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How Systems of Feedback Loops Regulate our Behavior – A Neuroscience Perspective

What Does It Take to Grab a Cupcake

flow.hamburg
PLAN SYSTEMS. MANAGE WORK. LEAD PEOPLE.

Acknowledgements

- LKU
  - Janice
  - Todd
- Patrick Steyaert
- University of Osnabrueck - Neurobiopsychology
  - Prof. Dr. Peter König
- Lotto24
  - Petra von Strombeck, CEO

About Me

- Cognitive Science, M.Sc.
  - Graduated exactly 10 years ago in Neuroscience and A.I.
- Professional experience
  - Sun Microsystems (OpenOffice.org) and later Oracle
  - Lotto24
- Started in 2013 with Kanban at portfolio level
- This is my 7th LeanKanban conference and my 7th retreat

flow.hamburg – The Geeky Kanban Couple

PLAN SYSTEMS. MANAGE WORK. LEAD PEOPLE.

Line of Thought

- Business environments are dynamic and complex
- Organizational survival is determined by its capability to move – Business Agility
- Organizations must have developed “brains” and feedback loops to coordinate their movement
- Dysfunctions of movement = dysfunctions of feedback
- Studying dysfunctions will help understand feedback loops and improve

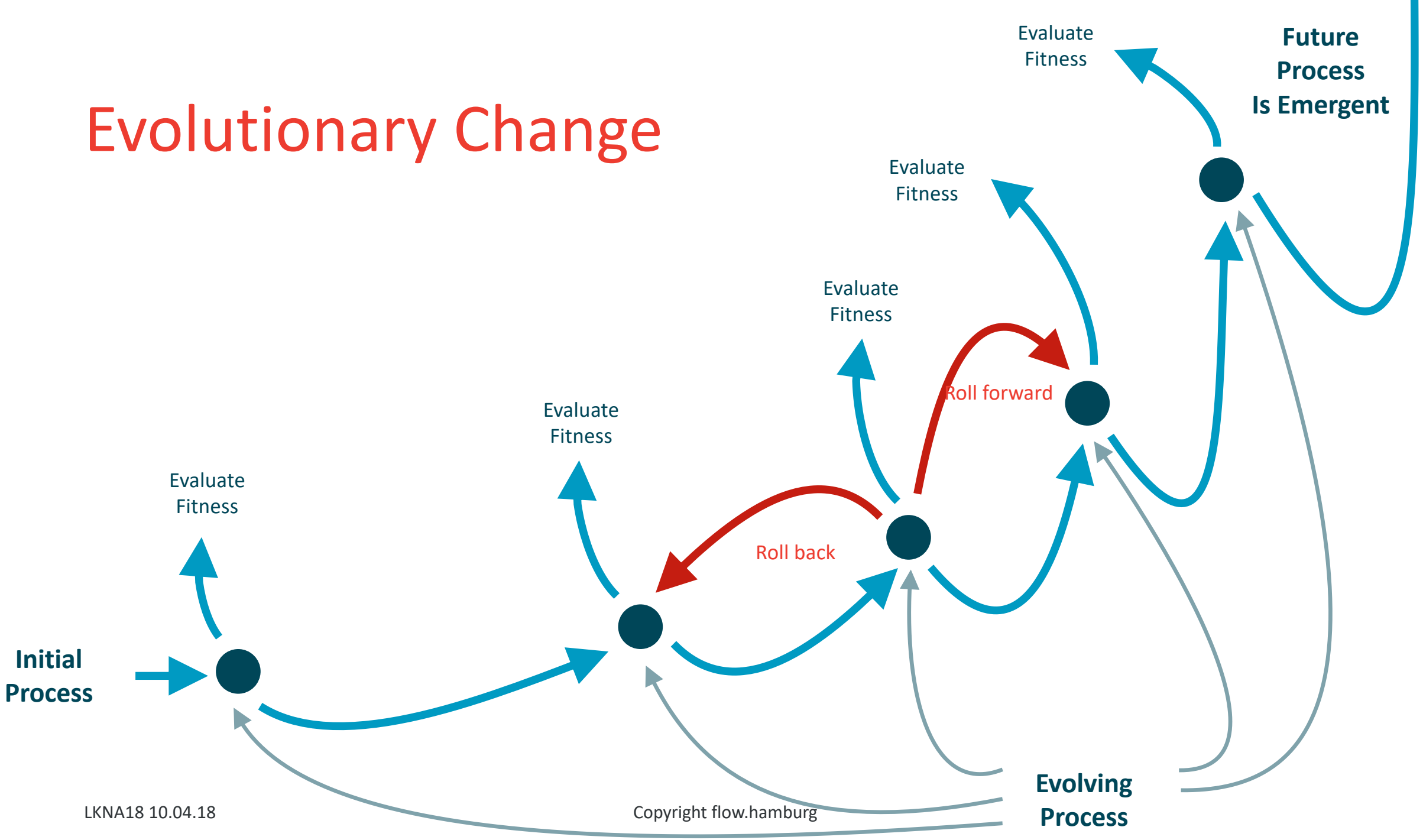
Why This Session?

Why am I standing here?

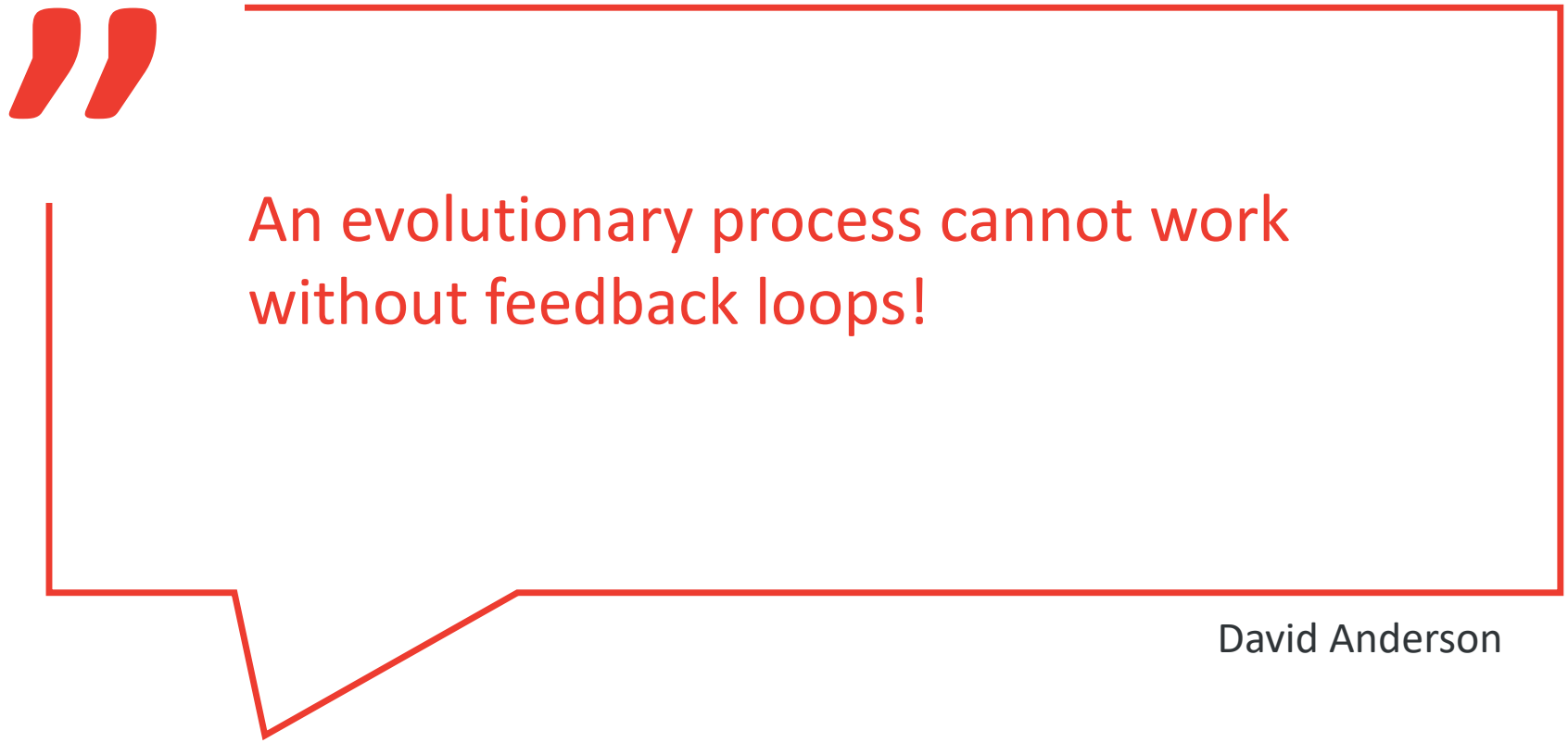
KANBAN

Successful Evolutionary Change for Your Tech[illegible]log[illegible] Business

Evolutionary Change



Feedback Loops



> An evolutionary process cannot work without feedback loops!

David Anderson

The Kanban Method

Foundational Principles

- Start with what you do now
- Agree to pursue improvement through evolutionary change
- Encourage acts of leadership at all levels
- Understand and focus on customer needs and expectations
- Manage the work and let people self-organize around it
- Evolve policies to improve outcomes

General Practices

- Visualize
- Limit W.I.P.
- Manage flow
- Make policies explicit
- Implement feedback loops
- Improve collaboratively, evolve experimentally

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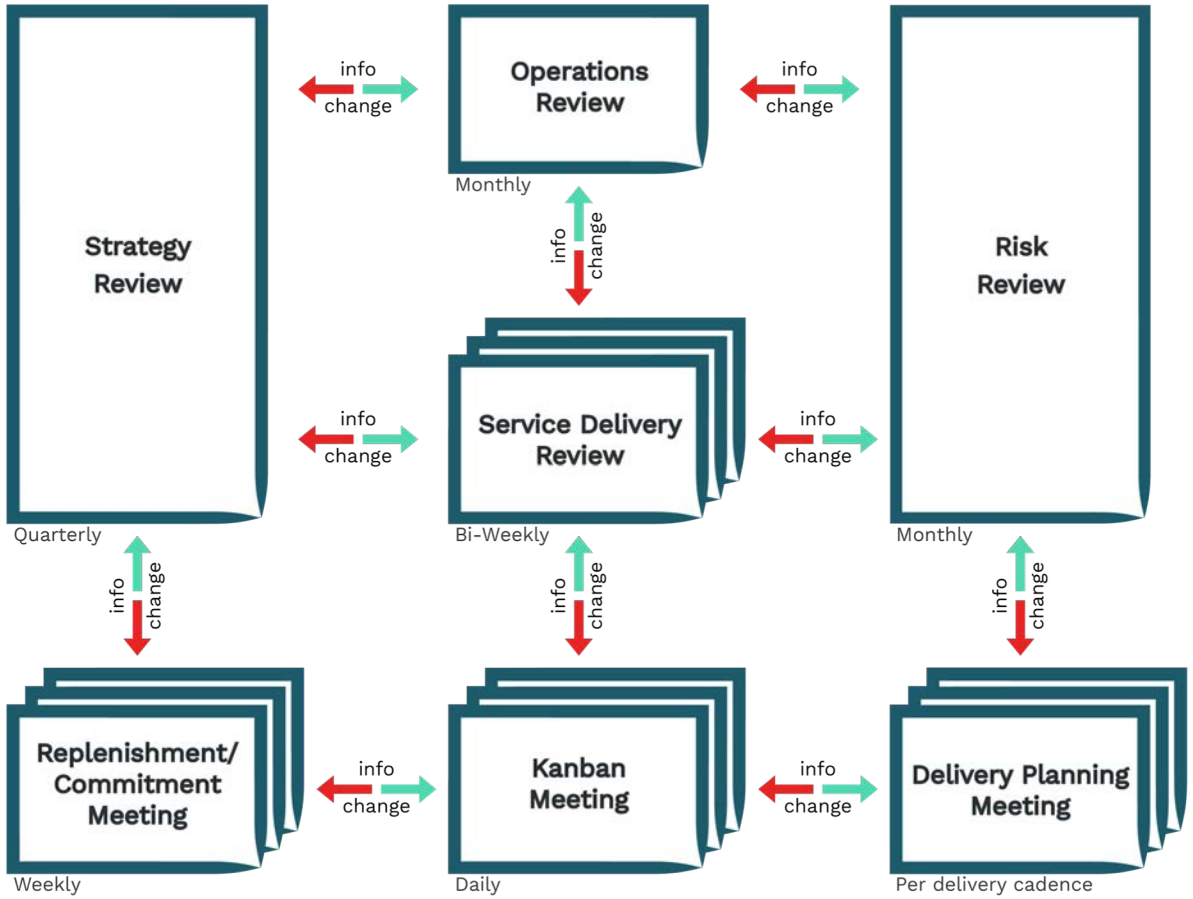
Kanban Cadences – An Element of Enterprise Services Planning (ESP)



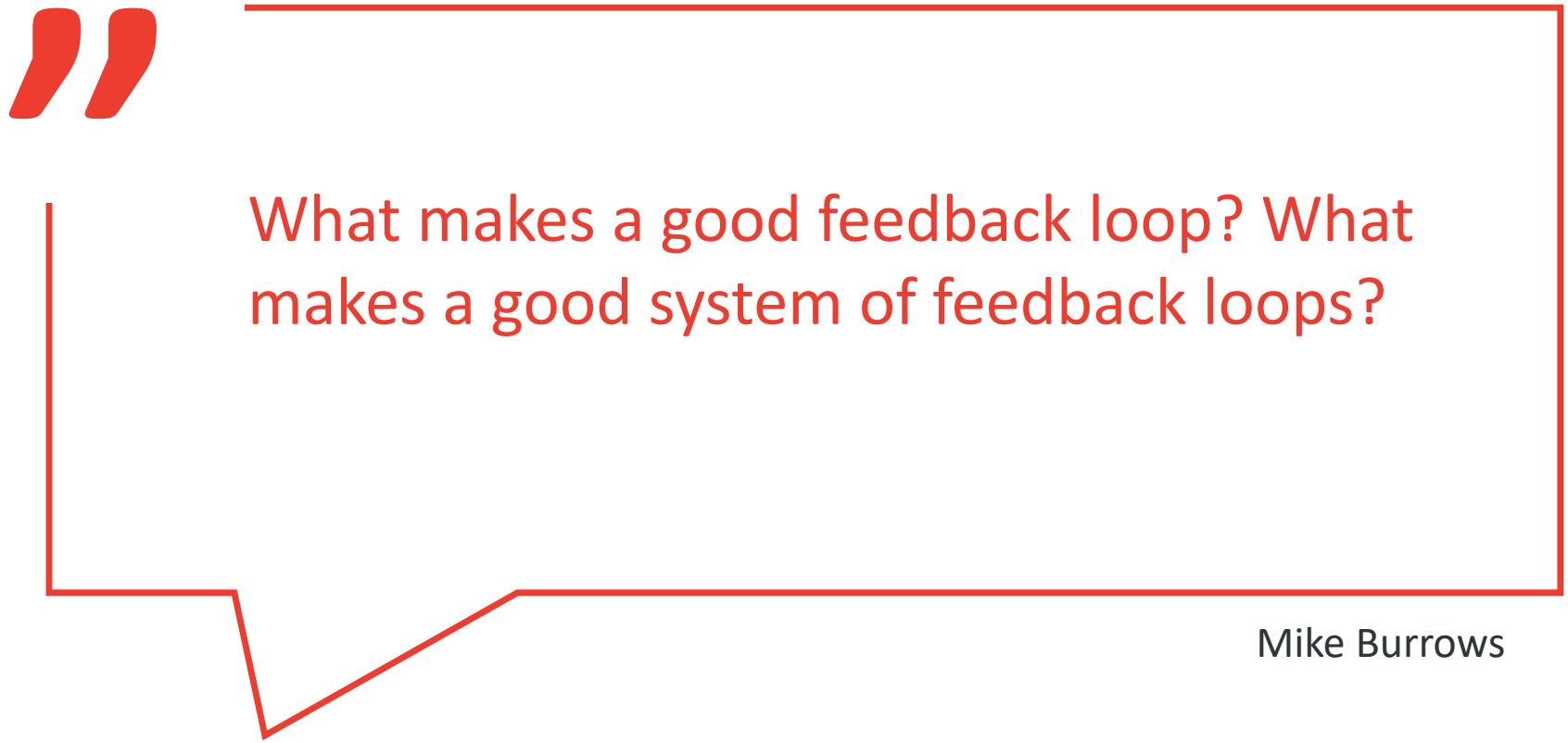
The Two Pillars of Kanban

- Evolutionary Change
- Feedback Loops

FUNDAMENTAL!

