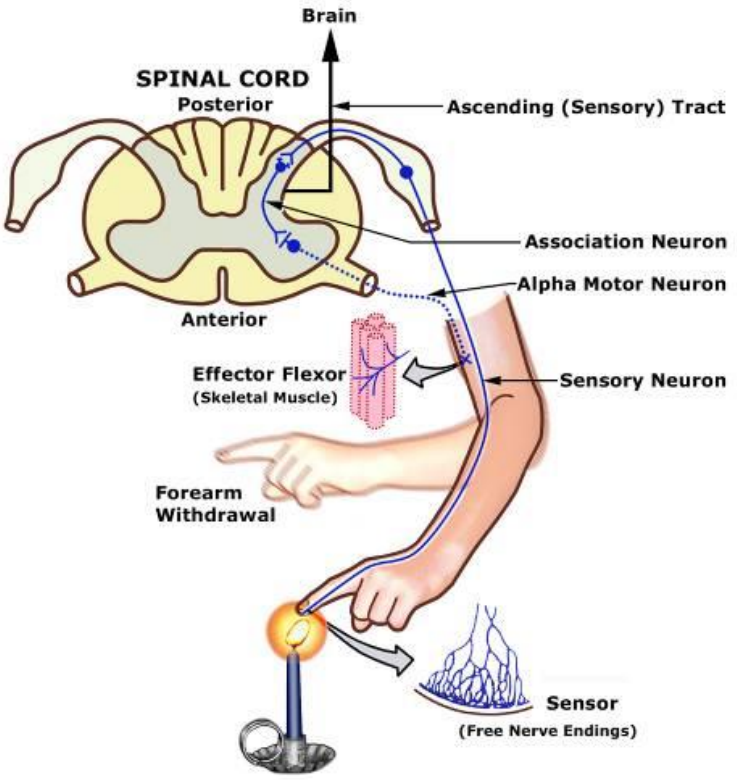

Fig. 1 Reaction reflex

On the other hand, the voluntary reaction is, by definition, a willful and therefore controllable response to a stimulus, often modified by learning and experience. A track athlete experienced in running 100 meter races may react faster to the sound of the starter's pistol than a relatively inexperienced competitor.

Both the reflex response and the voluntary reaction to a stimulus begin with the application of the stimulus to a receptor and end with a response by an effector. Anatomically, the neural pathways consist of the following essential elements common to both the involuntary reflex and the voluntary reaction:

1. ***Receptor****:* a specialized structure at the beginning of a sensory neuron that receives the stimulus.
2. ***Afferent neuron****:* the sensory neuron that relays sensory information from the receptor into the brain or spinal cord. Afferent neurons terminate within the central nervous system and synapse with association neurons and/or motor (efferent) neurons.
3. ***CNS (Central Nervous System) Center****:* a center in the brain or spinal cord where information is relayed across one or more synapses from the sensory neuron to the motor neuron.
4. ***Efferent neuron****:* the motor neuron that transmits information out of the brain or spinal cord to an effector.
5. ***Effector****:* smooth muscle cell, cardiac muscle cell, pacemaker system cell, secretory cell (in glands,) or skeletal muscle cell that provides the reflex or reaction response.

This exercise addresses reaction time in stimulus – response situations where the response is a voluntary reaction to a presented stimulus.

The interval between the stimulus delivery and the response to the stimulus is called the *latent period* or the *reaction time*. Reaction times for a given stimulus – response situation normally vary from person to person. The reaction time of one person repeatedly exposed to the same stimulus – response situation also may change, increasing or decreasing depending on circumstance.

Many factors affect, and thus determine reaction times. Although there may be slight differences from one person to another, once determined, many of these factors are normally stable and do not change with learning or repeated use. Such factors include mechanisms of receptor function and sensory neuron stimulation, the length and complexity of the reaction pathway, differences between sensory and motor nerve fiber conduction velocities, and so forth. Perhaps the most important of the variable factors affecting reaction time pertain to mechanisms of synaptic transmission. Synaptic transmission refers to the method by which a neuron, termed the presynaptic cell, communicates with or controls another neuron, the postsynaptic cell.

In this exercise, the subject's reaction time will be recorded in two types of situations: for regular intervals between presentation of the stimulus and for random intervals between stimuli. Statistical calculations will be used to compare the reaction times for groups of subjects in each of the four stimuli – response situations.

