Test of human reaction capacity (Item No.: P4070400)

Curricular Relevance

Area of Expertise: Biology

Education Level: University

Topic: Human Physiology

Subtopic: Other Senses

Experiment: Test of human reaction capacity

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	20 Minutes	1 Student

Additional Requirements:

Experiment Variations:

Keywords:

Reaction capacity, Strobe drum, Control loop, Feedback reaction, Dead time, Follow-through time, Threshold frequency

Overview

Principle

As in many technical processes, in the course of many biological functions the output values act back on the input values. With the many disturbing influences that affect biological systems, a feed-back reaction (control loop) of this type enables an equilibrium to be established (homeostatis). The components of a biological control loop (receptors, neurones, synapses, effectors) require a certain time for the transmission of a signal. This time between the onset of a disturbance (stimulus) and the reaction which it triggers is called the dead time. In this experiment the test subject follows a rectangular curve on a slowly rotating drum, using a felt-tip pen inserted into a slit. In a reaction test the dead time is determined.

Fig. 1: Experimental set-up

Equipment

Position No.	Material	Order No.	Quantity
1	Strobe drum	65976-00	1
2	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
3	Motor with disk holder	11614-00	1
4	Reaction test sheets, set of 20	65976-02	1
5	Support base, variable	02001-00	1
6	Plate holder	02062-00	1
7	Boss head	02043-00	2
8	Support rod, stainless steel, 500 mm	02032-00	2
9	Connecting cord, 32 A, 750 mm, red	07362-01	1
10	Connecting cord, 32 A, 750 mm, blue	07362-04	1
11	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1

Tasks

1. Measurement of dead time in a reaction test.
2. Analysis of the transient response.
3. Determination of threshold frequency for stimuli.
4. Study of the effects of noise and alcohol on reaction capacity.

Set-up and procedure

Set-up

- The strobe drum is fastened in one hole of the suppor tbase and the 500 mm support rods are inserted intothe base from the side (Fig. 1).
- The 250 mm rod is fastened in the other hole of the support base. The motor is clamped to this rod by means of a right-angle clamp so that the motor pulley is at the same height as the bottom of the drum.
- The drive belt is then attached and tightened. In order to keep the distance between the motor and the drum constant, the support rods inserted into the side of the support base, are securely fastened with the yellow levers.
- A plate holder is attached to one of the 500 mm rods with a right angle clamp (the adjusting screw of the plateholder faces inwards). The screen is attached so that the slit is exactly vertical and the screen does not touch the drive belt.
- A sheet of paper with rectangular curves (amplitude 3cm, 10 jumps/m) is attached to the outside of the drum with transparent adhesive tape.
- The motor is connected via the two connecting cords to the direct current output of the power supply. The voltage is first adjusted so that the drum rotates 3 times per minute (= 3 m/min = 5 cm/second).

Procedure

- The test subject should first follow the uppermost rectangular curve with a felt-tip pen through the slit for one complete rotation (10 jumps). The felt-tip pen should be pressed only gently on the paper so as to avoid slowing the drum down. After each jump of the curve, the test subject should try to reach the new position as quickly as possible even if this prolongs the transient phase.
- The drum speed is then increased stepwise (10 cm/s,15 cm/s, 20 cm/s) and a fresh rectangular curve is followed through one rotation at each step. The experiment is terminated when the speed becomes too high for the curves to be followed.
- The experiment can be repeated with the same test subject under different environmental conditions (e.g. noise) or after drinking alcohol.

Observations and results

Results

- As in many technical processes, in the course of many biological functions the output values act back on the input values. With the many disturbing influences that affect biological systems, a feed-back reaction (control loop) of this type enables an equilibrium to be established. The components of a biological control loop (receptors, neurones, synapses, effectors) require a certain time for the transmission of a signal. This time between the onset of a disturbance (stimulus) and the reaction which it triggers is called the dead time. Only after the expiry of the dead time does the system move more or less quickly out of its old equilibrium in the direction of the new equilibrium position. If this equilibrium position is still not reached when the next disturbance occurs, the system is no longer able to compensate for the action of this disturbance: the threshold frequency for disturbing effects is exceeded. In following the rectangular curves, a curve similar to that shown in Figure 2 is drawn.
- To calculate the dead time, the displacement (in cm) between the jumps on the curve and the places at which the curve drawn by the test subject moves up or down is measured. The displacement divided by the speed of the drum (in cm/s) gives the dead time in seconds.
- To calculate the follow-through time, the distance between the end of the dead time and the place a twhich the line drawn by the test subject is again a straight line is measured. Like the dead time, this distance is divided by the speed of the drum.
- The mean dead time is calculated from 10 individual measurements for each speed. This mean value represents the reaction time for the speed in question. Depending on the test subjects (frame of mind, alcohol consumption, age etc.) and on the experimental conditions (noise etc.) it varies from 0.1 to 0.5 seconds.
- The threshold frequency is given by the sum of reaction time and mean follow-through time. It is reached when this sum corresponds to the time interval between two successive jumps of the rectangular curve.
- The entire experiment can be divided into functional steps and by using terms from control engineering (disturbance, regulating unit, regulator etc.) it can be represented in a control loop diagram.

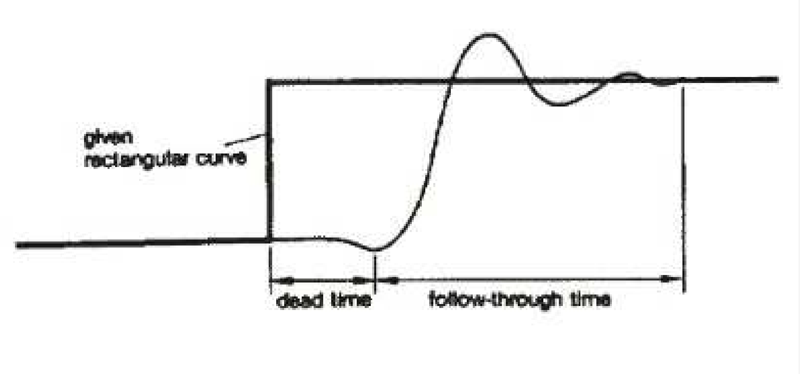

Fig. 2: Reaction curve