https://tinyurl.com/ydhncyyw

Motivation – KCP Alias

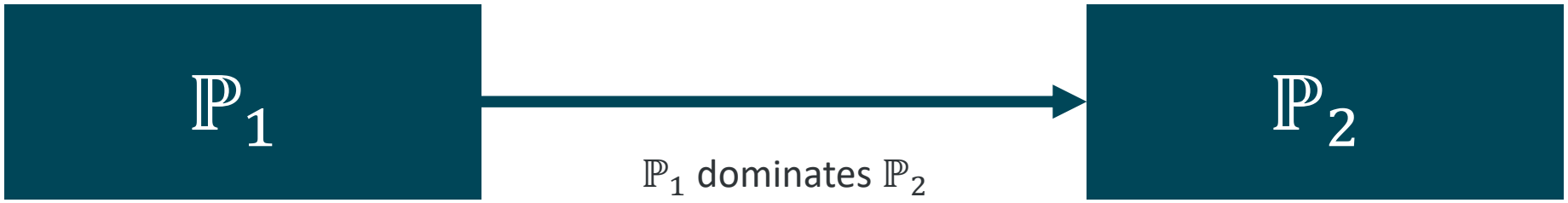


Feedback – The Basic Principles

https://tinyurl.com/ycyddf6r

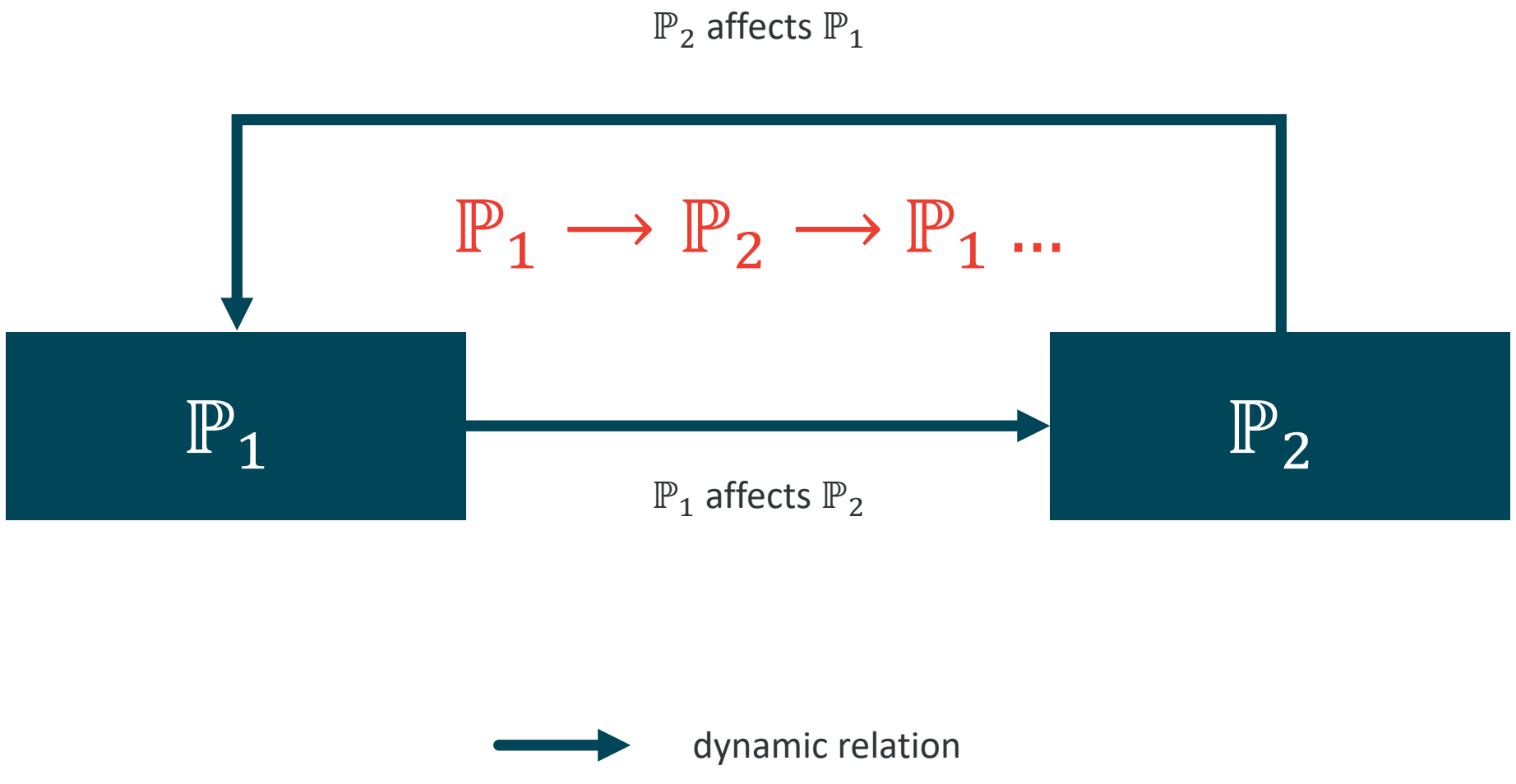
Coupling – Relation of two Parts

$$\mathbb{P}_1 \longrightarrow \mathbb{P}_2$$

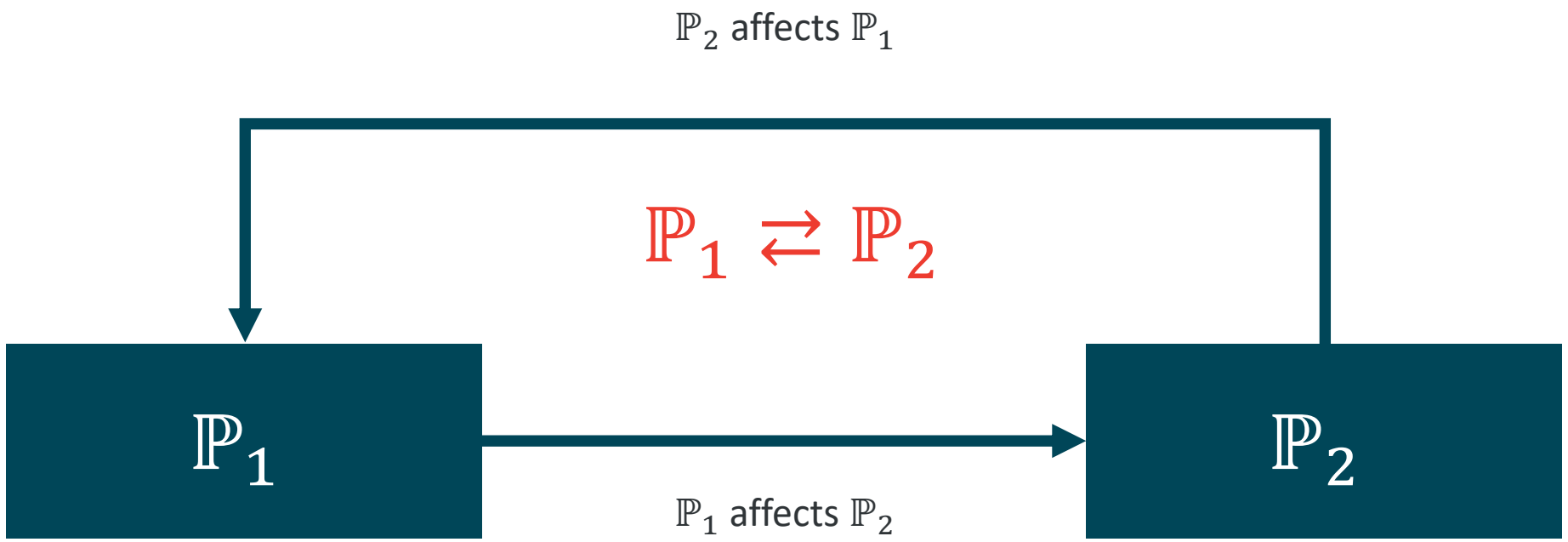


linear relation

Coupling – Relation of two Parts



Coupling – Relation of two Parts



dynamic relation

$$\mathbb{P}_1 \longrightarrow \mathbb{P}_2$$

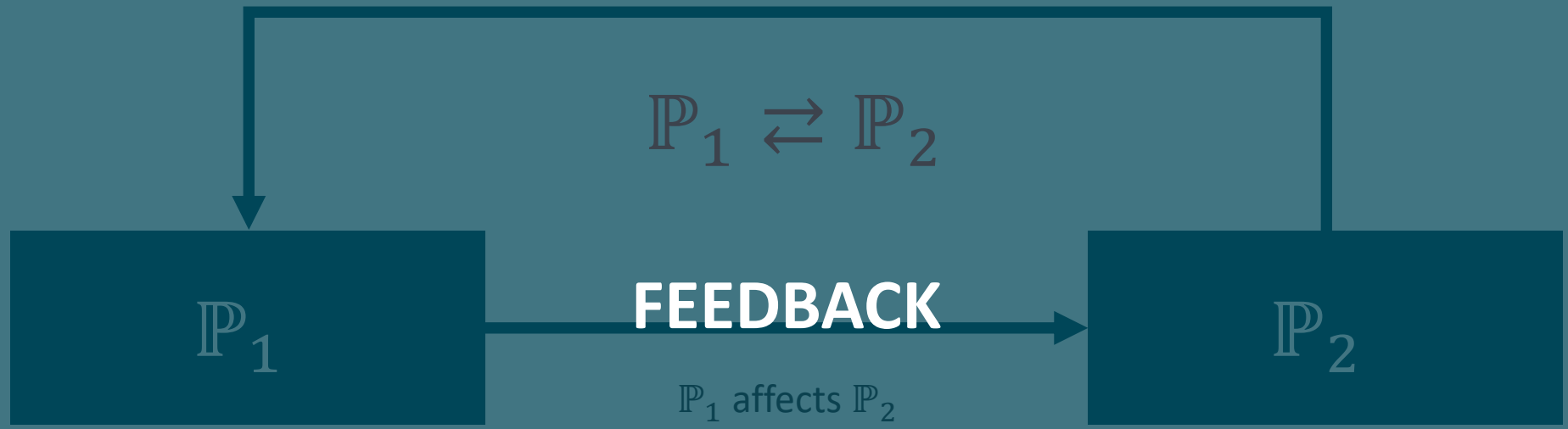
Open Loop System[1]

Linear Relation

$\mathbb{P}_2$ affects $\mathbb{P}_1$

$$\mathbb{P}_1 \rightleftarrows \mathbb{P}_2$$

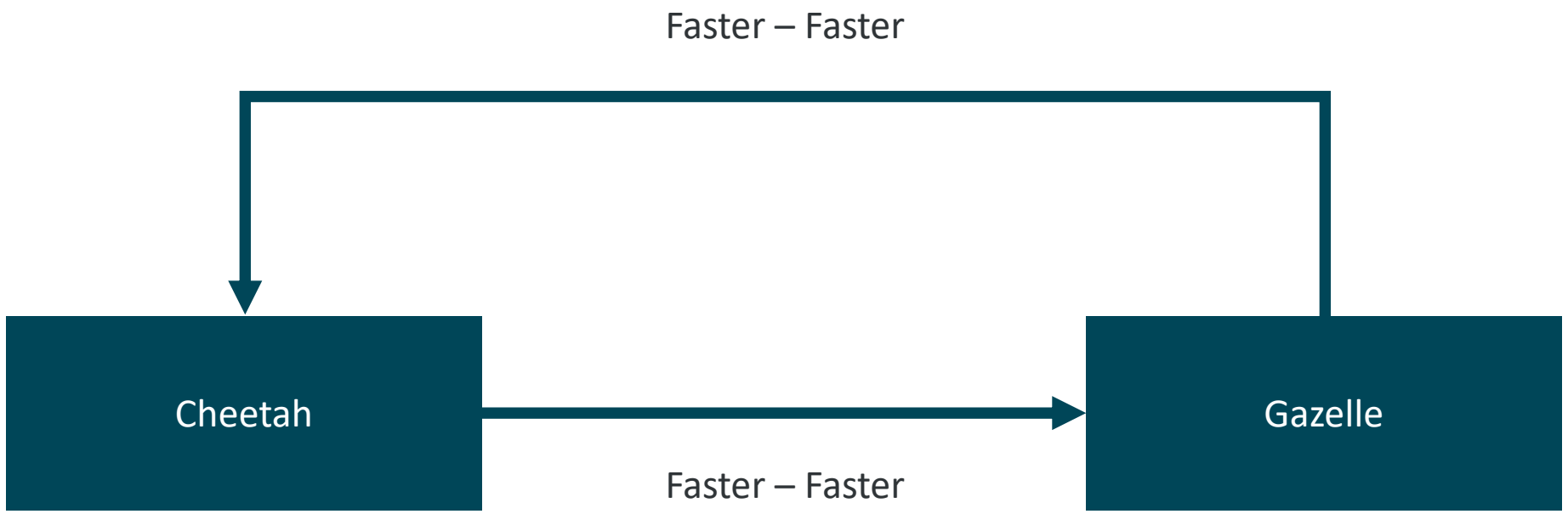
Closed Loop System[1]



Dynamic Relation

1. Don Reinertsen, Managing The Design Factory

Co – Evolution (Positive Loop)



Prey – Predator Population (Negative Loop)

Relationships (Negative Loop)

Does it really stabilize?

A Vicious Cycle (Positive Loop)

Two Types – Radically Different Effects

Positive Feedback Loops

- In signal = out signal **sign**
- Reinforce effects
- Produce instability
- Even catastrophe

Negative Feedback Loops

- In signal ≠ out signal **sign**
- Damping effects
- Produce stability
- Resistant to change

Feedback Loops Are Pervasive

Scale

- Nature
- Societies
- Economies
- Businesses
- Work Systems
- Individuals

Impact

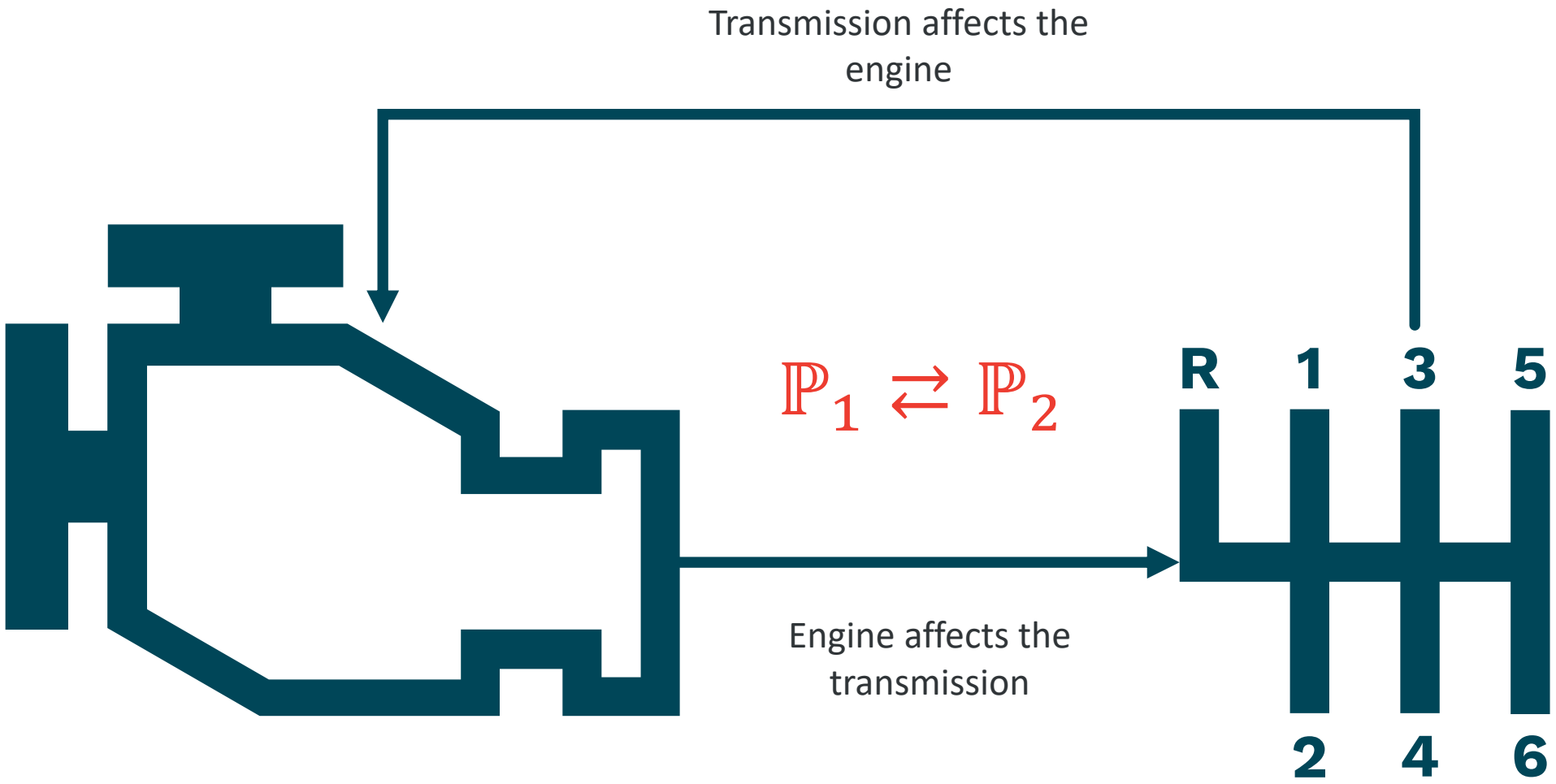
- Climate Change
- Conflict
- Black Friday
- Success or Failure
- Overburdening or Relief
- Learning or Diseases

How about Technology?

> … feedback in technology always works in the same, predictable way, until its – occasionally planned – failure.

Jürgen Beetz, Feedback, 2016

Technology vs. Biology



A Machine Changing its Internal Organization

> … what sort of a thermostat could, if assembled at random, rearrange its own parts to get itself stable for temperature?

Design For A Brain, W. Ross Ashby, 1954

What Does It Take To Grab a Cupcake?

A Brain and Feedback Loops!

https://tinyurl.com/y7oaafzj

The See Squirt

- Starts off as an egg
- Develops into tadpole like creature
- Spinal cord, simple eye, tail
- Simple brain for control

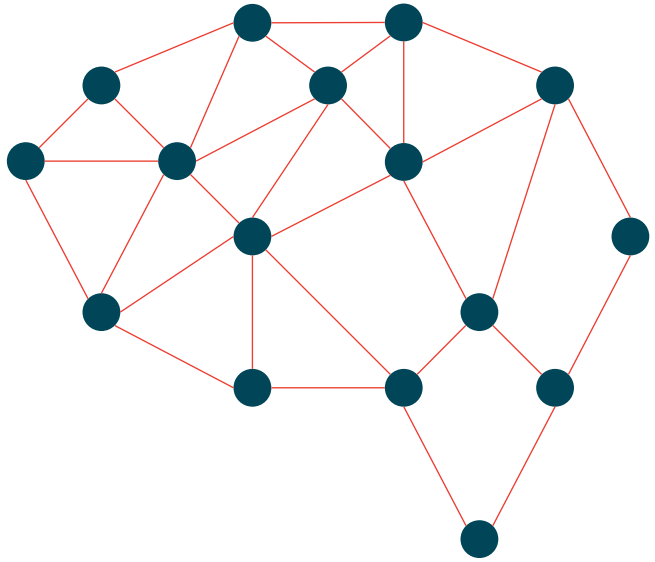
https://tinyurl.com/y88w9l9c

Looses brain when stops moving

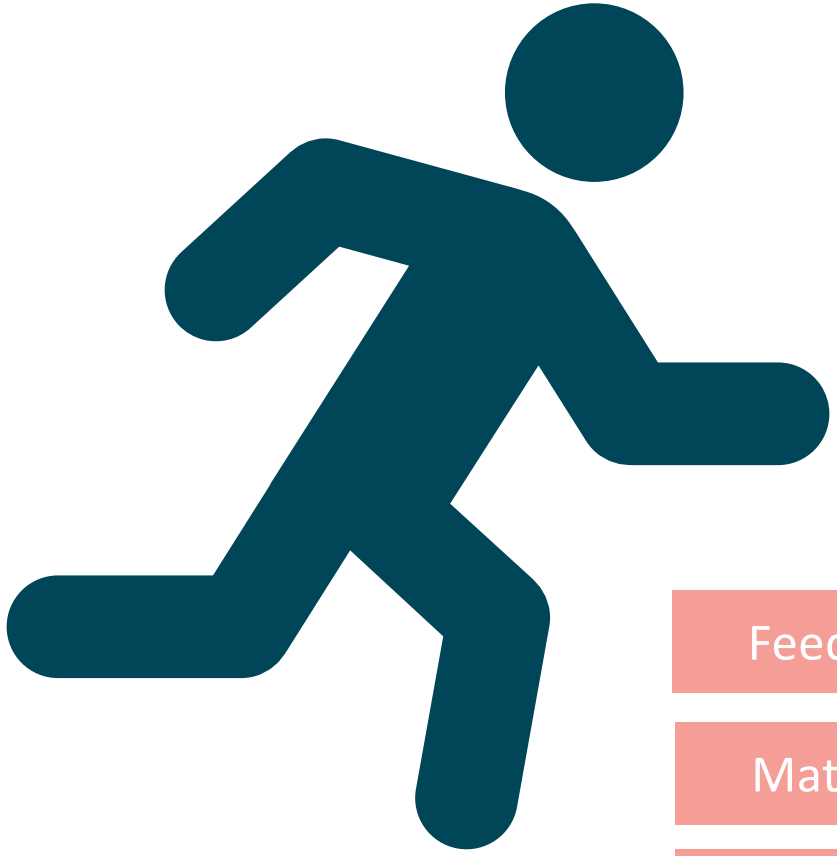
- Starts off as an egg
- Develops into tadpole like creature
- Spinal cord, simple eye, tail
- Simple brain for control

https://tinyurl.com/y88w9l9c

300.000.000 years of evolution



made for



- Feed
- Mate
- Fight or Flight

Requirements for Motion

- A movement apparatus
- Supporting systems
- Processing of external signals
- Processing of internal signals
- Coordination

Some Facts About The Human Brain

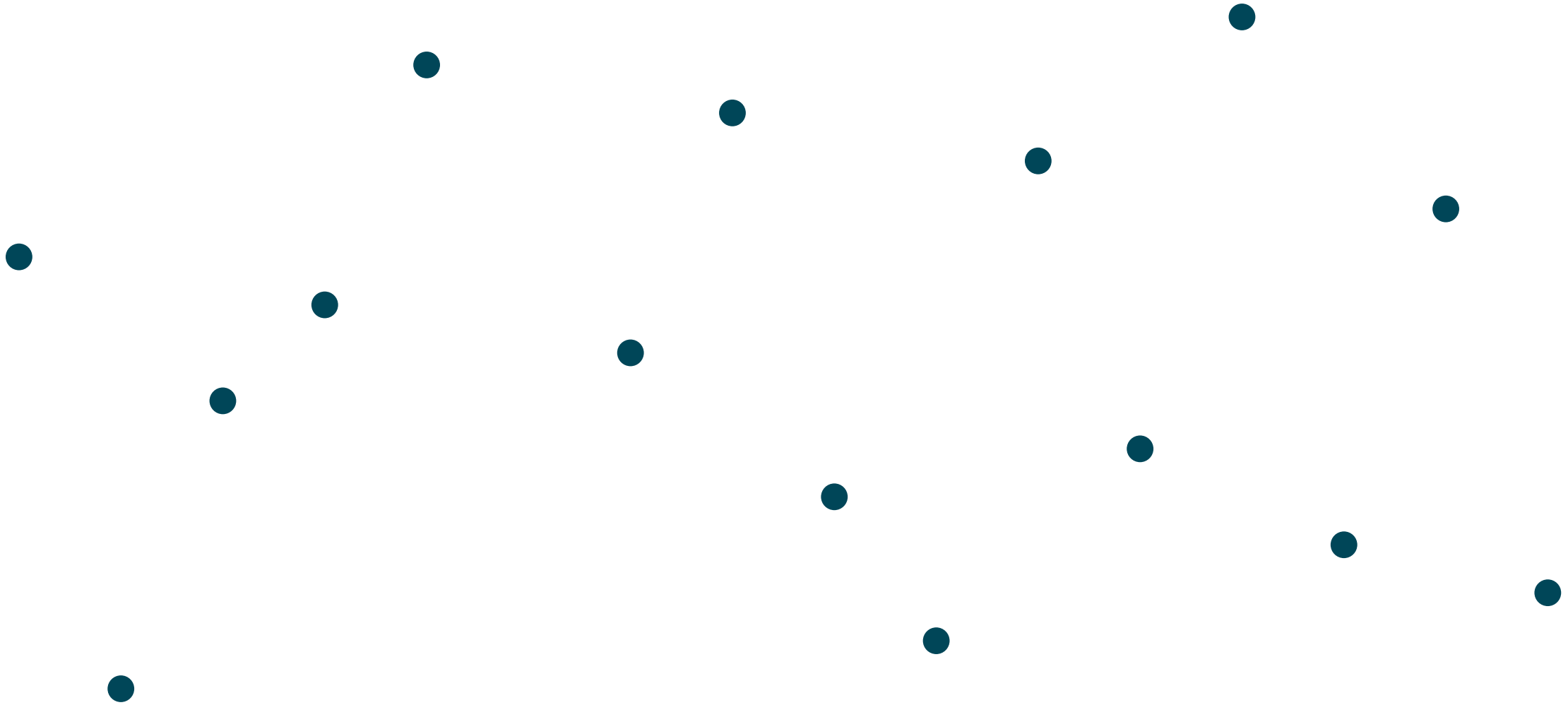
- About three pounds
- A trillion of neurons – 10^{12}
- Up to a 10.000 synaptic connections with other neurons
- A quintillion number of synapses – 10^{15}
- Potential number of all connection higher than the number of all atoms in the universe
- **More than a universe in three pounds**

Systems Thinking

> More is different!