In order to compare the reaction times from the two types of presentation schedules, you can summarize the results as statistics or measures of a population. There are certain statistics that are usually reported for the results of a study: **mean**, **range**, **variance**, and **standard deviation**. Mean is a measure of central tendency. Range, variance and standard deviation are measures of distribution or the "spread" of data.

- The **mean** is the average or the sum of the reaction times divided by the number of subjects (n).
- The **range** of scores is the highest score minus the lowest score. The range is affected by extremely high and low reaction times, so investigators also describe the "spread" or distribution of times with two related statistics: variance and standard deviation.
- **Variance** is determined by calculating the average squared deviation of each number from its mean.
- **Standard deviation** is the square root of the variance.

Using the statistics of mean and distribution, investigators can compare the performance of groups.

PROCEDURE

1. Download 4 Matlab files from the webpage of this course.

2. Run MATLAB application.

3. Set the path so that it shows the foldr with downloaded Matlab scripts.

4. Run the script (Matlab file) by typing in the name of the *.m file to Command Window of Matlab programming environment and press Enter. Complete the instructions presented in the screen.

5. Write in Tables 2-3 the reaction times: (RT1 – red_green_times, red_green_times_reg, *srednia_zielony*, srednia_zielony_reg; RT2 – segmentX_times, *s1*-s4; RT3 – czas_rozp, *srednia_rozp*; RT4 – czas_wyb, *srednia_wyb*)

6. Perform measurements, calculations and analysis and fill in the report.

Laboratory Report

Group members names: ……..

Date: ……

Table 1 Participants characteristics

Patient	Age	Weight	Height	Gender
1				
2				
3				
4				
5				

1. **Mean reaction time in different tasks**

Table 2 Average reaction time (RT) depending on the type of stimuli and task type

Patient	Sound	Image		
	Average RT	Average RT	Average Recognition RT	Average Choice RT
1				
2				
3				
4				
5				

2. **Complete the table with reaction times in milliseconds using data from task RT2 (simple reaction time – sounds)**

Table 3 Comparison of reaction times

Stimuli No	Random intervals		Regular intervals	
	Segment 1	Segment 2	Segment 3	Segment 4
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Mean:				

3. **Comparison of reaction time depending on the number of stimuli. Complete Table 4 with data from Segments 1 and 3 and calculate means in order to check how the reaction time changes during the sensory-motor task.**

Table 4 Comparison of reaction times

Patient	Segment 1 (random intervals)			Segment 3 (regular intervals)		
	Stimulus 1	Stimulus 5	Stimulus 10	Stimulus 1	Stimulus 5	Stimulus 10
1						
2						
3						
4						
5						
Means:						

4. **Complete Tables 5-7 to calculate mean reaction time of the group in different segments, as well as standard deviation and variance for each person.**

Table 5 Group data summary

Patients means	Random intervals		Regular intervals	
	Segment 1	Segment 2	Segment 3	Segment 4
1				
2				
3				
4				
5				
Group means:				

Table 6 Random pattern of stimuli presentation – segment 2

Patient	Patient's mean	Group mean	Standard deviation	Variance
1				
2				
3				
4				
5				

Table 7 Regular pattern of stimuli presentation – segment 4

Patient	Patient's mean	Group mean	Standard deviation	Variance
1				
2				
3				
4				
5				

Control questions

1. On average, which stimuli (auditory or visual) require longer simple reaction time (Table 2)?

   ……

   ……

   ……

2. Which task is the most difficult, based on the mean reaction time (Table 2)?

   ……

   ……

   ……

3. What changes occurred in the mean reaction time between the 1st and the 10th stimulus?

   Segment 1:

   ……

   ……

   Segment 2:

   ……

   ……

   In which segment the difference in mean reaction time is the largest (underline)?

   Segment1/Segment 2

4. Estimate the reaction time after which there is no significant reduction of the reaction time. What physiological processes are can you describe that appear between presentation of the stimulus and pressing a key (Table 4 and 5)?

   ……

   ……

   ……

5. Which type of the stimuli presentation shows the shortest reaction time (Table 4)?

   Random / Regular

6. Which type of the stimuli presentation shows lower standard deviation and variance (Table 4 and 5)?

   Random / Regular

7. Show the dependence between the task difficulty level and the statistical data concerning the reaction time (Table 4 and 5).

   ……

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8. What are the differences in reaction times and the process of training would you predict for left and right hand?

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