Reflexes
Reaction time
Outline

• basic principles of reflexes
  – reflex arc
  – types of reflexes
• clinical testing of reflexes
• Achilles reflexogram
• reaction time – basic principles
• testing reaction time
Reflex action

- reflex: is an involuntary response to a stimulus
- reflex actions are mediated via the reflex arc
- reflex arc: the neural pathway that mediates a reflex action; most sensory neurons do not pass directly into the brain, but synapse in the spinal cord, this allows quick reactions
Reflex arc
Types of reflexes

• regarding the number of neurons involved:
  – monosynaptic
  – polysynaptic

• regarding the mechanisms:
  – unconditional
  – conditional
Types of reflexes

• monosynaptic: the reflex arc consists of only two neurons (one sensory neuron, and one motor neuron; monosynaptic refers to the presence of a single chemical synapse)
  – peripheral muscle reflexes or deep tendon reflexes (patellar reflex, achilles reflex): brief stimulation of the muscle spindle results in contraction of the muscle
  – high conduction velocity, short latency, without extension (i.e. no irradiation, increase in stimulus intensity increases only the amplitude of the response)
Types of reflexes

- polysynaptic: one or more interneurons connect afferent (sensory) and efferent (motor) signals; all but the most simple reflexes are polysynaptic
  - longer response time, response proportional with the intensity of stimulus - Pfluger's laws
Pfluger's law of generalization (1)

- Law of localization: if stimulus is of low intensity it will only induce the contraction of local muscles
- Law of unilaterality: if a mild irritation is applied to one or more sensory nerves, the movement will take place usually on one side only, on the side which is irritated
- Law of symmetry: if the stimulation is sufficiently increased, motor reaction is manifested, not only on the irritated side, but also in similar muscles on the opposite side of the body.
Pfluger's law of generalization (2)

- Law of radiation: if the excitation continues to increase, it is propagated upward, and reactions take place through centrifugal nerves coming from the cord segments higher up.
- Law of generalization: when the irritation becomes very intense, it is propagated in the Medulla Oblongata, which becomes a focus from which stimuli radiate to all parts of the cord, causing a general contraction of all muscles of the body.
Types of reflexes

• regarding the number of neurons involved:
  – monosynaptic
  – polysynaptic

• regarding the mechanisms:
  – unconditioned
  – conditional
Types of reflexes

• unconditioned:
  – inborn (all individuals of a species possess them)
  – essential for survival
  – simple (blink, cough, sneeze) or complex (gulping reflex, defensive reflex).
Types of reflexes

- conditional (classical conditioning, Pavlovian or respondent conditioning, Pavlovian reinforcement):
  - a form of associative learning that was first demonstrated by Ivan Pavlov
  - classical conditioning involves presentations of a neutral stimulus along with a stimulus of some significance
    - the neutral stimulus (conditioned stimulus) could be any event that does not result in an overt behavioral response from the organism
    - presentation of the significant stimulus (unconditioned stimulus) necessarily evokes an innate, unconditional response
    - if the two are repeatedly paired, eventually the two stimuli become associated and the organism begins to produce a behavioral response to the neutral stimulus. This is called the conditioned response.
Examining reflexes in humans

- tendon reflexes
- cutaneous reflexes
- Achilles reflexogram
Tendon reflexes

- the sensory receptor that detects change in tension is the Golgi tendon organ which lies within the tendon
- tendons are tapped with reflex hammer
- a strong contraction indicates a 'brisk' reflex
- a weak or absent reflex is known as 'diminished'
Tendon reflexes – biceps reflex

- examines the function of the C5-C6 reflex arc
- tap the biceps brachii tendon using a tendon hammer
- the test activates the stretch receptors inside the biceps brachii muscle, which communicate mainly with the C5 spinal nerve and partially with the C6 spinal nerve to induce a reflex contraction of the biceps muscle and jerk of the forearm
Tendon reflexes – triceps reflex

- examines the function of the C6-C8 reflex arc
- tap the tendon with the reflex hammer while the forearm is hanging loose at a right angle to the arm
- a sudden contraction of the triceps muscle causes extension, and indicates a normal reflex
Tendon reflexes – patellar reflex

- examines the function of the L2-L4 reflex arc
- striking the patellar tendon with a tendon hammer just below the patella stretches the quadriceps muscle in the thigh
- this contraction, with the relaxation of the antagonistic flexor hamstring muscle causes the leg to kick (knee jerk)
Tendon reflexes – Achilles reflex

- examines the function of the L5-S1 reflex arc
- the Achilles tendon is tapped while the foot is dorsi-flexed
- a positive result is the jerking of the foot towards its plantar surface (ankle jerk)
Plantar reflex

- the lateral side of the sole of the foot is rubbed with a blunt instrument or device (not causing pain, discomfort or injury to the skin); the instrument is run from the heel along a curve to the toes (metatarsal pads)

- three responses possible:
  - Flexor: the toes curve inward and the foot everts; this is the response seen in healthy adults ("negative" Babinski)
  - Indifferent: there is no response
  - Extensor: the hallux dorsiflexes and the other toes fan out – the "positive Babinski's sign"; indicates damage to the CNS
Achilles reflexogram (reflex time)

- movement of the sole of the foot is produced by percussion of the Achilles tendon
- the reflexometer records a contraction-relaxation curve preceded by a small stimulus artifact
- the time between the stimulus and the point where the muscle is halfway relaxed is generally measured (tap to half-relaxation time)
- normal values:
  - age under 40 years: 260-340 msec
  - age over 40 years: 280-360 msec
Reflexes in frogs

• Observing the behaviour of the **live frog**
  – Extension reflex of the limb S: forced extension of limb, R: flexion of limb
  – Righting reflex S: positioning frog on its back, R: turning over to normal position
  – Clasping response (sexual behaviour of male frogs) S: stroke its belly gently with your wet finger, R: clasping your finger
  – Compass reflex S: rotating the vessel, R: it turns its head and trunk in the opposite direction
  – Cornean reflex – S: touching the cornea with a blunt object, R: blinking and retracting the bulb

• **Spinal (decerebrate) frog** – it does not feel any pain!
  – Wiping reflex (or scratch reflex) – S: filter paper wet with sulfuric acid placed on its skin, R: removing it
  – laws of Pflüger: contractions extending to the stimulus of increased intensity (higher concentrations of acetic acid)
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Reaction time

- reaction time: the time between the presentation of a sensory stimulus and the subsequent (behavioral) response
- RT is fastest when there is only one possible response (simple reaction time) and becomes slower as additional response options are added (choice reaction time)
- RT increases as the number of synapses increases
- simplest reaction to stimuli - reflexes
Reaction time depends on

• stimuli
  – faster RT as the stimulus intensity increases
  – faster RT to auditory stimuli when compared to visual, tactile

• conditions
  – training decreases reaction time
  – fatigue, disease, low temperature, high altitude, alcohol and some medicine (Diazepam, Phenobarbital) and drugs (cocaine) increase RT

• the individual
  – age: longer in children, decreases until age 20, stable through adulthood than increases in elderly
  – gender: faster in man
  – psychical factors: attention, emotions may influence reaction time
Reaction time testing

• visual
  – determine the RT to visual stimuli

• rulers
  – RT to visual stimulus
  – should be around 7-15 cm within your age group (<200 msec)

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t = \sqrt{\frac{2d}{g}}
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