Jürgen Beetz, Feedback, 2016

From Parts To Systems – From Simple To Complex



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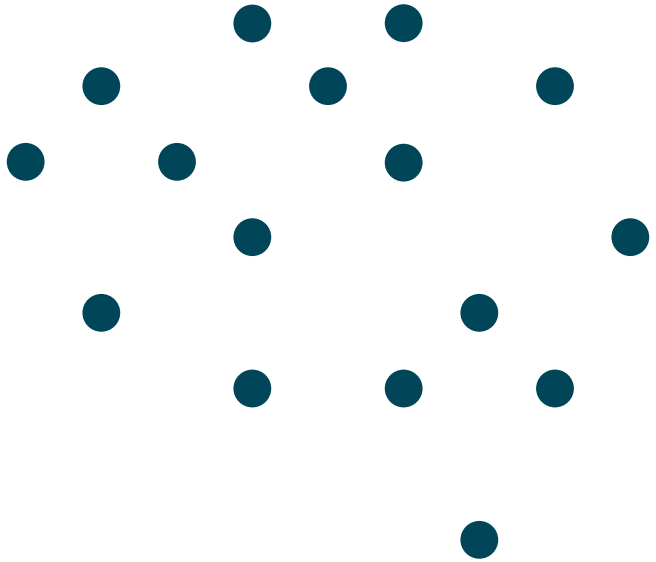

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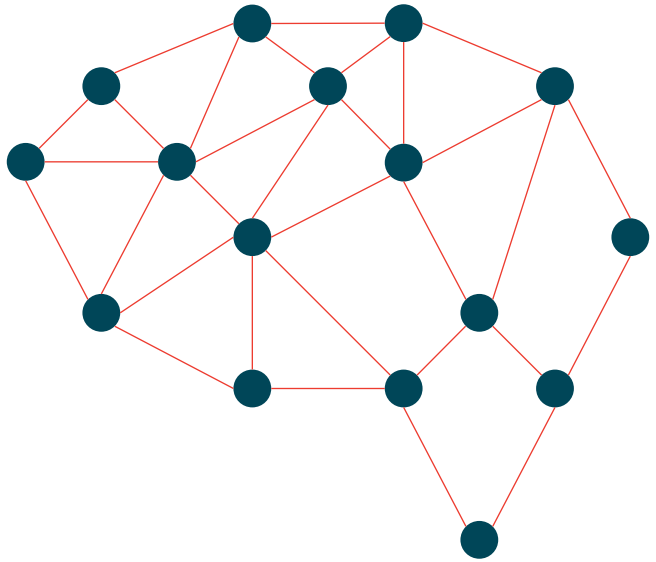
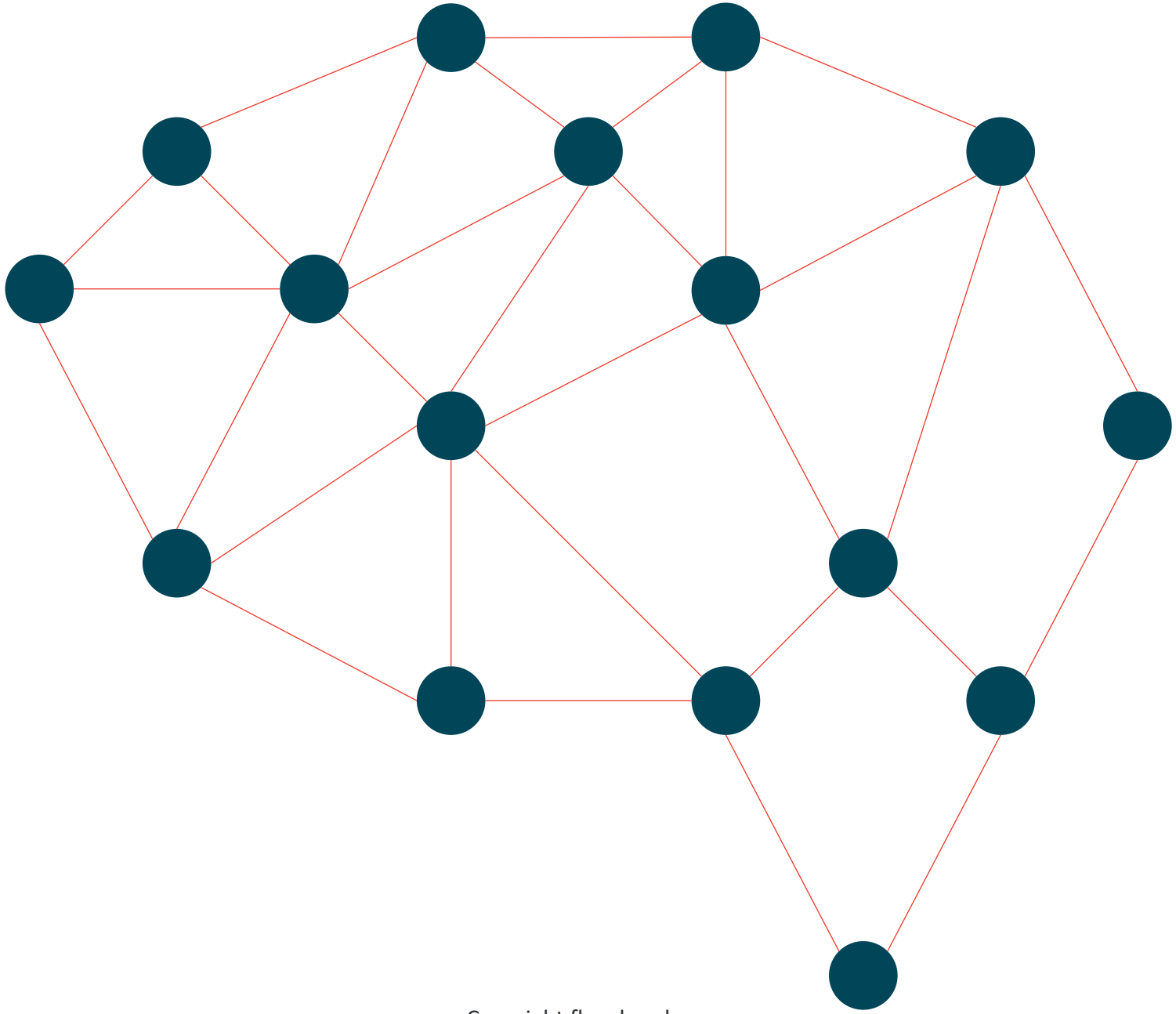
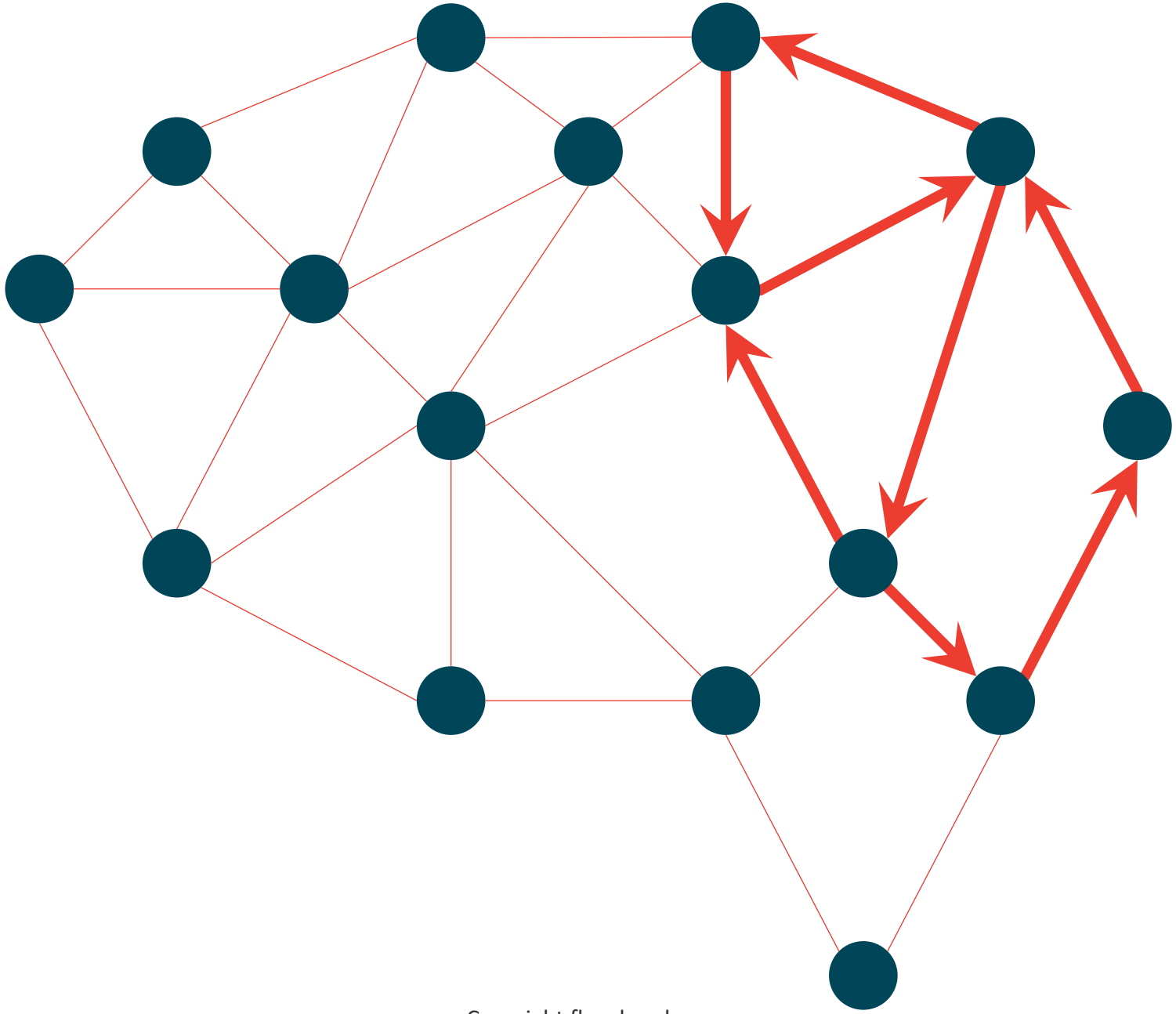
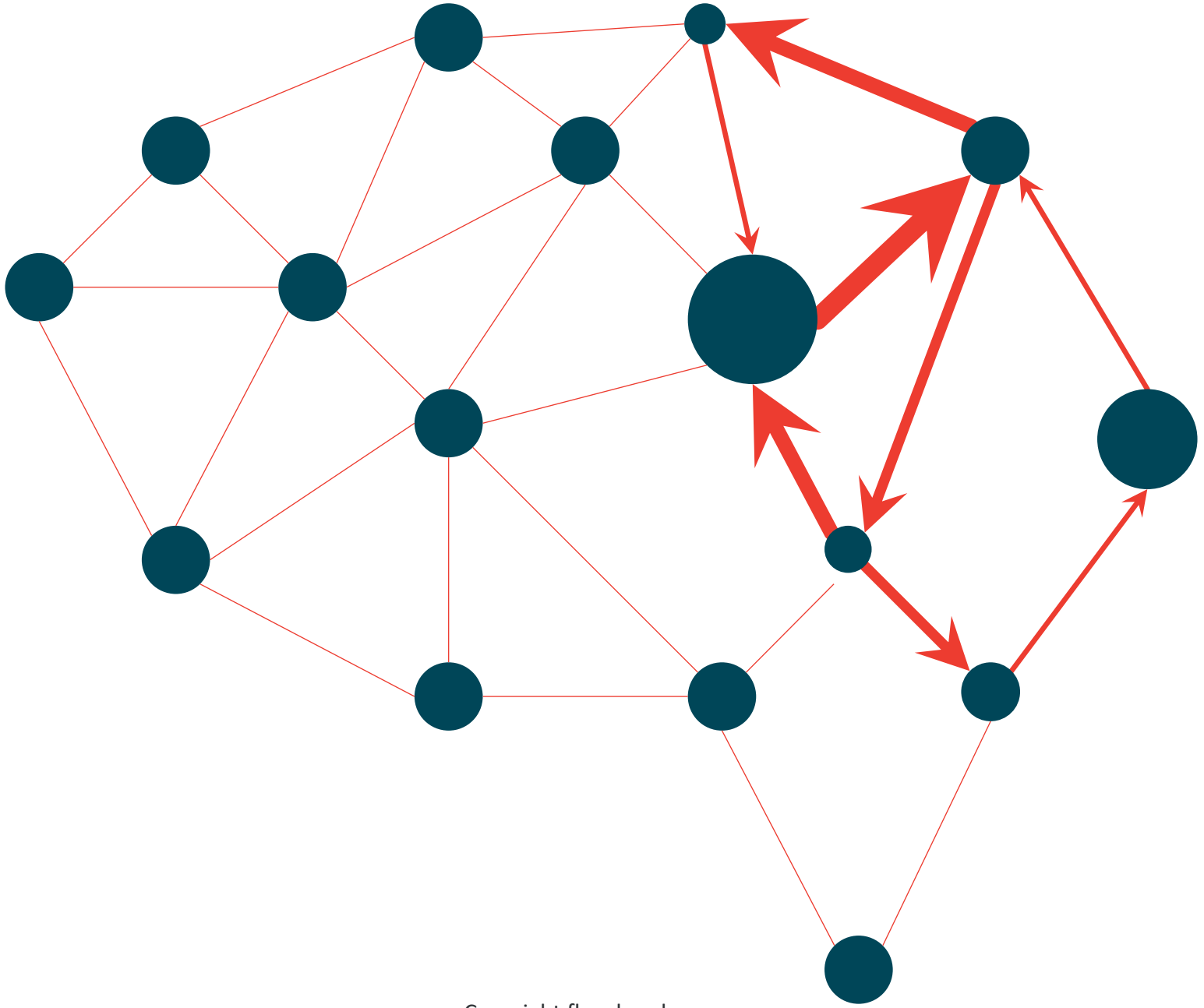




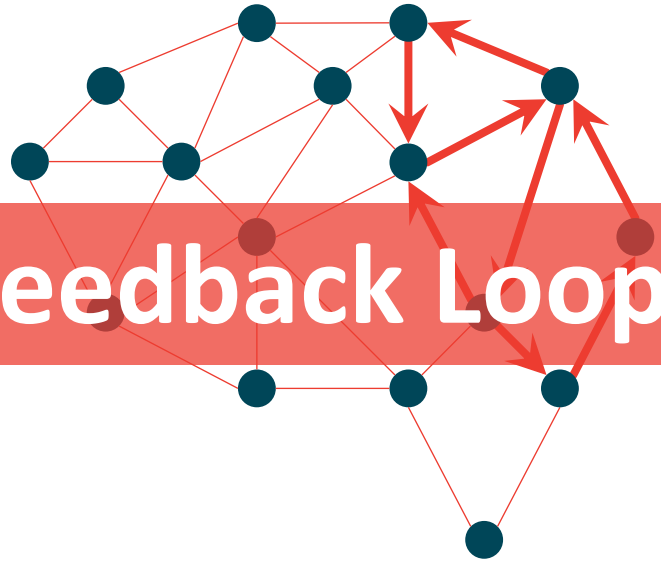




From Parts To Systems – From Simple To Complex

Emergent Properties

Structure



Feedback Loops

Reshaping & Rewiring (Plasticity)

Interaction

Interdependence

What does it take to grab a cupcake?

> A brain and feedback loops!

Things to think about …

- Under which conditions do organizations operate?
- What is necessary for organizational survival?
- Do organizations require movement?
- Which don’t?
- Do all organizations have or need “brains” and feedback loops?

Humans Move With a Purpose[1]

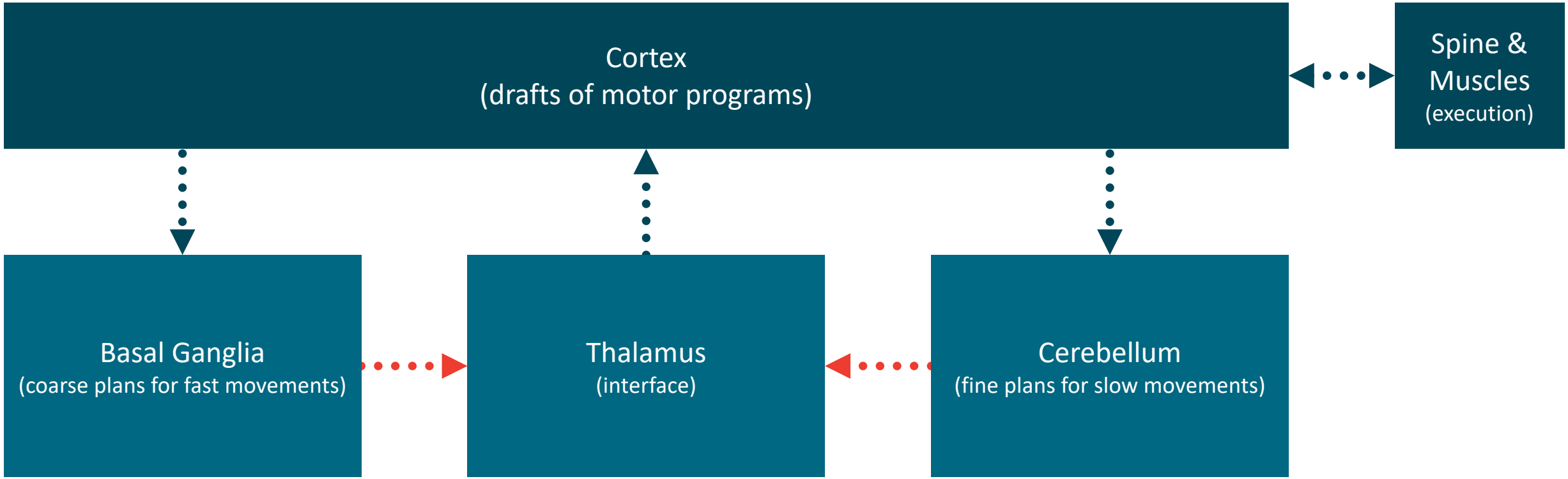
Voluntary Motor Control – Achieving Balance Through Excitation and Inhibition

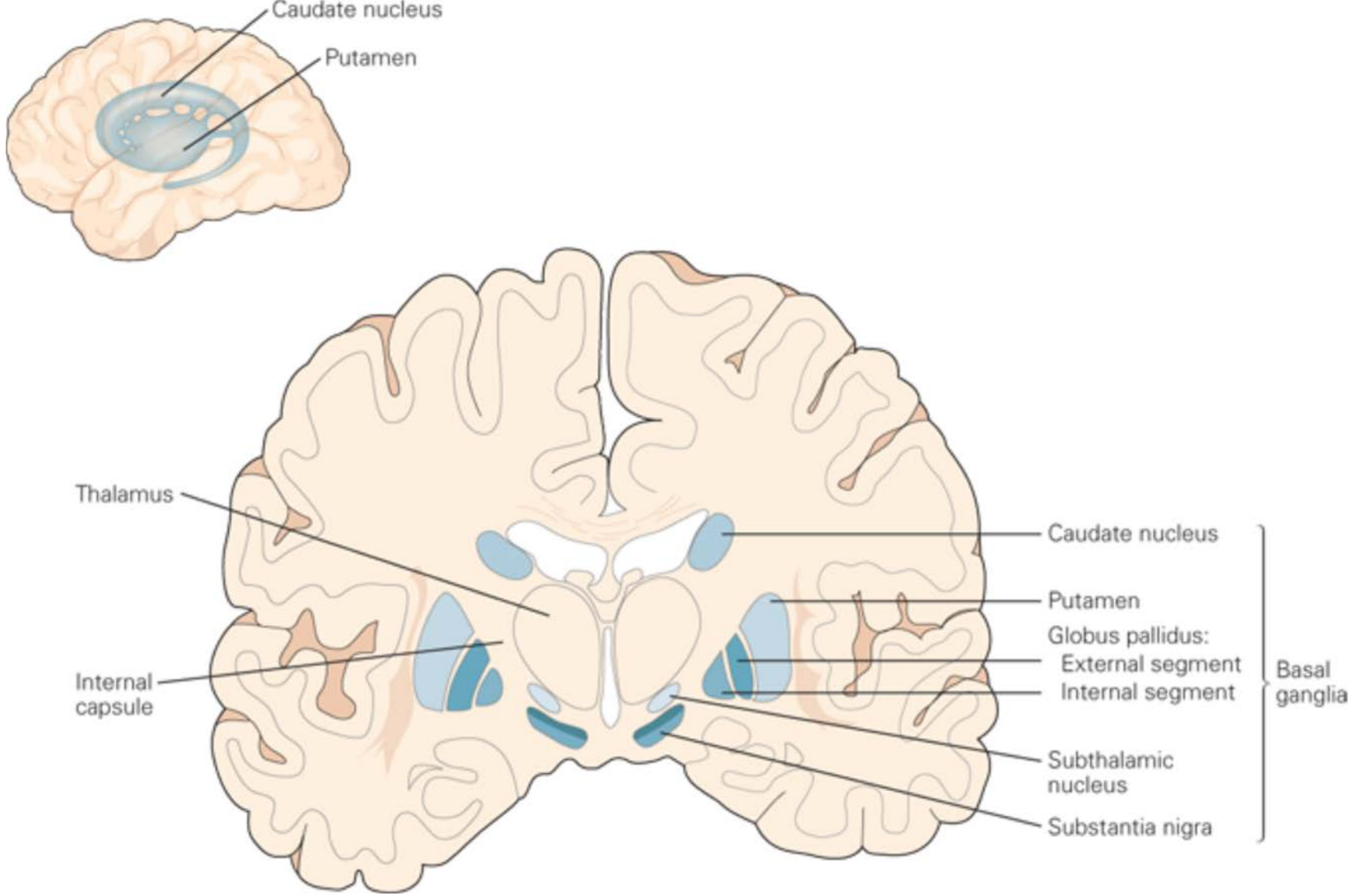
1. The Cognitive Neuroscience. Gazzaniga, 2009

The Challenge

- Degrees of freedom in limb movement
- Almost Infinite number of possible muscle activation patterns that could lead to similar movements
- Massive redundancy
- Naturally occurring errors

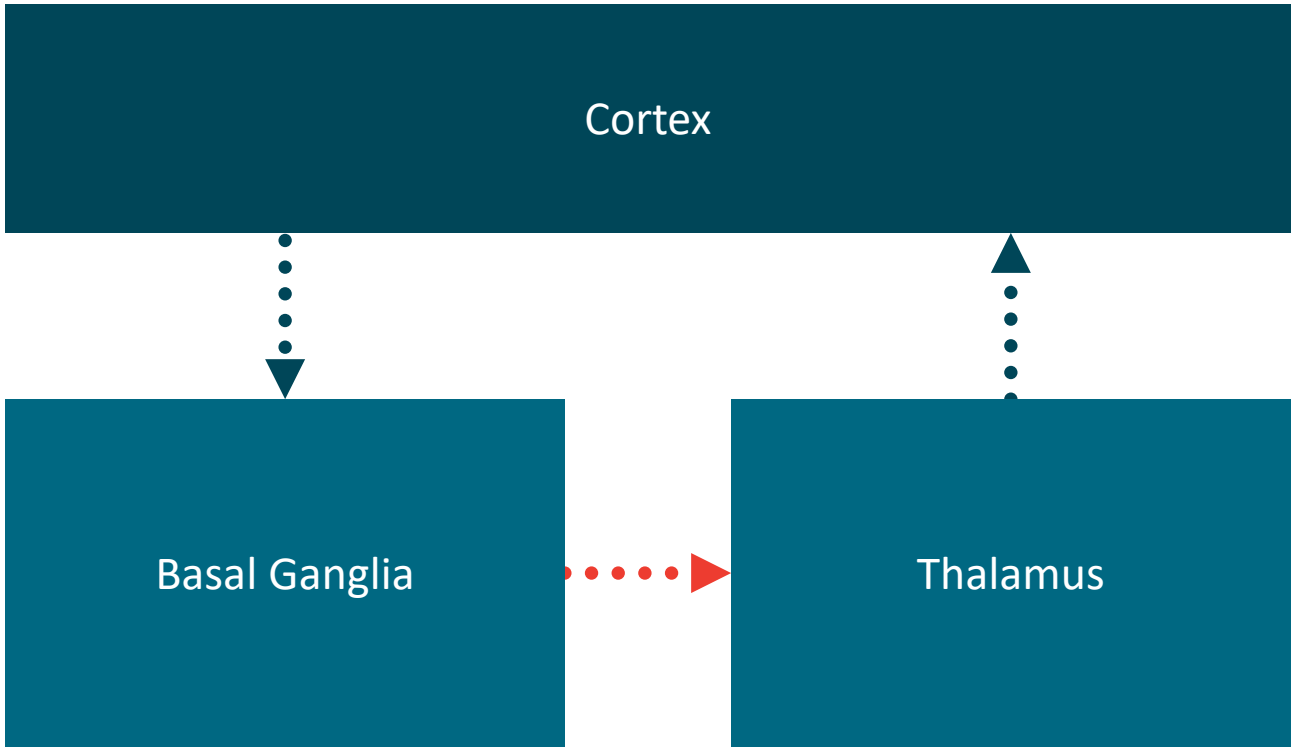
Basics of Motor Control

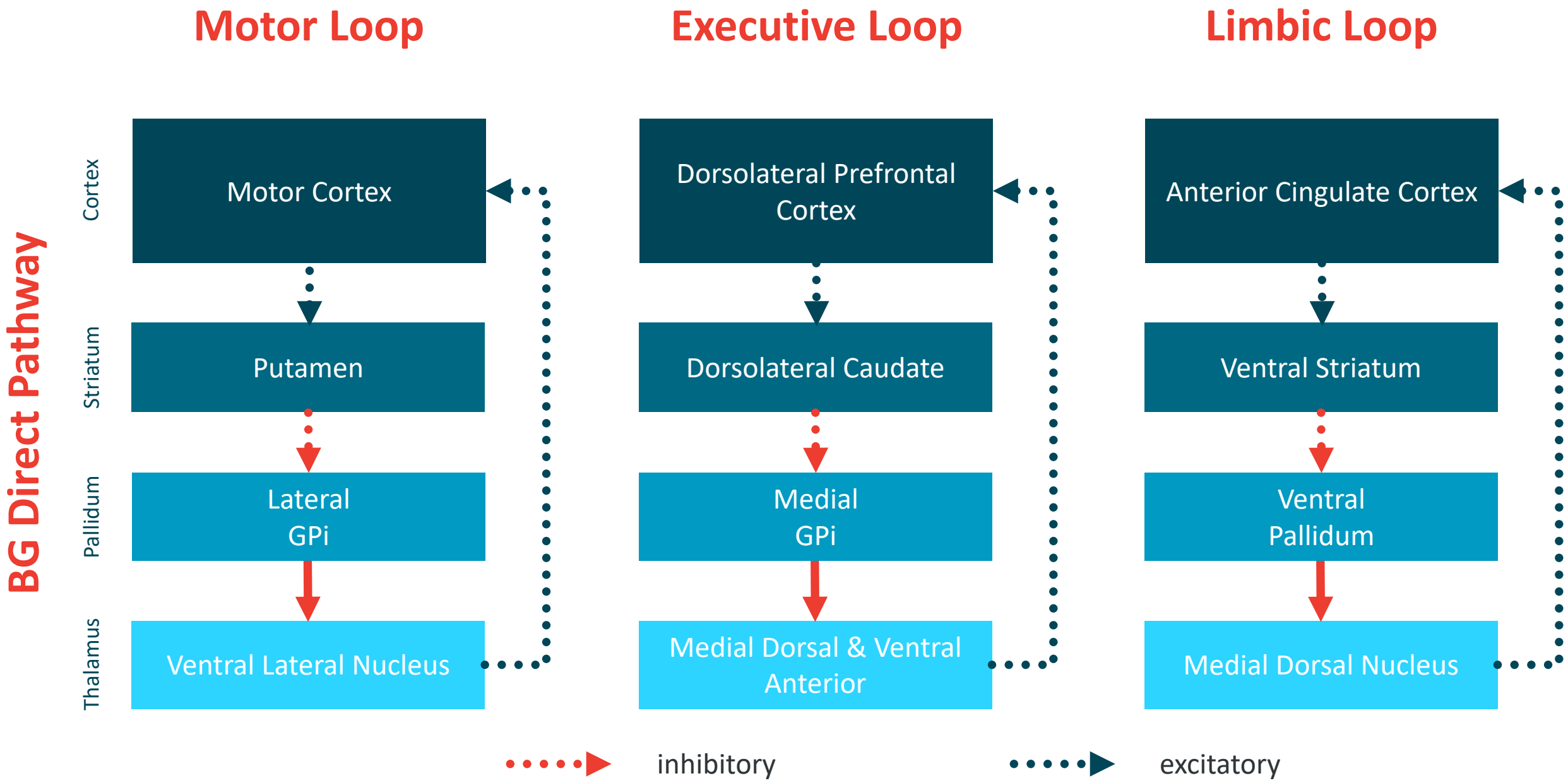




The basal ganglia and surrounding structures. The nuclei of the basal ganglia are identified on right in this coronal section. (Adapted, with permission, from Nieuwenhuys, Voogd, and van Huijzen 1981.)

