Multi-Neurone Emotional Circuits

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1 What is a synaptic weight?

It's the strength of connection between two neurons.

If neuron A connects to B:

$A \rightarrow B$ (weight = w)

Weight decides:

- How strongly A influences B
- Whether B fires or stays quiet.
- The shape of the spike train in B

High weight (strong connection)
→ A's spike strongly boosts B
→ emotional amplification
→ stress-like behaviour

Low weight (weak connection)
→ B barely reacts
→ calm or suppressed emotional response

2. Excitatory vs Inhibitory Connections

Excitatory neuron
Makes the next neuron more likely to spike

$A \xrightarrow{(+)} B$

voltage in B goes UP

Inhibitory neuron
Makes the next neuron less likely to spike.

$A \xrightarrow{(-)} B$

voltage in B goes down.

Emotional meaning:

- Excitatory → fear, excitement, activation
- Inhibitory → calmness, regulation, suppression

3. Synaptic Delay

Spike from A reach B with a delay (like network latency):

A fires at $t = 10$ ms
B receives spike at $t = 12$ ms

This makes timing more realistic and affects emotional pattern

4. 2-Neuron Emotional Circuit

Example:

Stimulus → Amygdala Neuron (A) → PFC Neuron (B)

What happens?

- Strong stimulus → A spikes rapidly
- A's spikes drive B
- B tries to regulate → slowly, smoother spikes
- The interaction creates emotional pattern

5. 3-Neuron Emotional Circuit

Add a "memory / context" neuron (Hippocampus):

Stimulus → Amygdala (A) → PFC (B)
→ Hippocampus (C) →

- A reacts immediately
- C adds emotional context
- B integrates both signals → more realistic emotion

6. Emotional Behaviour Patterns

♡ Calm

- Weak input to A
- A fires slowly
- B fires slower
- Pattern stable, rhythmic

Stress

- Strong input to A
- A fires rapidly
- B tries to regulate → chaotic pattern
- Irregular ISI's

Fear

- Sudden burst in A
- Burst goes to B
- Strong emotional spike train

Excitement

- Steady mid strong input
- Rhythmic firing in A and B

Summary

- Synaptic weight = strength of connection
- Excitatory = increase voltage in next neuron
- Inhibitory = decreases voltage
- Delay = spike arrival timing
- Emotional circuit = 2-3 neurons interaction
- A → B creates emotional circuit
- Spike pattern differ for calm, fear, stress, excitement