Cortico-Basal Ganglia Loop (Simplified)

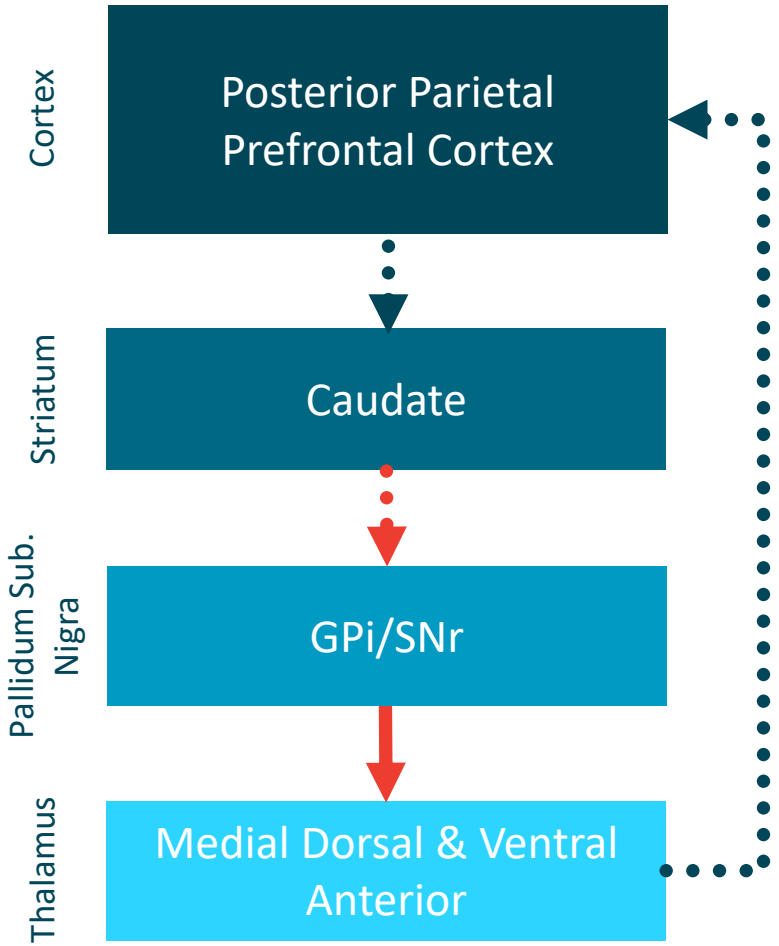


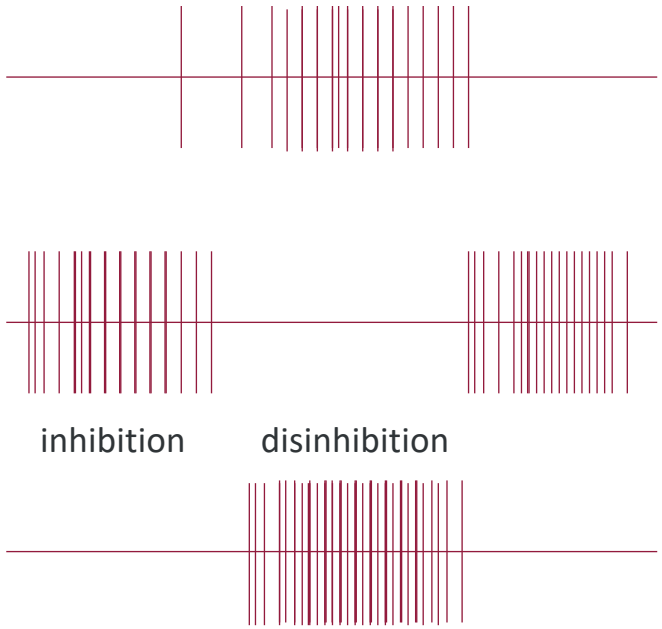


Oculomotor Loop

Activity Illustration

BG Direct Pathway





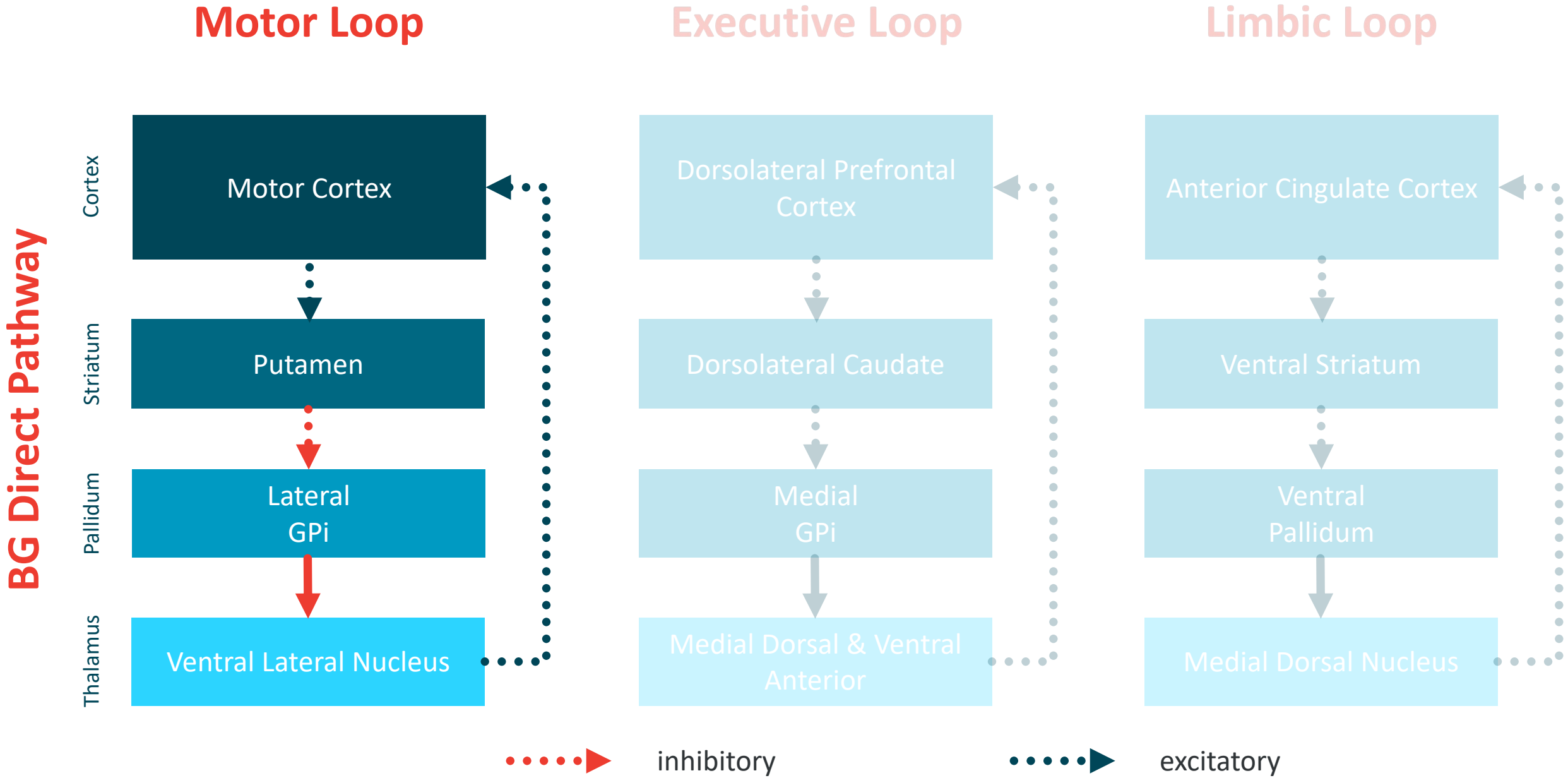
burst firing

inhibition disinhibition

removed inhibition

inhibitory

excitatory

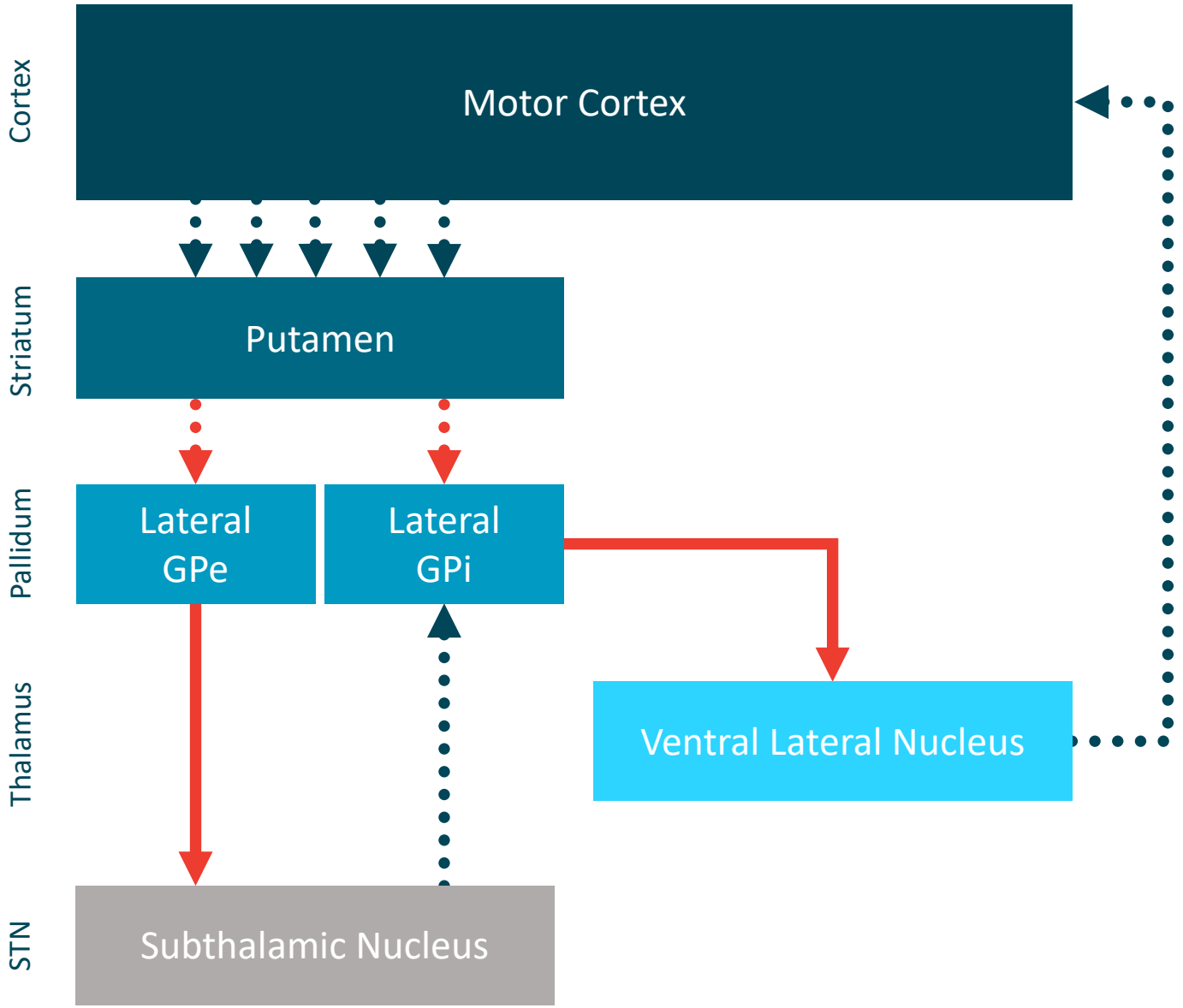


BG Motor Loop

inhibitory

tonic inhibition

excitatory



BG Motor Loop

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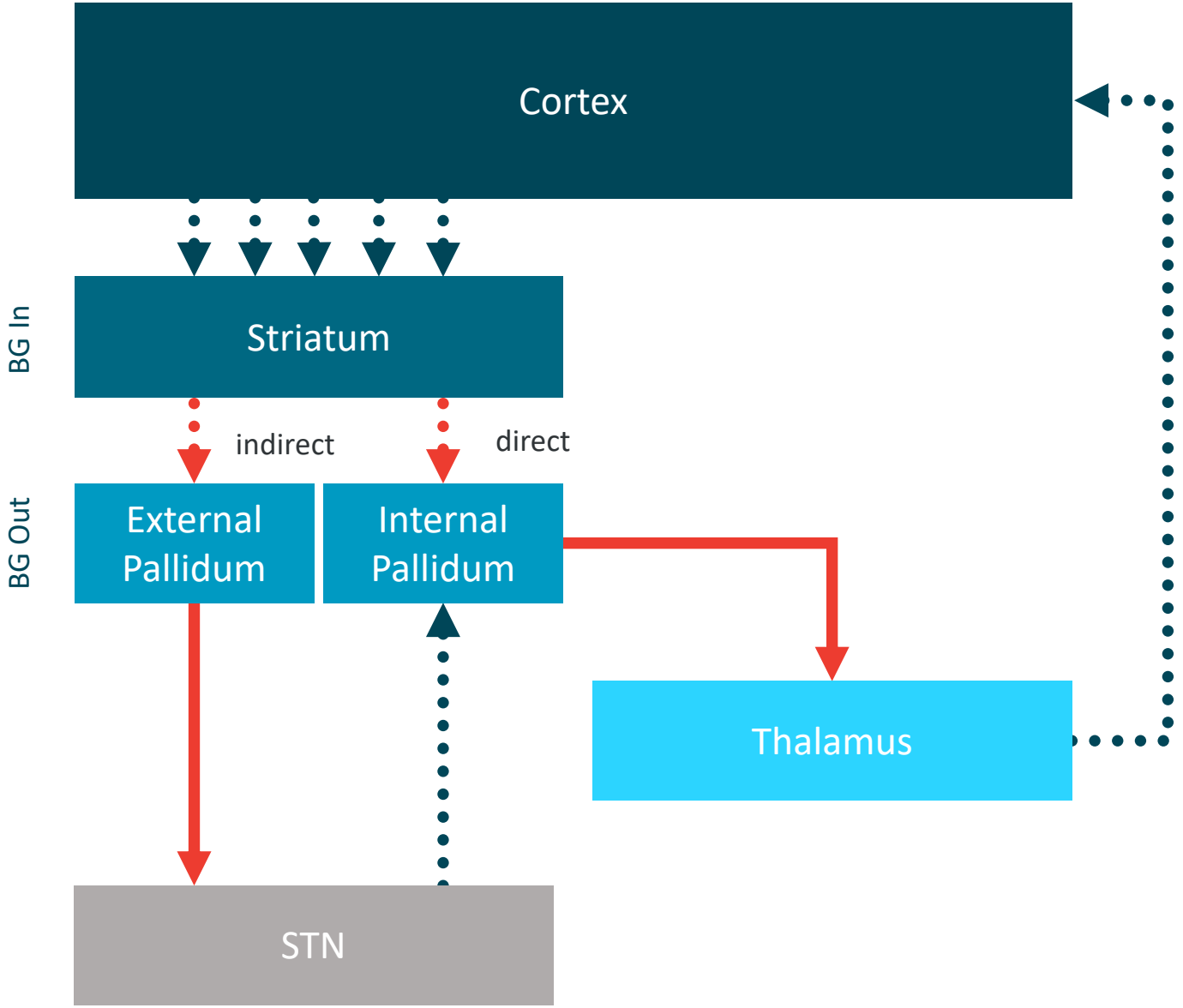
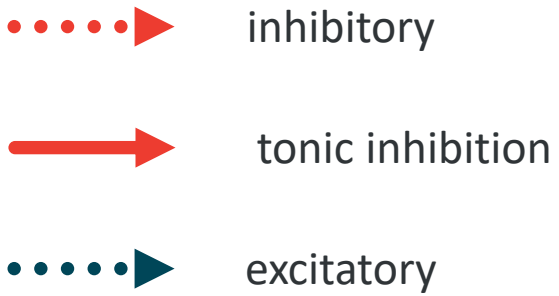
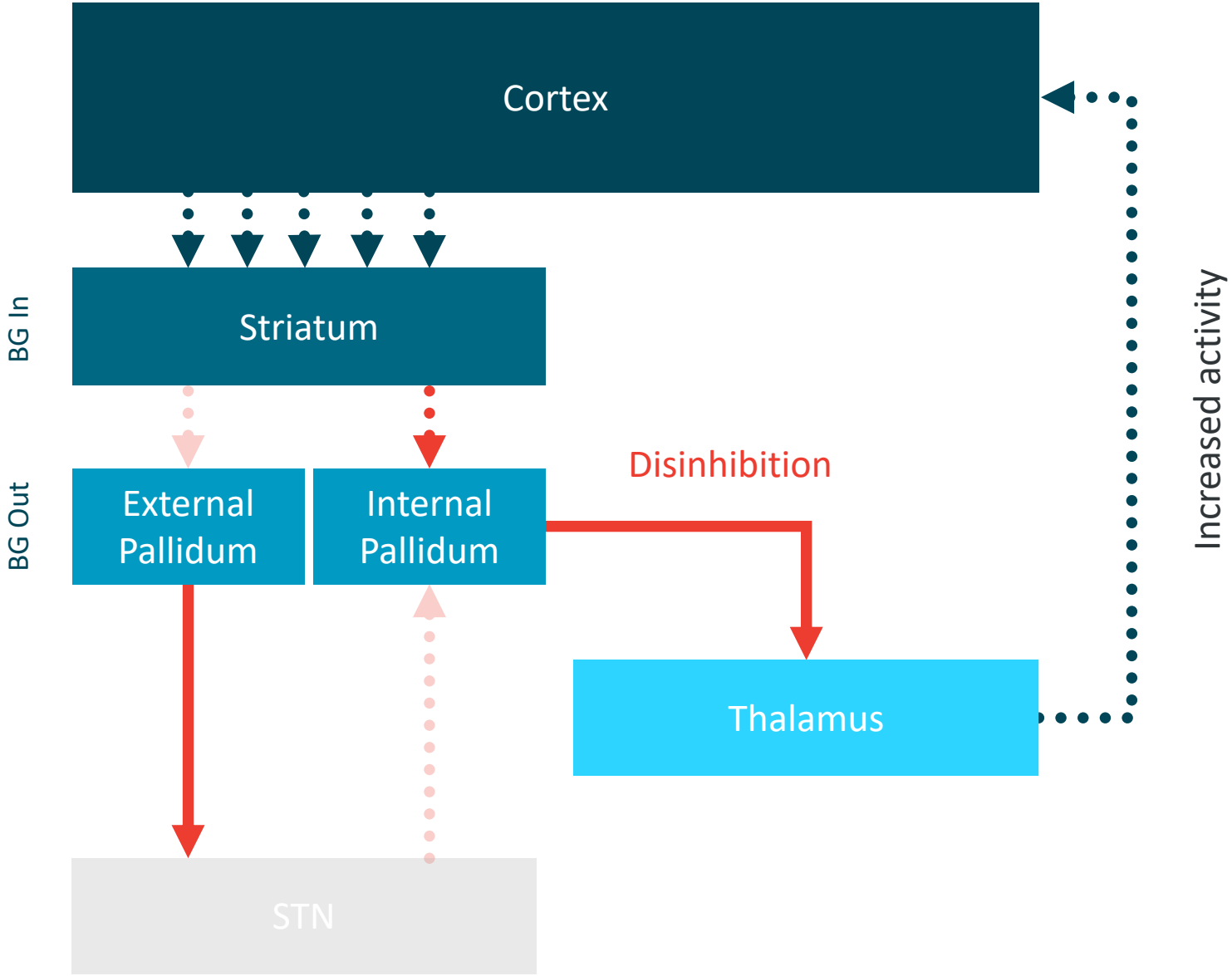
tonic inhibition

excitatory



BG Direct Pathway



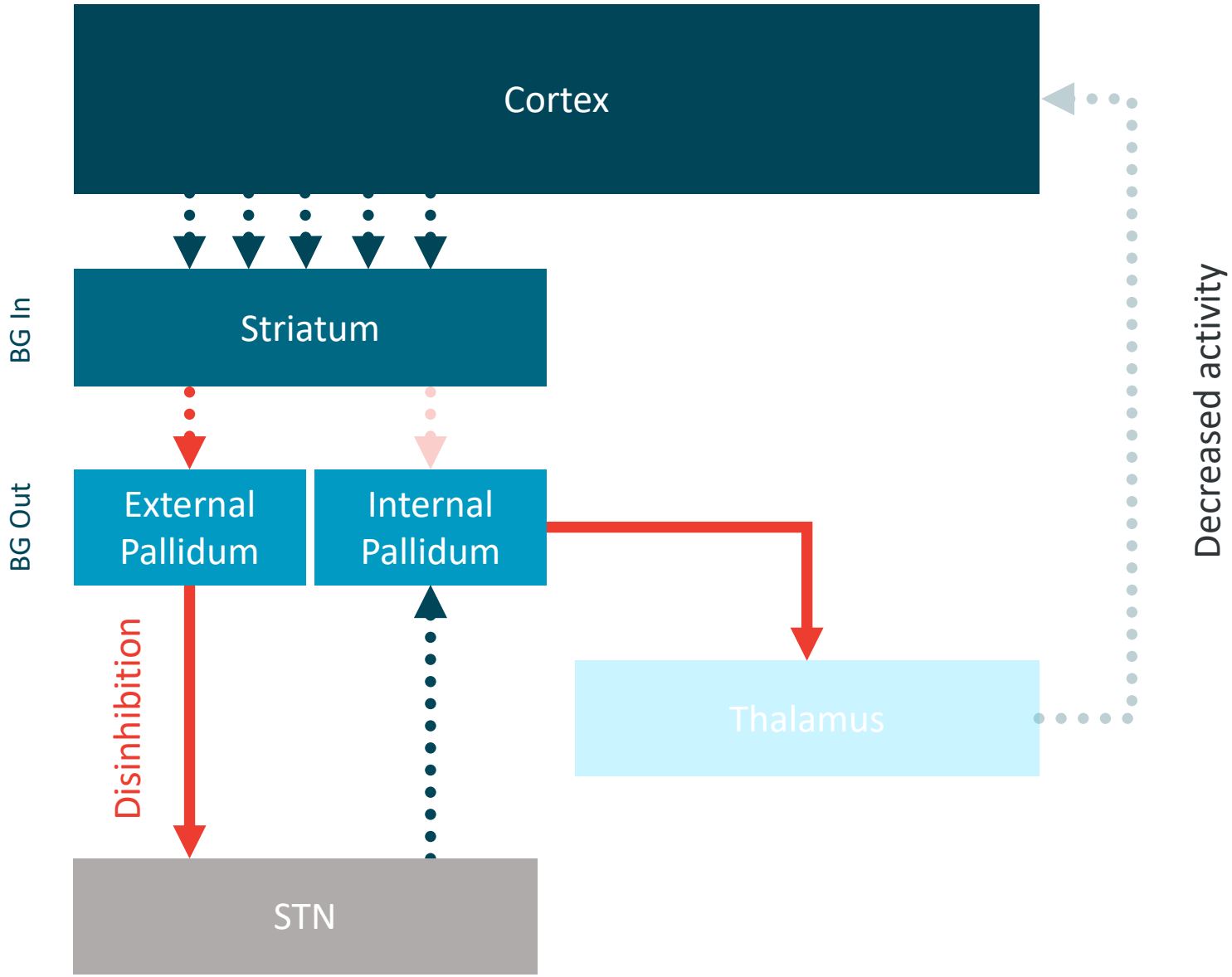


BG Indirect Pathway

inhibitory

tonic inhibition

excitatory



Two Pathways Model – Opposite Effects

Direct Pathway		Indirect Pathway
	Inhibition of the thalamus	
	Excitatory input from thalamus to cortex	
	Overall motor activity	
Go!	**Effect**	**No-Go!**

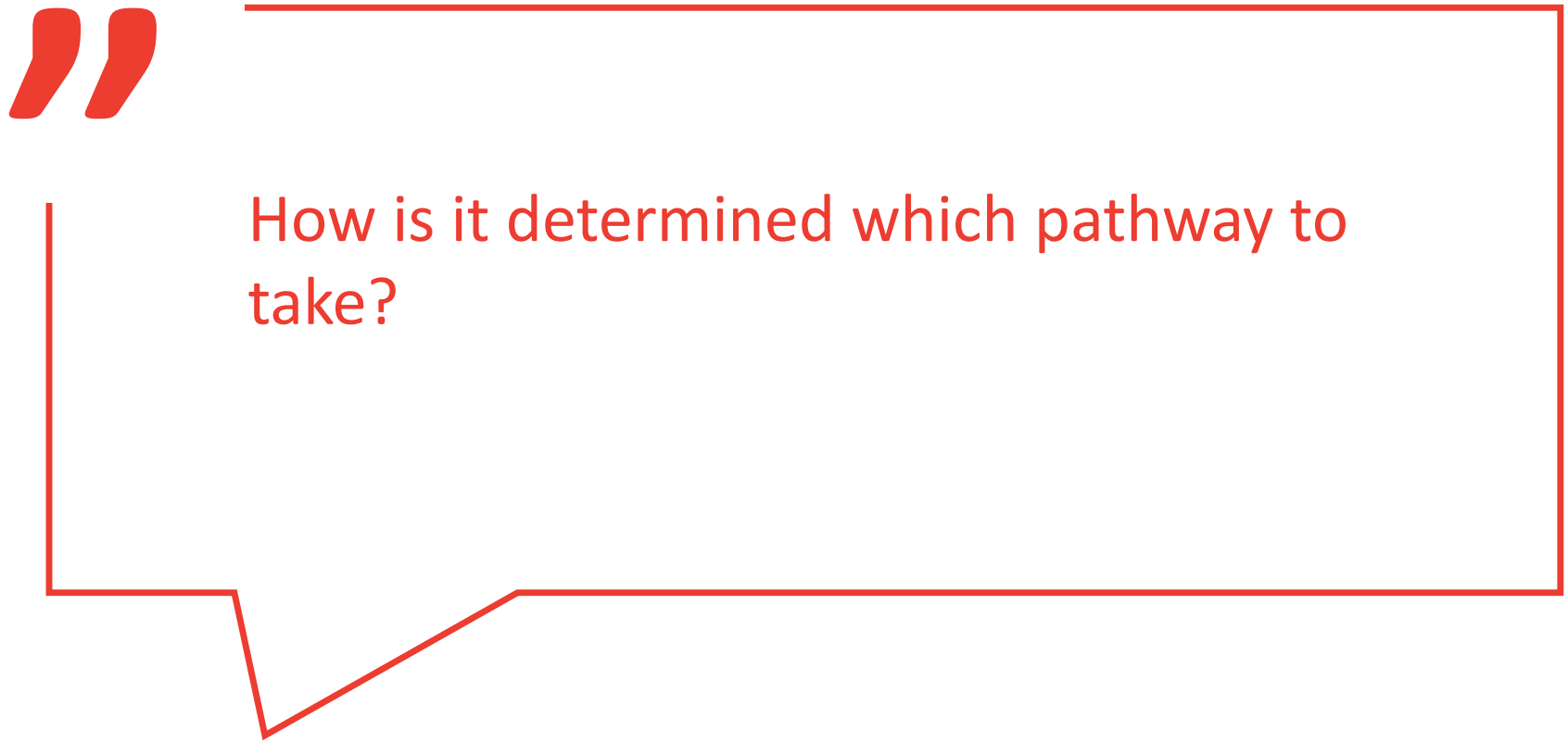
Selective Initiation or Suppression of Movement

The Basal Ganglia modulate the flow of actions

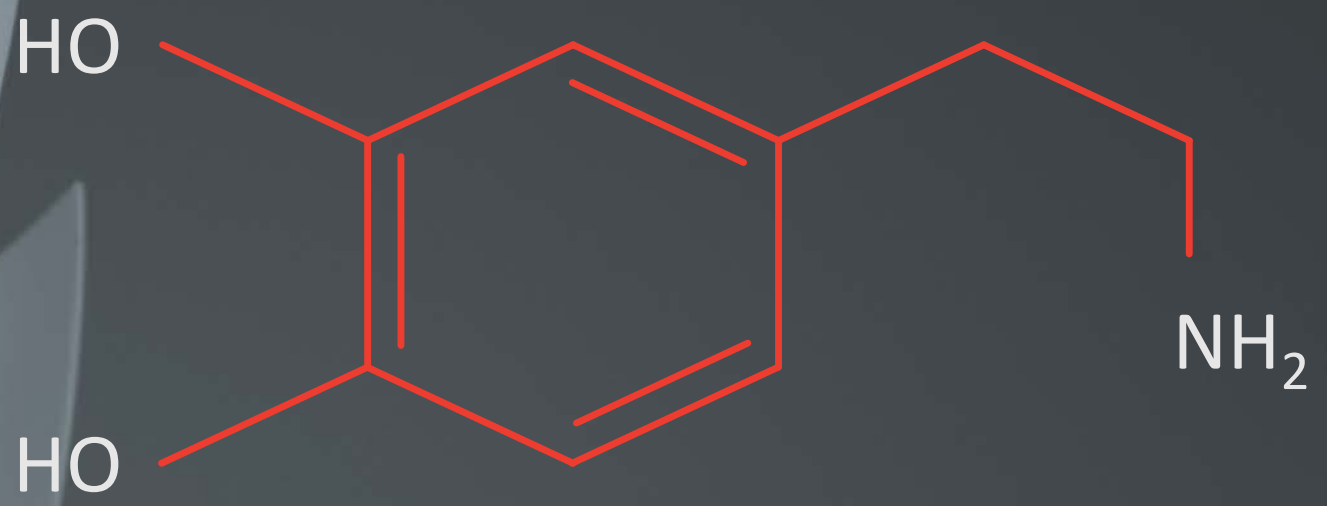
LKNA18 10.04.18

https://tinyurl.com/y7rfocao

But wait …



Enter Dopamine!



https://tinyurl.com/y9ar3jzy

BG Motor Loop

inhibitory

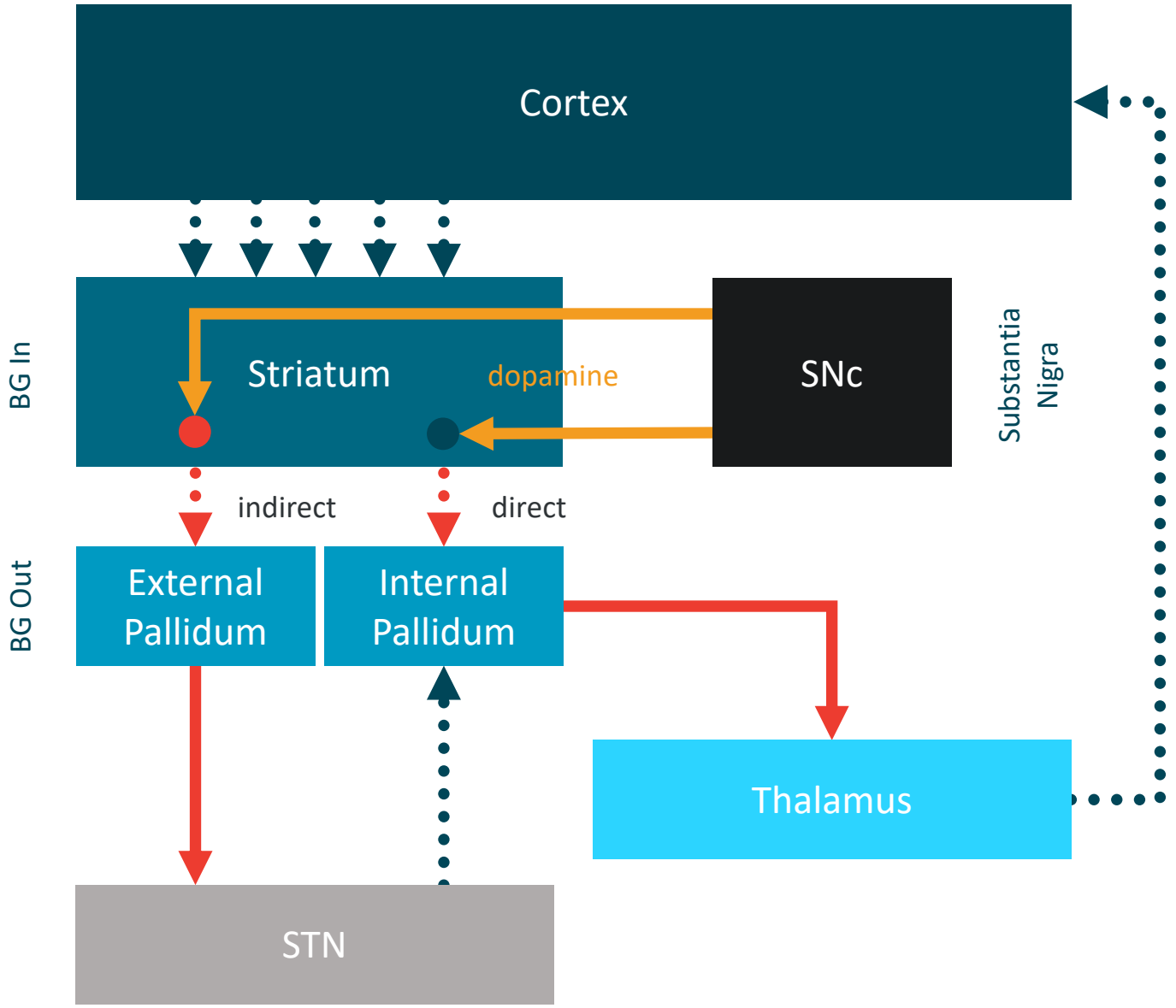
tonic inhibition

excitatory

modulatory
tonic firing, 3 – 6 Hz

Dopamine D1 receptor

Dopamine D2 receptor



Gating-Like Modulation Through Dopamine

- Strong signals take the **Go** pathway and are **expedited**
- Weak signals take the **No-Go** pathway and are **delayed or discarded**

- Dopamine bursts **reinforce** cortically initiated activation

- **Support activation of intended motor programs**
- **Minimize interference of conflicting motor programs**

Dopamine – It’s About Reward!

https://tinyurl.com/ybcv3hqj

Reward & Punishment

- Compare signal to expected value
  - **Learning** loop through **expectation** and **experience**

- The Policy
  - **Select** most rewarding motor programs → **Go** pathway
  - **Avoid** punishing ones → **No-Go** pathway
  - **Filter out** the noise

- Caution
  - Tonic dopamine levels influence the relative balance
  - The more dopamine the **more risky** the choices
  - **Insensitivity** to negative outcome

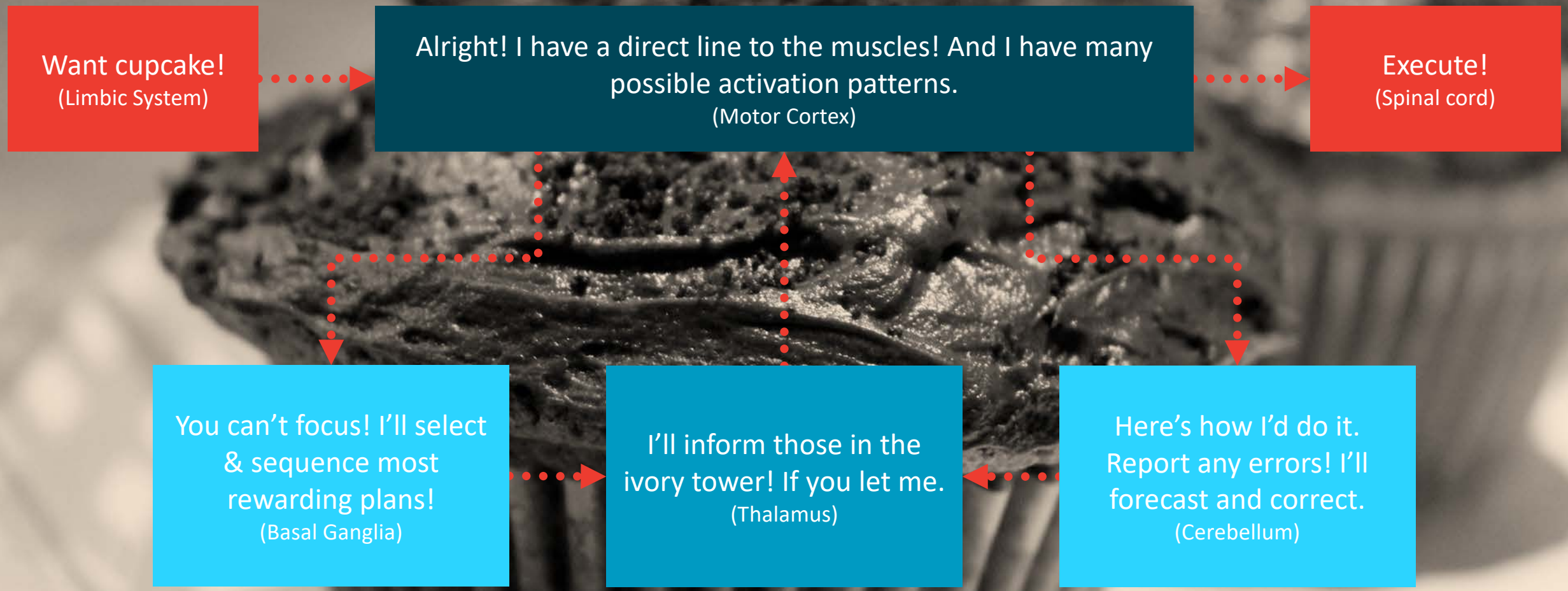
What Does It Take to Grab a Cupcake?

An End-to-End System View

The Challenge

- Degrees of freedom in limb movement
- Almost Infinite number of possible muscle activation patterns that could lead to similar movements
- Massive redundancy
- Naturally occurring errors

End-to-End System View



https://tinyurl.com/ybcv3hqj

End-to-End System View

https://tinyurl.com/ybcv3hqj

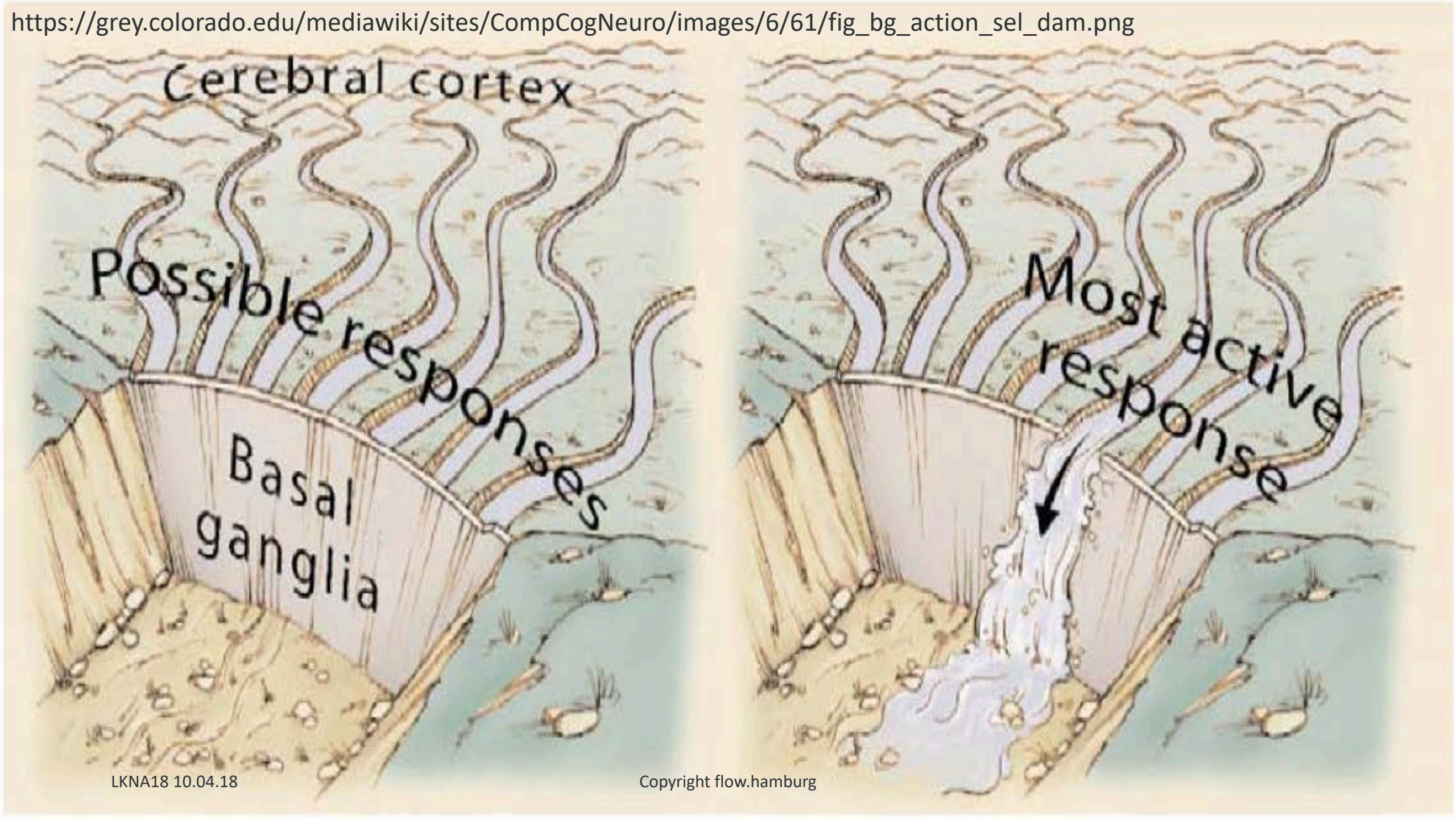
Grabbing a Cupcake Requires …

- Motivation
- Huge number of activation plans
- Selection and sequencing
  - Reward and punishment
  - Excitation & Inhibition
- Detailing out the plans
- Executing
  - Continuously monitor
  - Continuously adapt

Summary

- Movement is a complex product of multiple areas
- Involved areas are organized in a hierarchy
- These areas are connected through specific pathways
- Feedback loops enable coordination
  - Suppress unintended movements (inhibition)
  - Let through intended movements (excitation)
- **Balance is achieved through using both loops types**
  - Positive loops for reinforcement
  - Negative loops for stabilization
- **Dopamine modulates on the fly**

https://grey.colorado.edu/mediawiki/sites/CompCogNeuro/images/6/61/fig_bg_action_sel_dam.png



Things to think about …

- What type of feedback loops have you seen?
- What are their inner mechanics?
- Do feedback loops change in your organizations?

- Have you recognized the **rational brain**?
- Have you recognized the **intuitive brain**?

Dysfunctional Feedback Loops

Every disturbance of a function in the brain reveals how it operates under normal, healthy condition

Dysfunctions of Motor Control

Too little (hypokinesia)

- Morbus Parkinson
  - Death of cells in SNc
  - Loss of dopamine
  - Disability to modulate

Too much (hyperkinesia)

- Chorea Huntington
  - Death of cells in striatum
  - Loss of GABA
  - Disability to suppress
- Hemiballismus
  - Damage to STN
  - Disability to suppress

Morbus Parkinson

- Initially described by James Parkinson in 1817
- A British medic and pharmacologist

- Death of neurons in SNc (dopamine production)
- Lack of dopamine for modulation

- Problems initiating movements
- Problems terminating running movements

Normal Condition

inhibitory

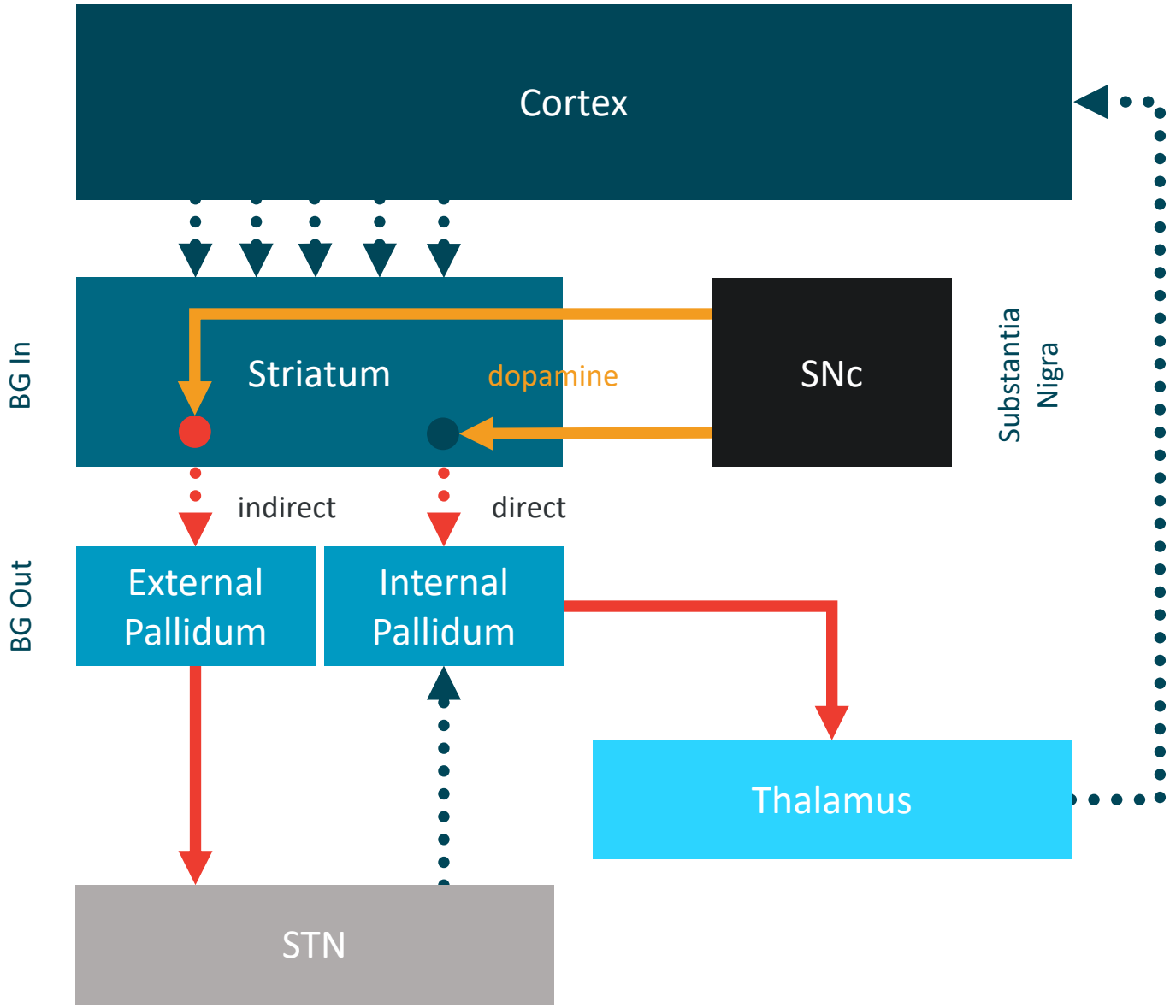
tonic inhibition

excitatory

tonic firing, 3 – 6 Hz

Dopamine D1 receptor

Dopamine D2 receptor



Parkinson Disease

inhibitory

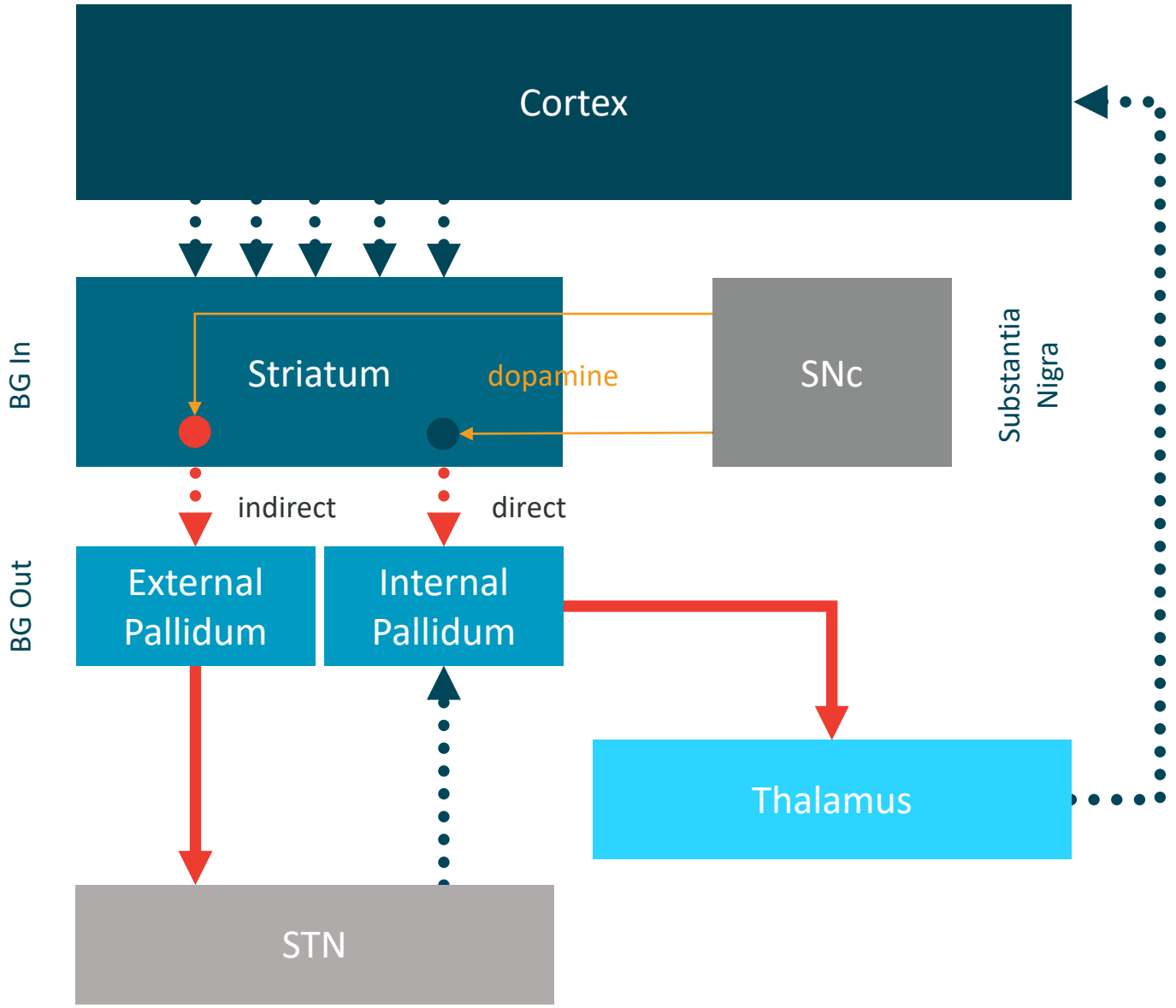
tonic inhibition

excitatory

tonic firing, 3 – 6 Hz

Dopamine D1 receptor

Dopamine D2 receptor



Parkinson Disease

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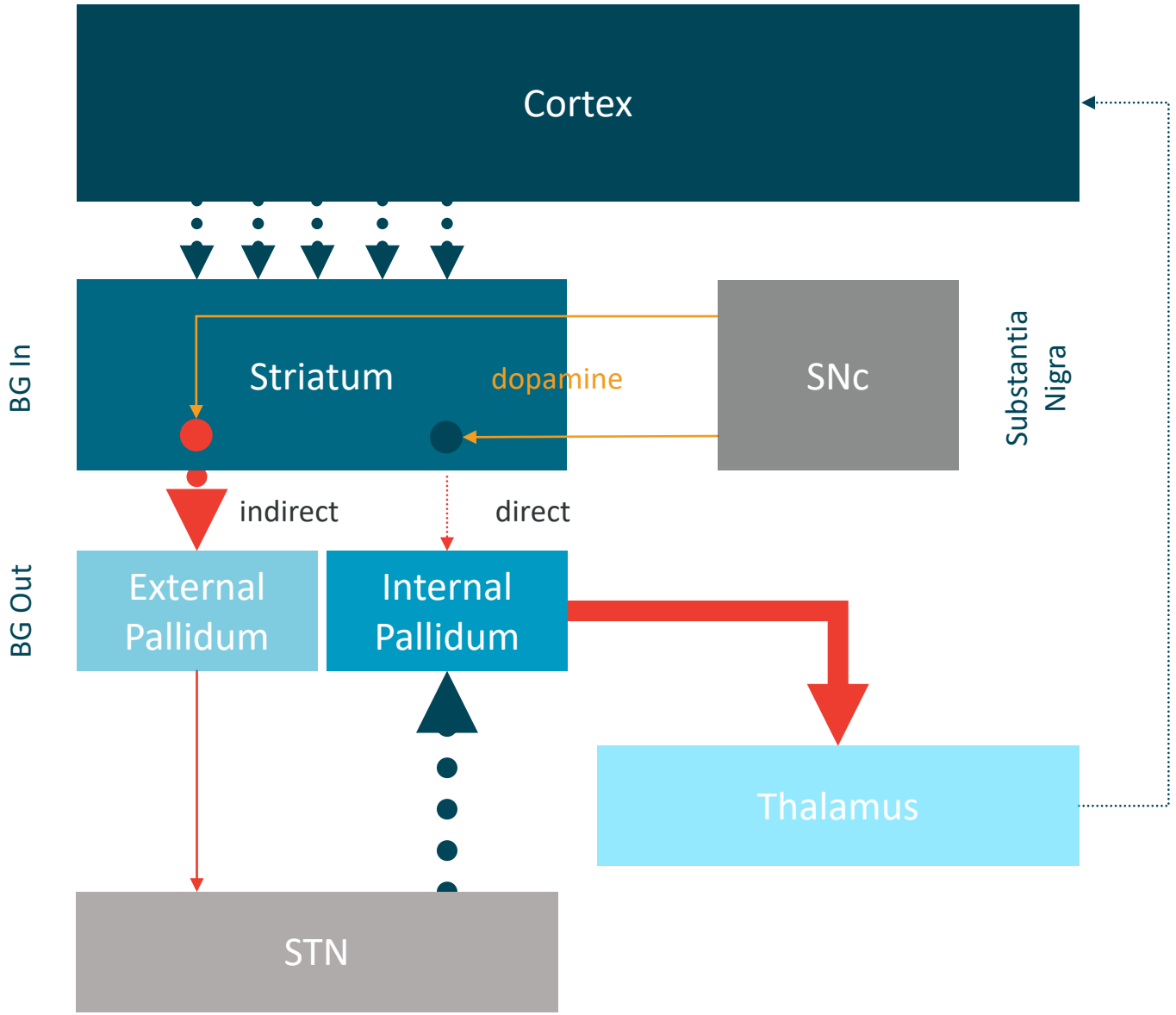
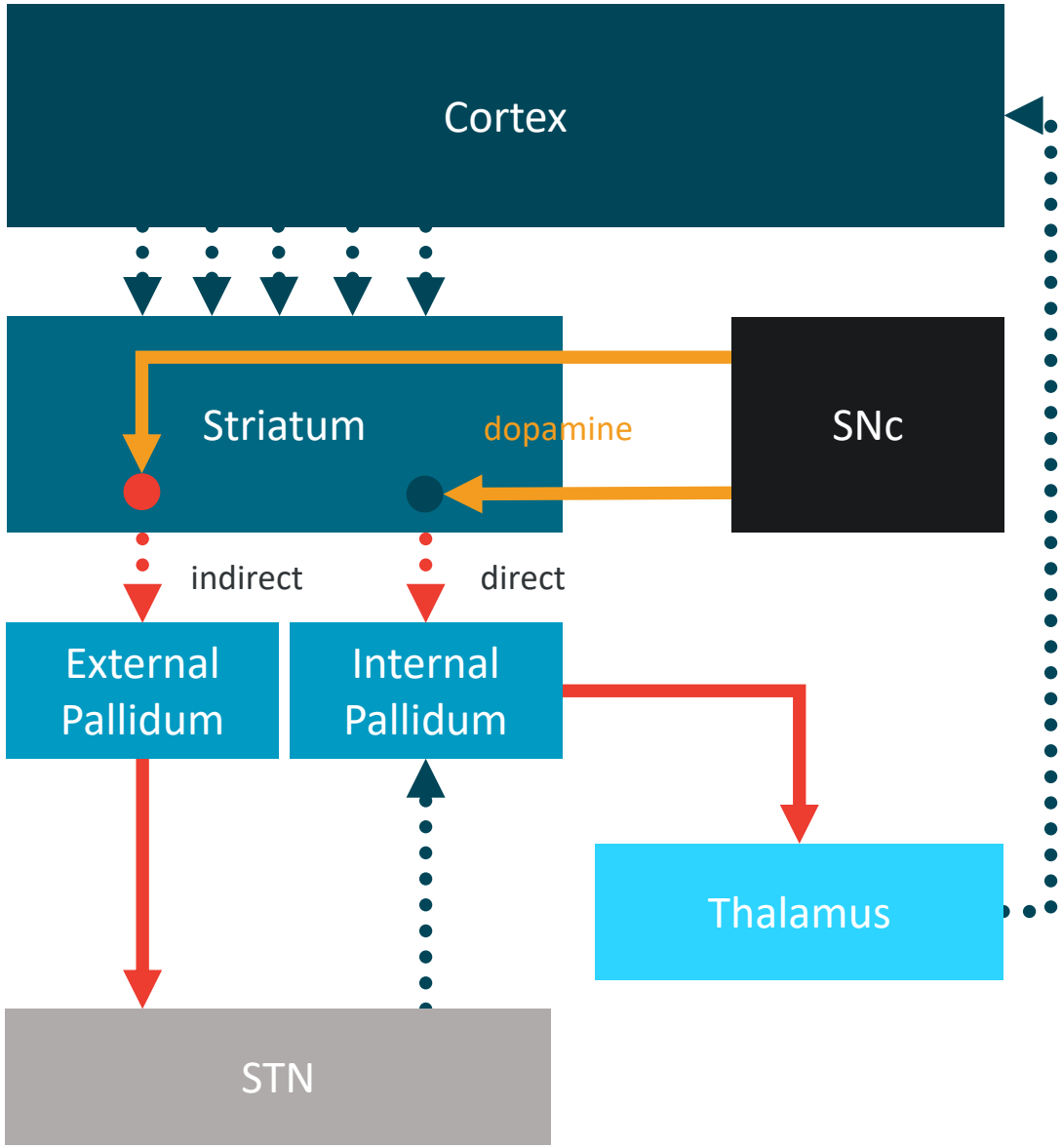
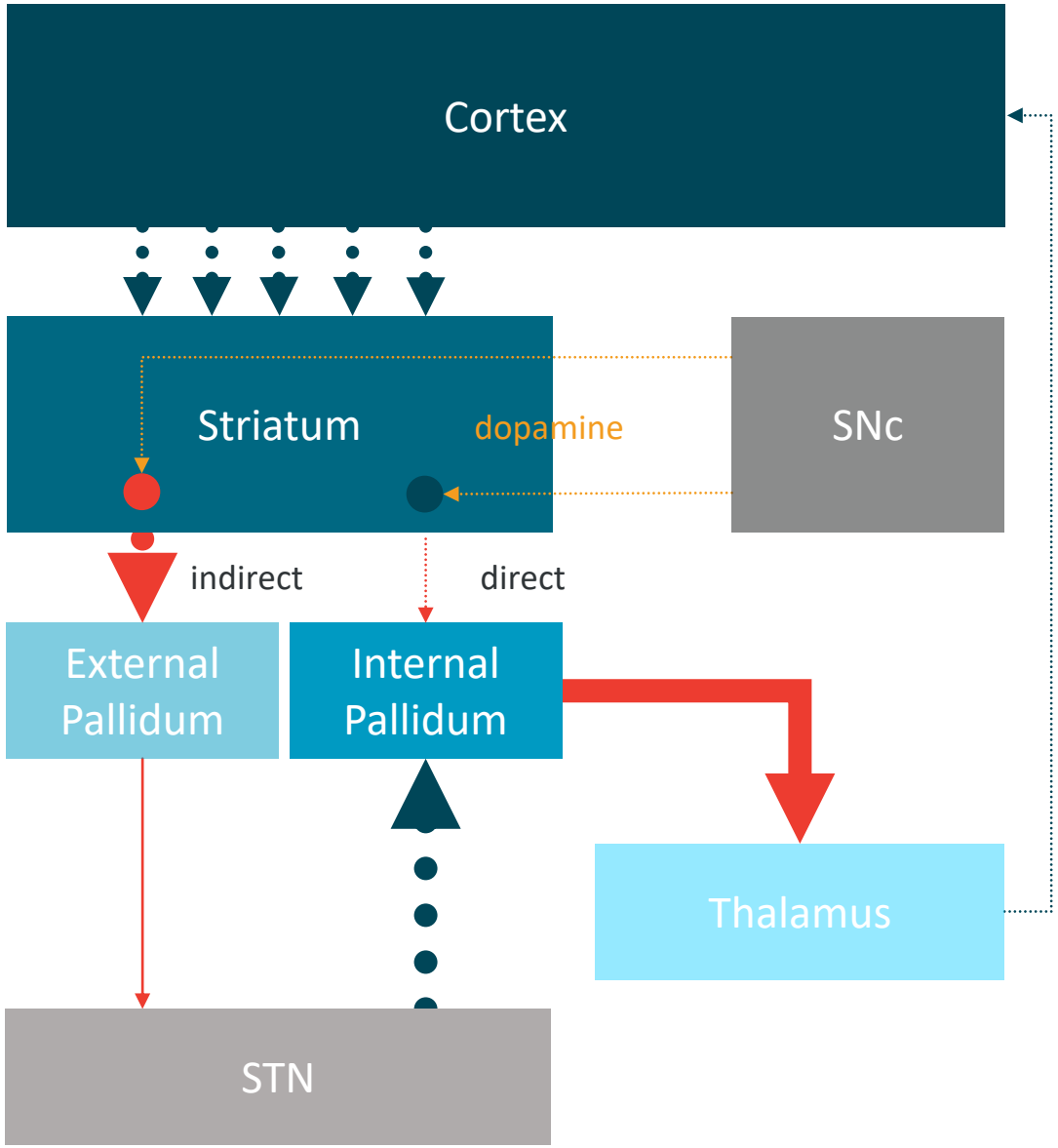


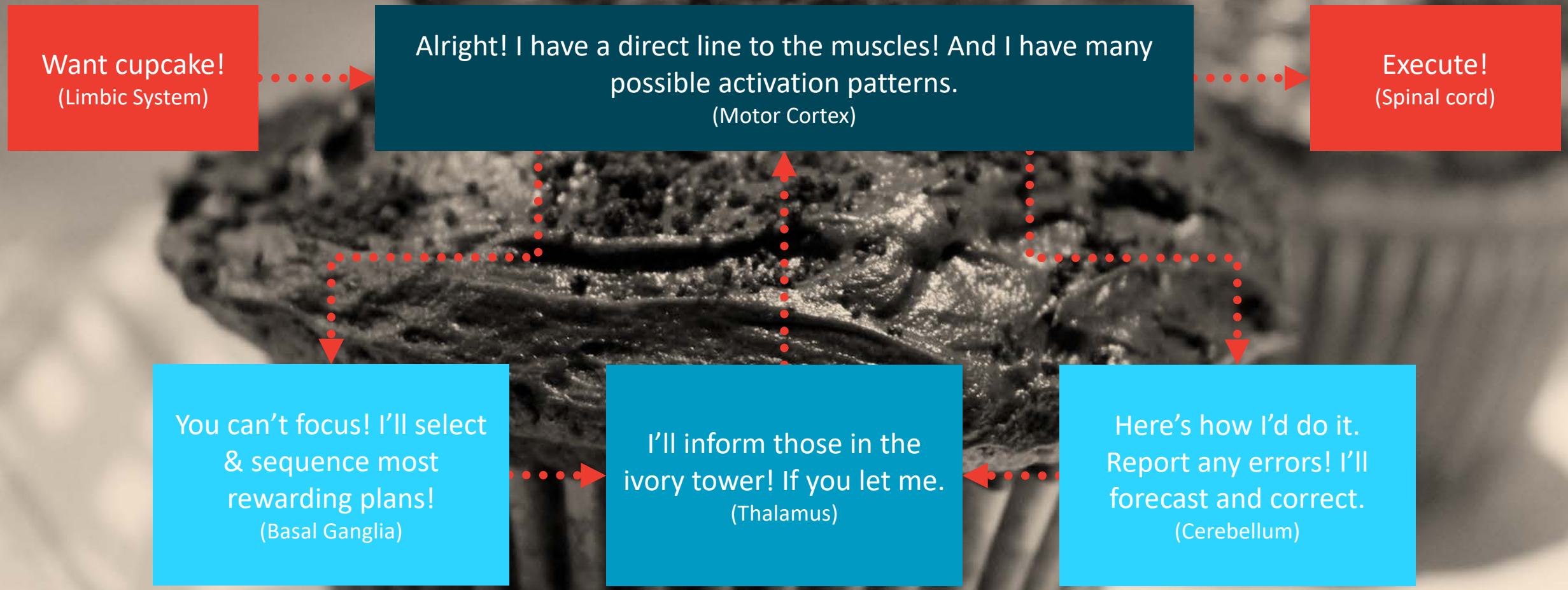
Normal Condition



Parkinson Disease



Parkinson Disease



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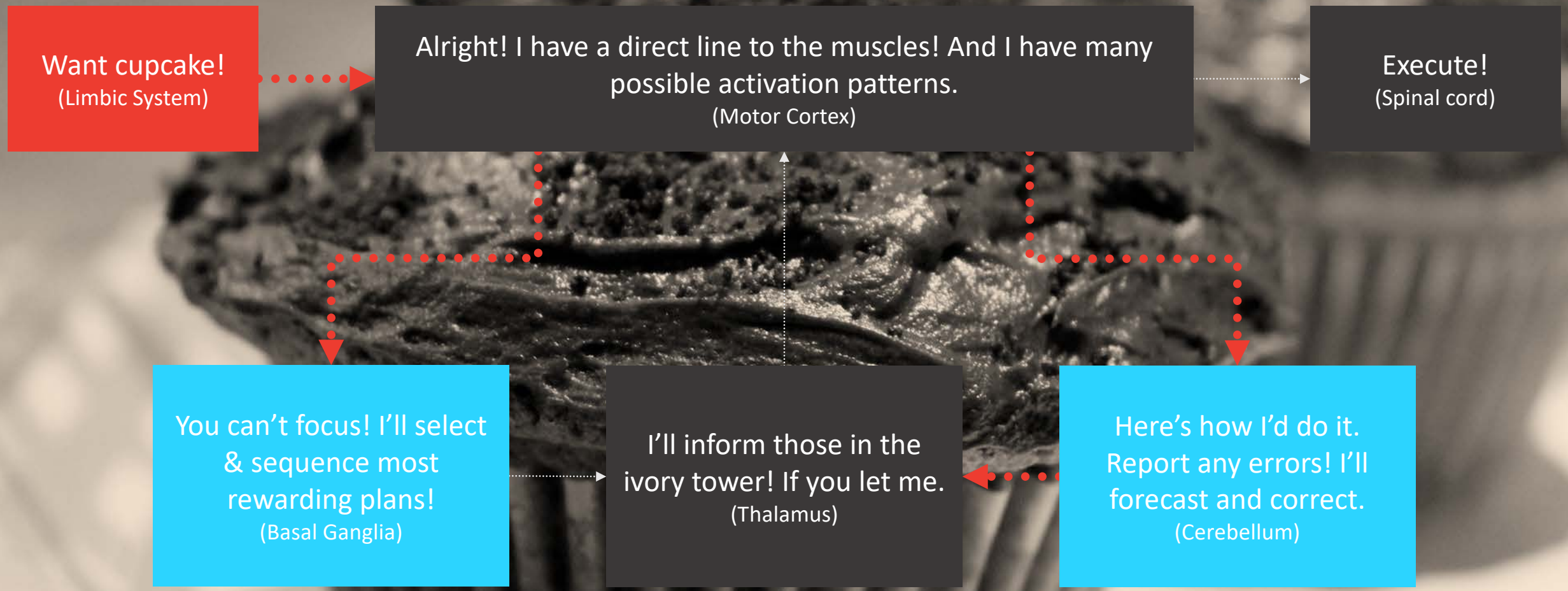
Parkinson Disease



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Cupcake?

”

You will have a hard time initiating your movement in order to grab your cupcake!

Chorea Huntingon

- Thorough description by George Huntington in 1872
- M.D. from New York

- Death of neurons in striatum
- Lack of a neurotransmitter (GABA)

- Problems suppressing unintended movements
- Reduced muscle tone

Normal Condition

inhibitory

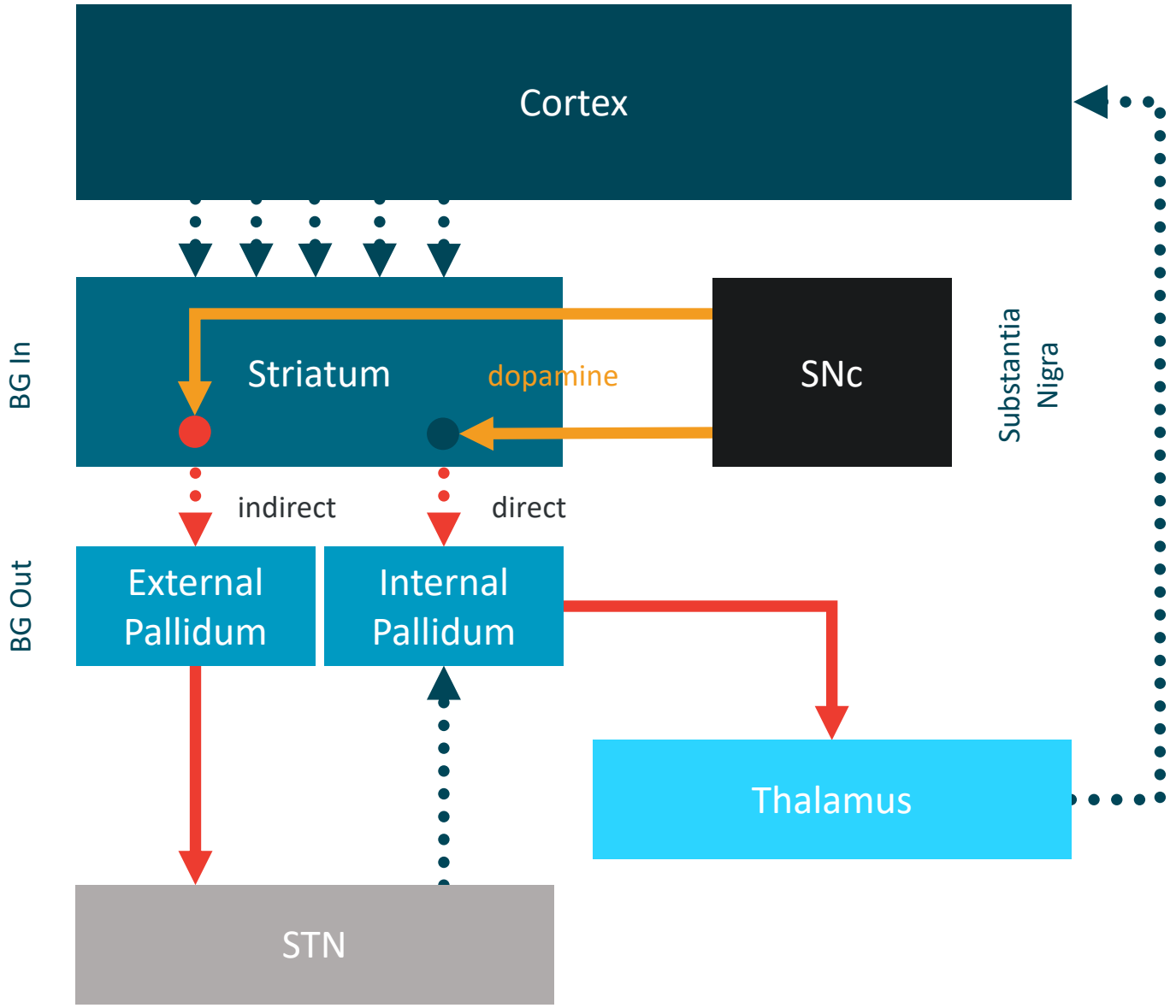
tonic inhibition

excitatory

tonic firing, 3 – 6 Hz

Dopamine D1 receptor

Dopamine D2 receptor



Huntington Disease

inhibitory

tonic inhibition

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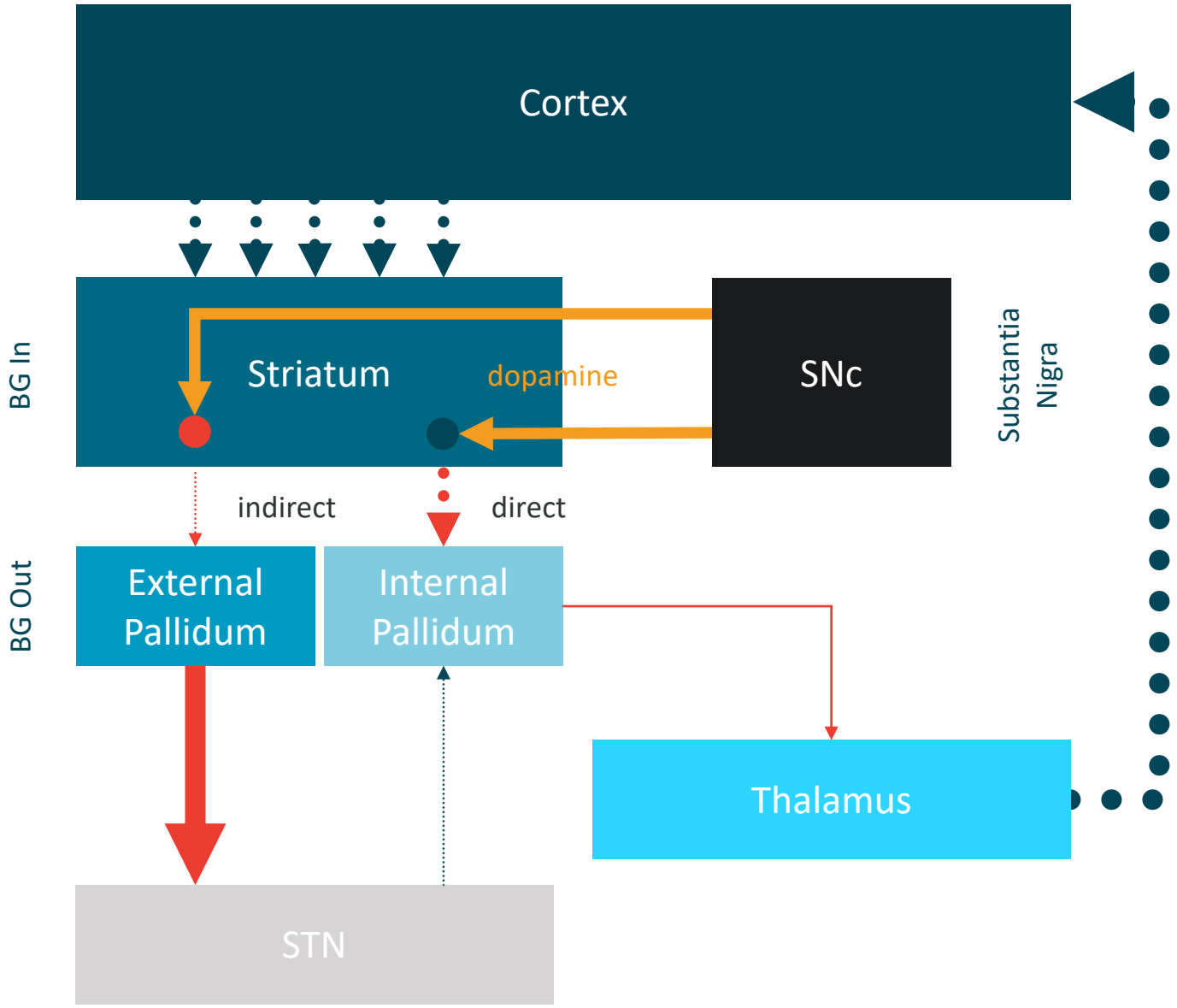
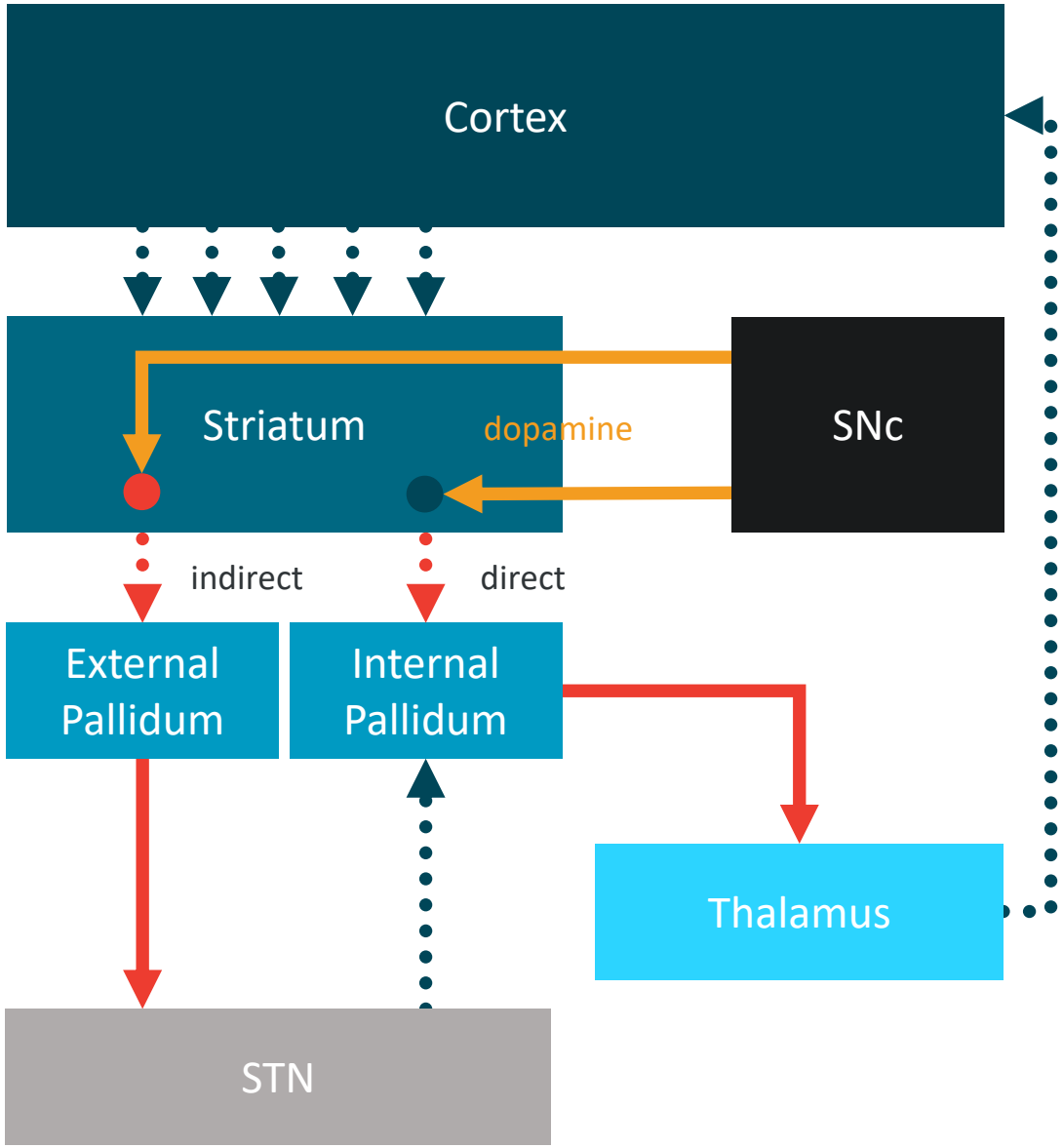
tonic firing, 3 – 6 Hz

Dopamine D1 receptor

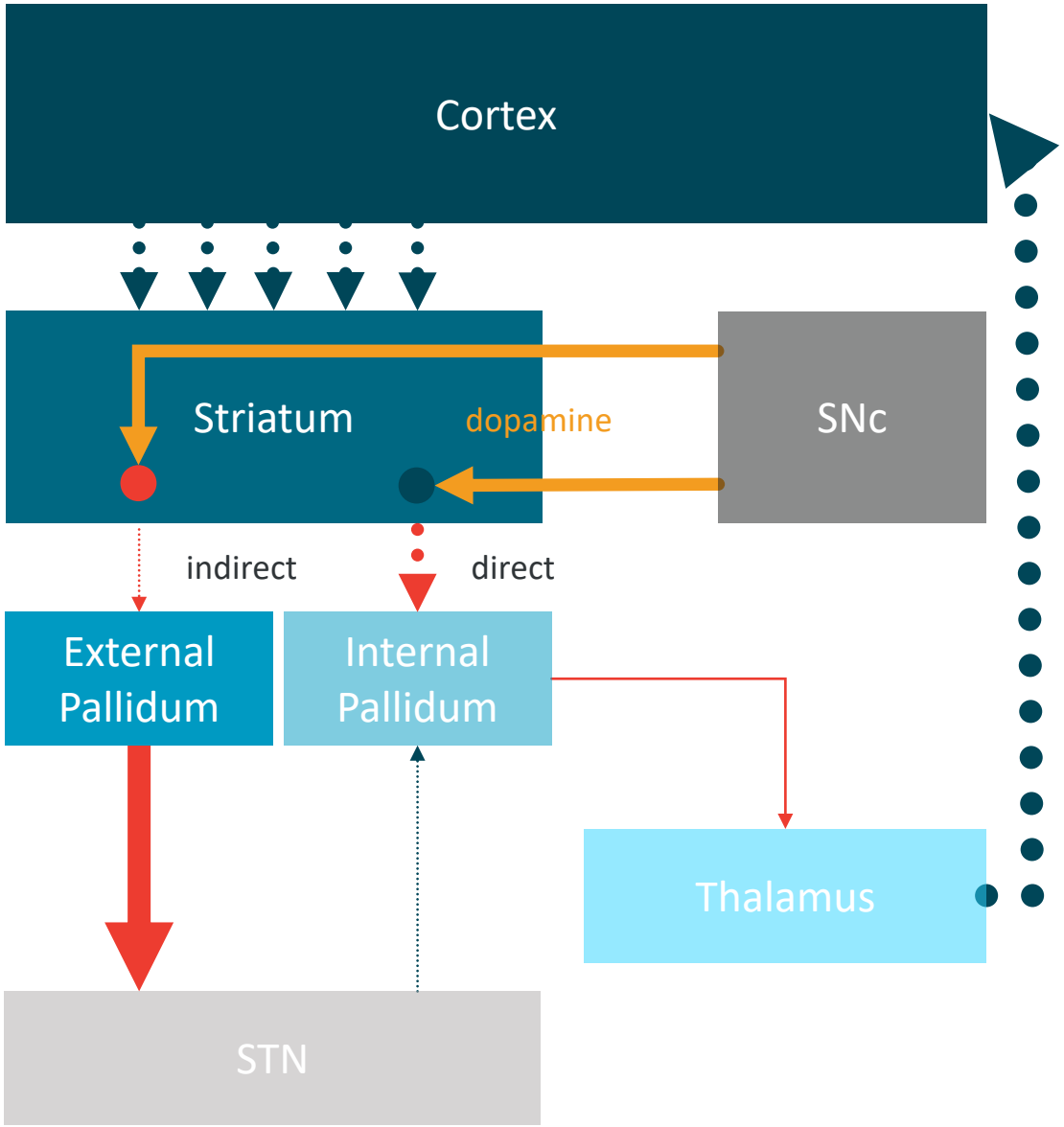
Dopamine D2 receptor



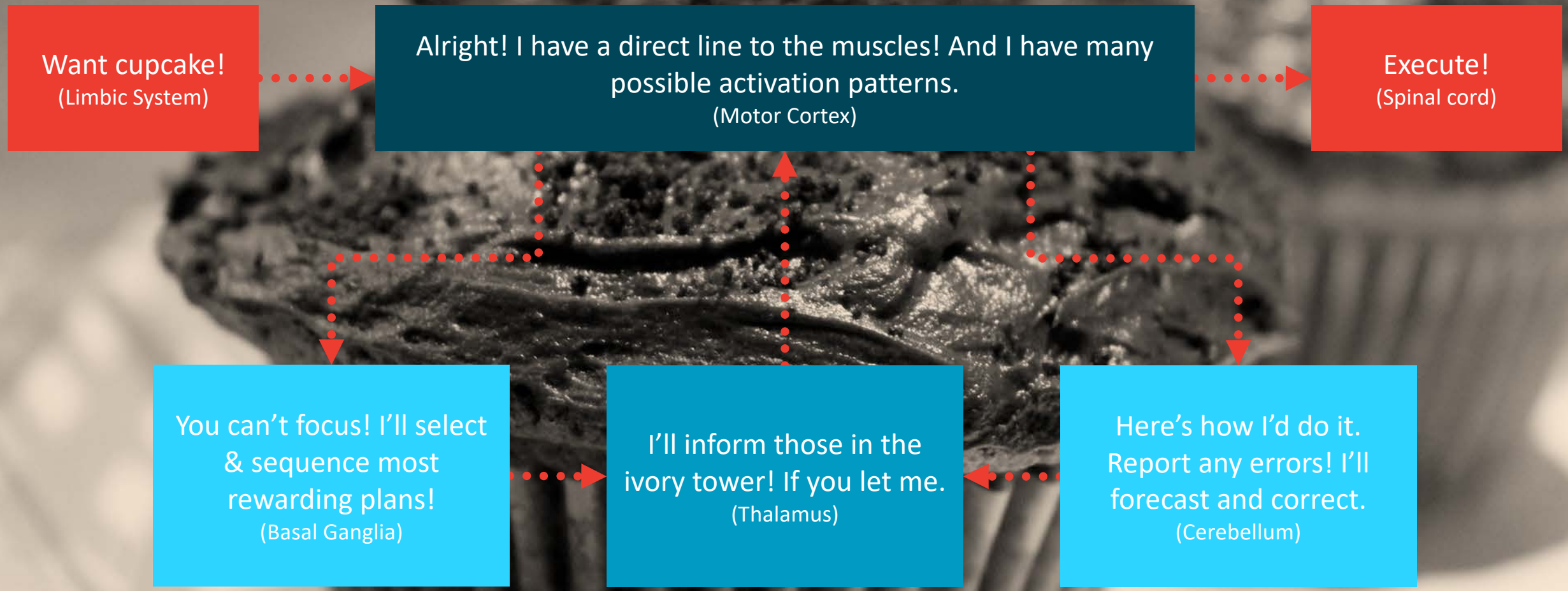
Normal Condition



Huntington



Huntington Disease



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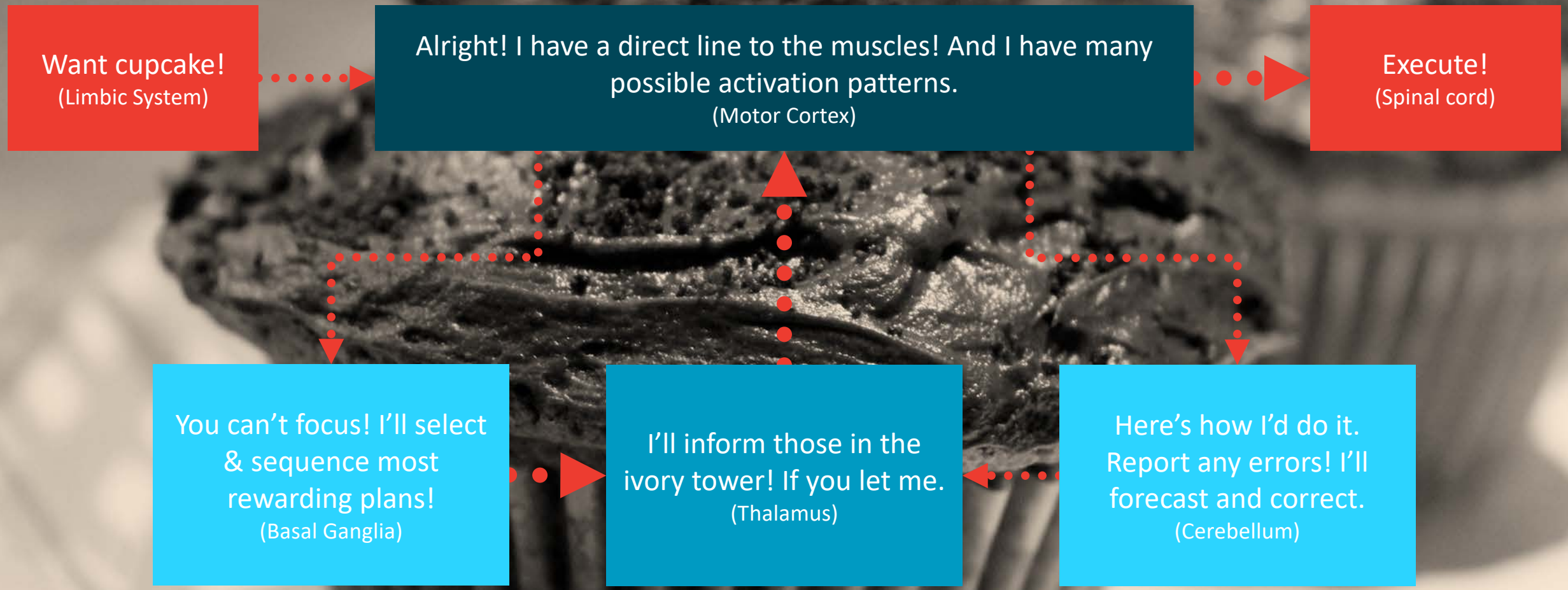
Huntington Disease



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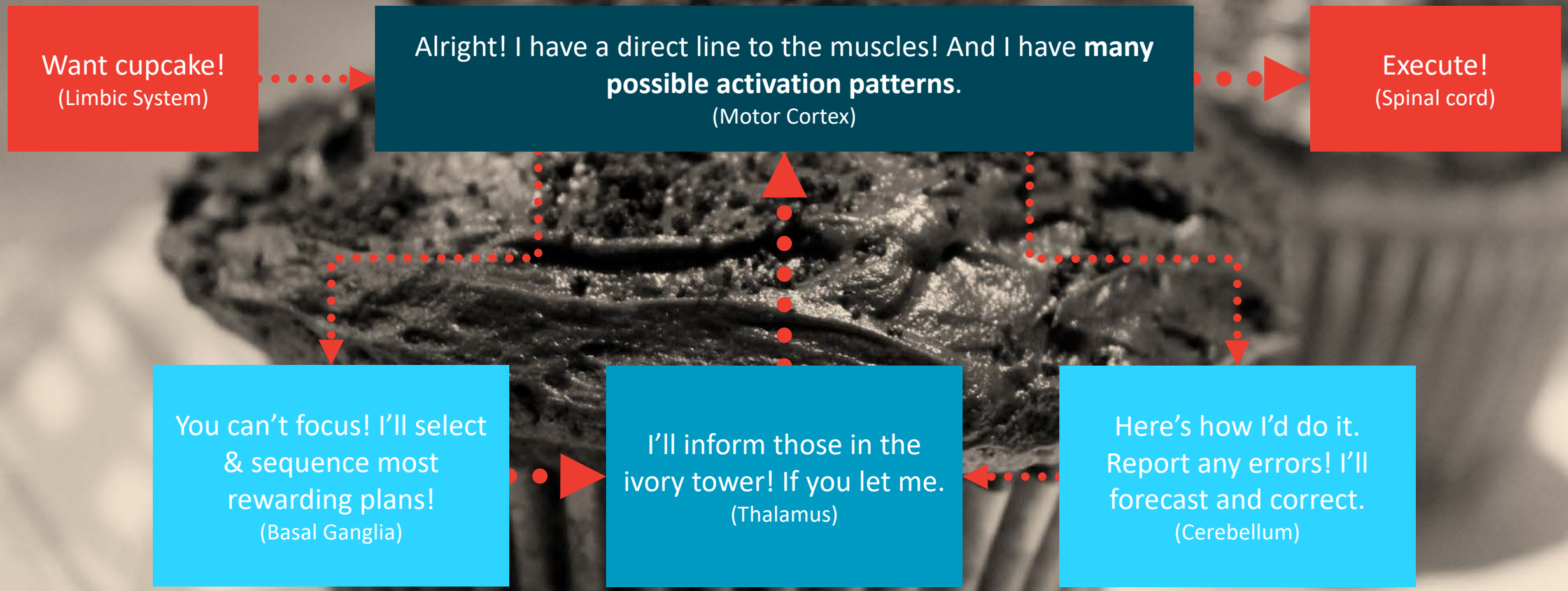
Huntington Disease



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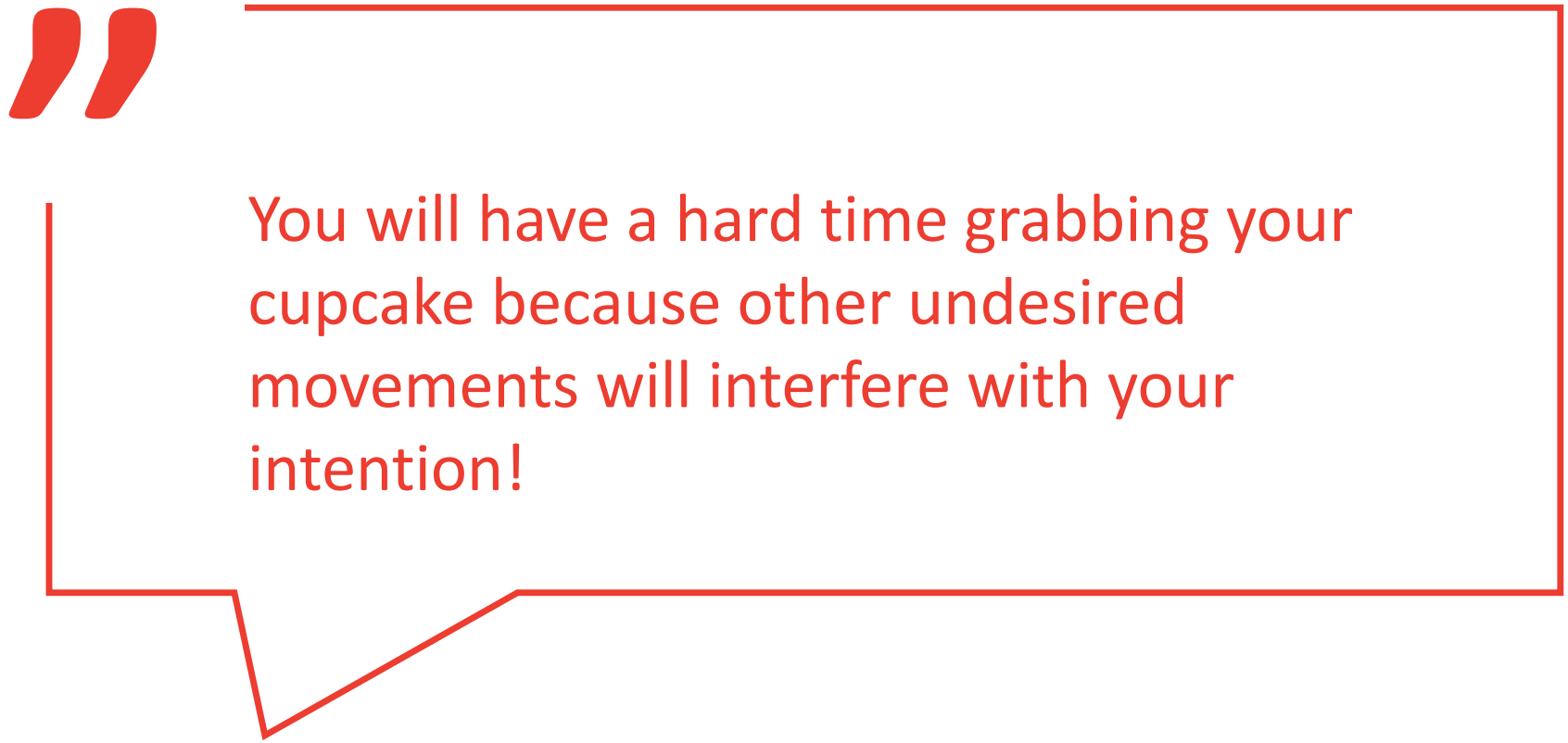
Cupcake?



Dysfunctional Feedback Loops – Recap

- Two categories of movement disorders
  - Difficulties to **initiate** intended movement
  - Difficulties to **suppress** unintended movements

- Both result from damages of the same loop (Cortex-BG)

- Imbalance of excitation and inhibition
- Significant impact on overall motor control

Organizational Dysfunctions

Dysfunctions of Motor Control

Too little (hypokinesia)

- Morbus Parkinson
  - Death of cells in SNc
  - Loss of dopamine
  - Disability to modulate

Too much (hyperkinesia)

- Chorea Huntington
  - Death of cells in striatum
  - Loss of GABA
  - Disability to suppress
- Hemiballismus
  - Damage to STN
  - Disability to suppress

Organizational Dysfunctions

Too little

- Difficulties to initiate what is desired
- Difficulties to discard what is already running

Too much

- Difficulties to avoid what is not intended
- Constant interference

Organizational Hypokinesia – Difficulties to initiate

- Cumbersome upstream process
- Analysis paralysis
- Starvation of downstream
- Hand off processes
- Sign off processes
- Large lead times for acquiring options
- Information hiding or information radiators
- Lack of agreement about intent (Einheit)

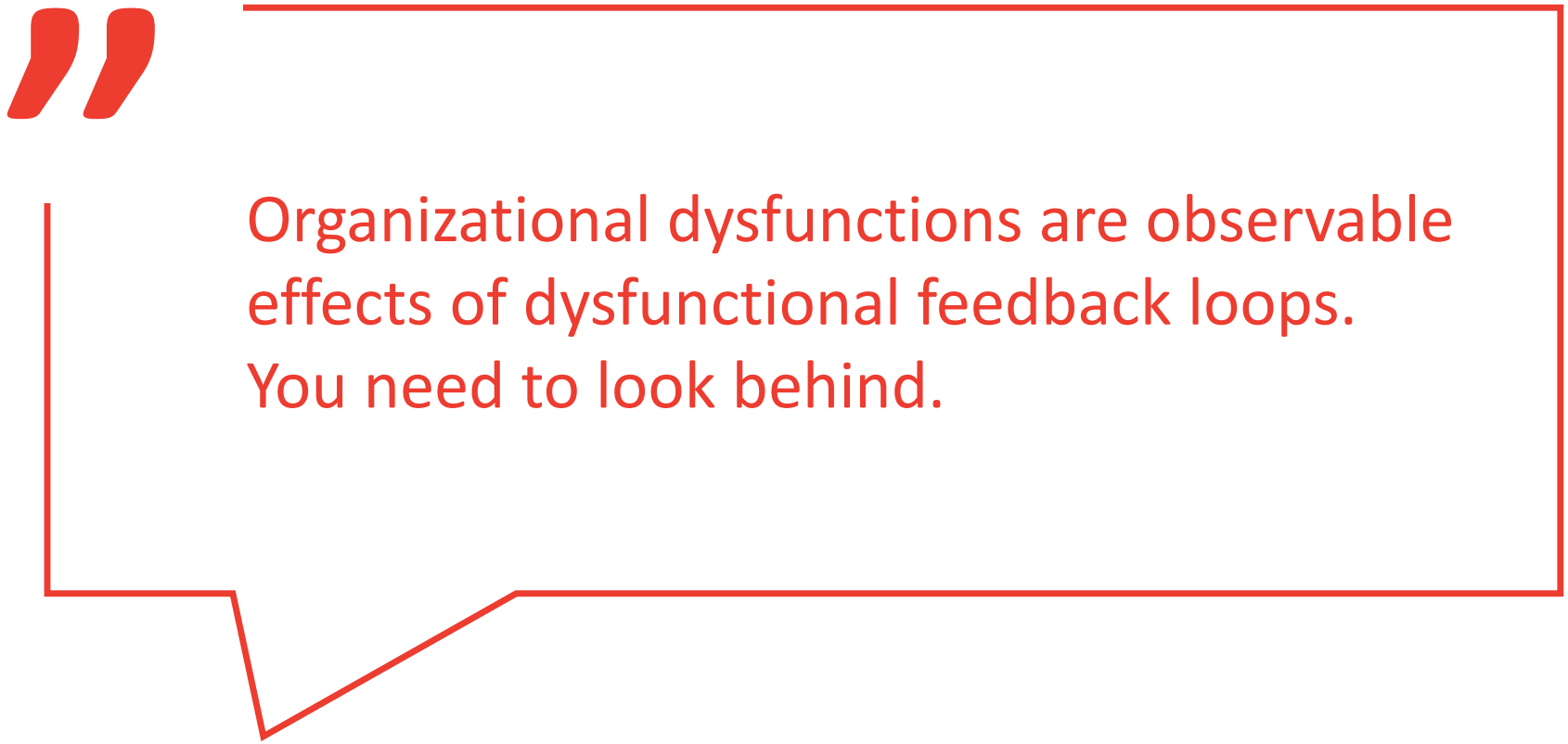
LKNA18 – Nicolas' & Frédéric's Talk

> The longer the process takes to launch a project, the harder it is to stop it!

Organizational Hyperkinesia – Difficulties to avoid the unintended

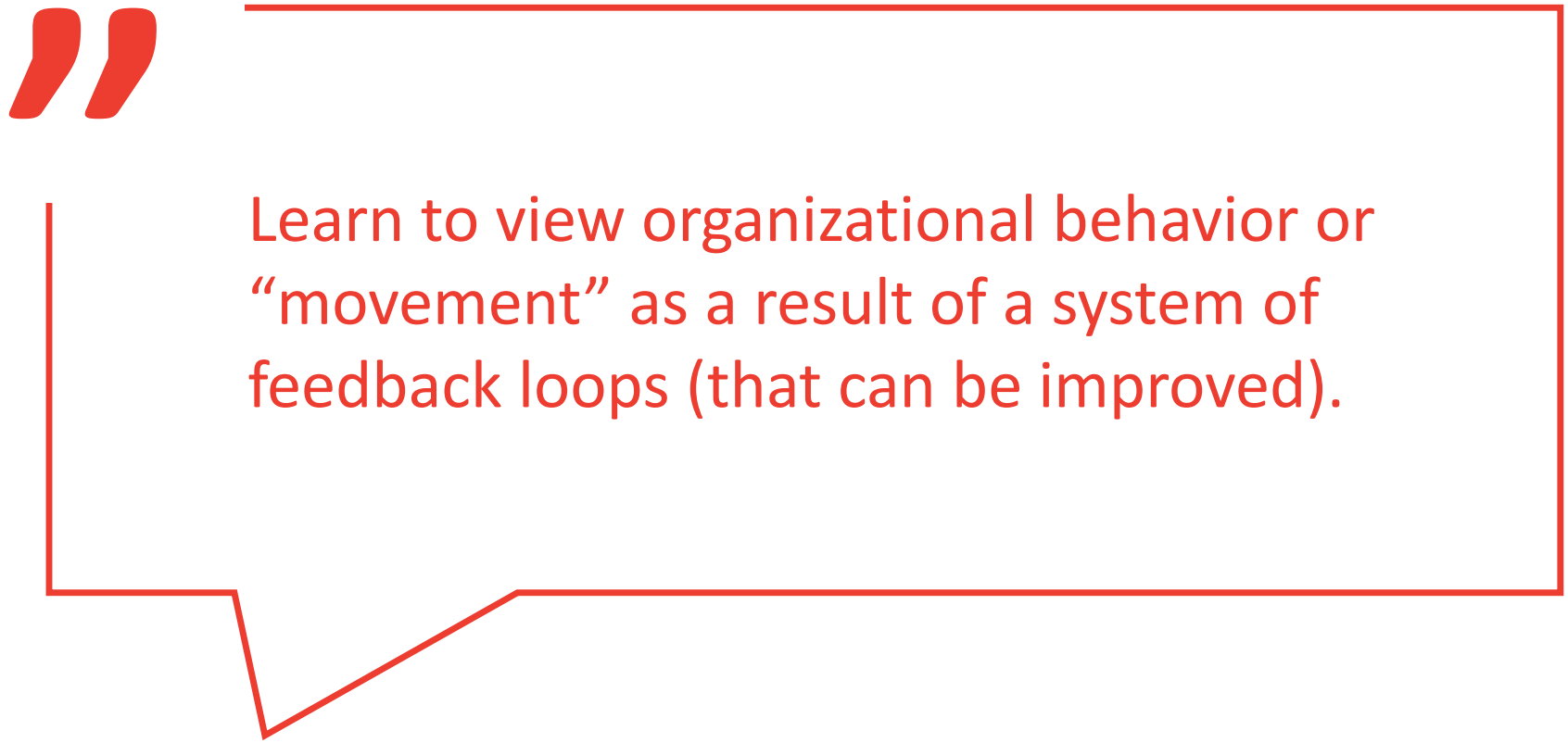
- Irrefutable demand
- No demand shaping
- Premature commitment
- Push behavior
- No sense of capability or capacity
- No sense of risk management
- No sense of optionality
- Rewarding starting work instead of finishing

So what?



The Feedback Lens beta

The Feedback Lens



The Feedback Lens

What to look for

- What feedback loops are already there? How are they used?
- What are no loops at all?
- Feedback loops dementia?
- What changes occur through active feedback loops?
- Signs of organizational plasticity?

What to do

- Map how information and decisions flow through the system
- Pay attention to what information or decisions go through and what don’t
- Insert a “virus” or a trace element and watch it propagate
- Identify the “**reward**” systems!

Use the Kanban Litmus Test

- Has the customer interface changed?
- Has the customer contract changed?
- Has your service delivery business model changed?
- Has managers changed their behavior?

Take – Aways

Message #1 – Organizational Movement

- Living beings developed brains in order to move
- Movement requires external and internal coordination
- Organizations compete in a environment that favors those who can move swiftly – Business Agility
- Organizational movement requires a management system (brains) and feedback loops for coordination of external and internal interactions

Message #2 – Dynamic Loop Types

- In technical systems, engineered by humans, feedback loop types are usually hard-wired
- In naturally occurring systems they are not
- These systems can switch from escalation to de-escalation, from excitation to inhibition
- Novelty can emerge, grow and stabilize
- Organizations should develop their management capability to **adjust & switch** feedback loop types **dynamically**

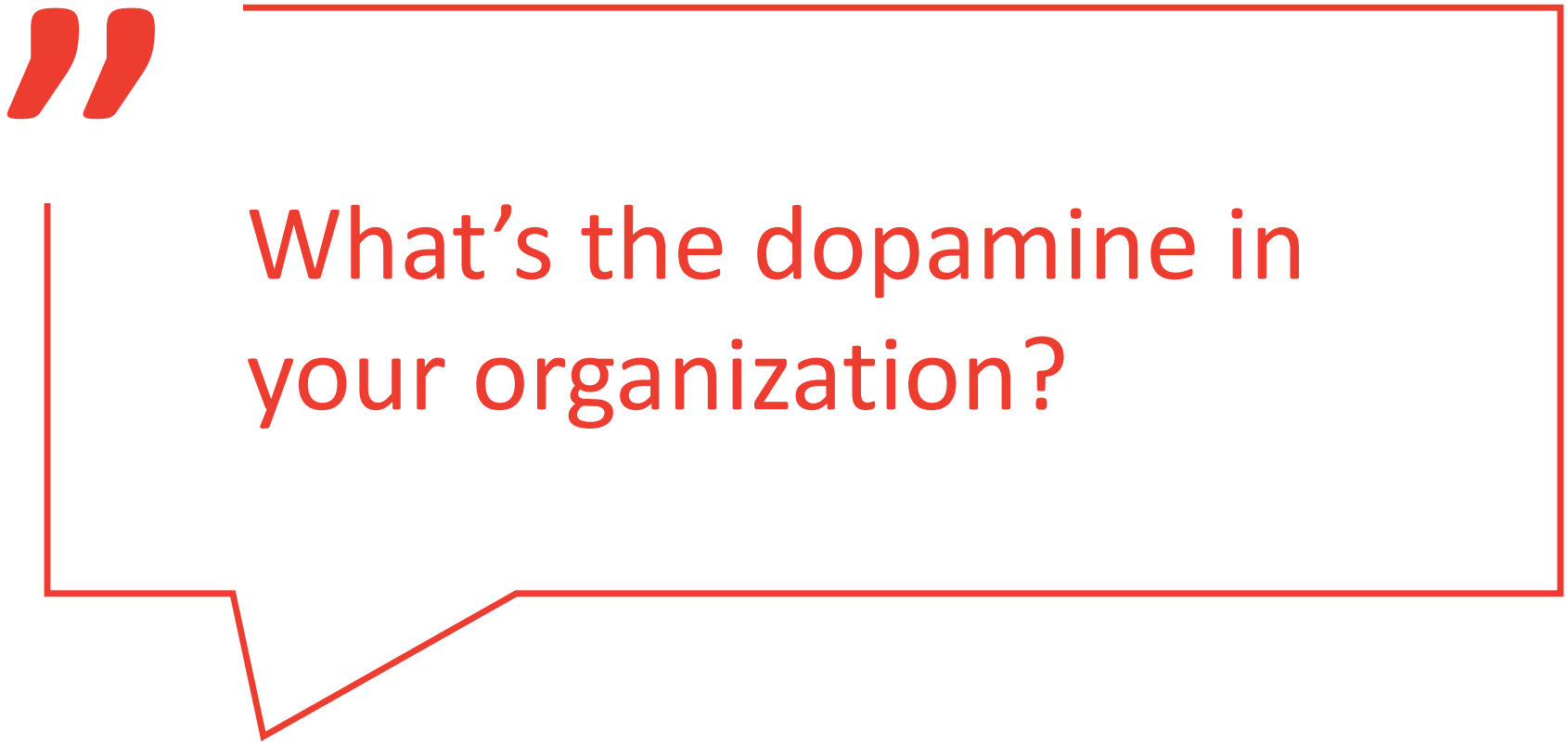
Message #3 – Organizational Plasticity

- Brain – The ability of your brain to reorganize itself, both physically and functionally, throughout your life due to environment, behavior, thinking and emotion.

- Organization – …

- **That might be a great topic for next year!**

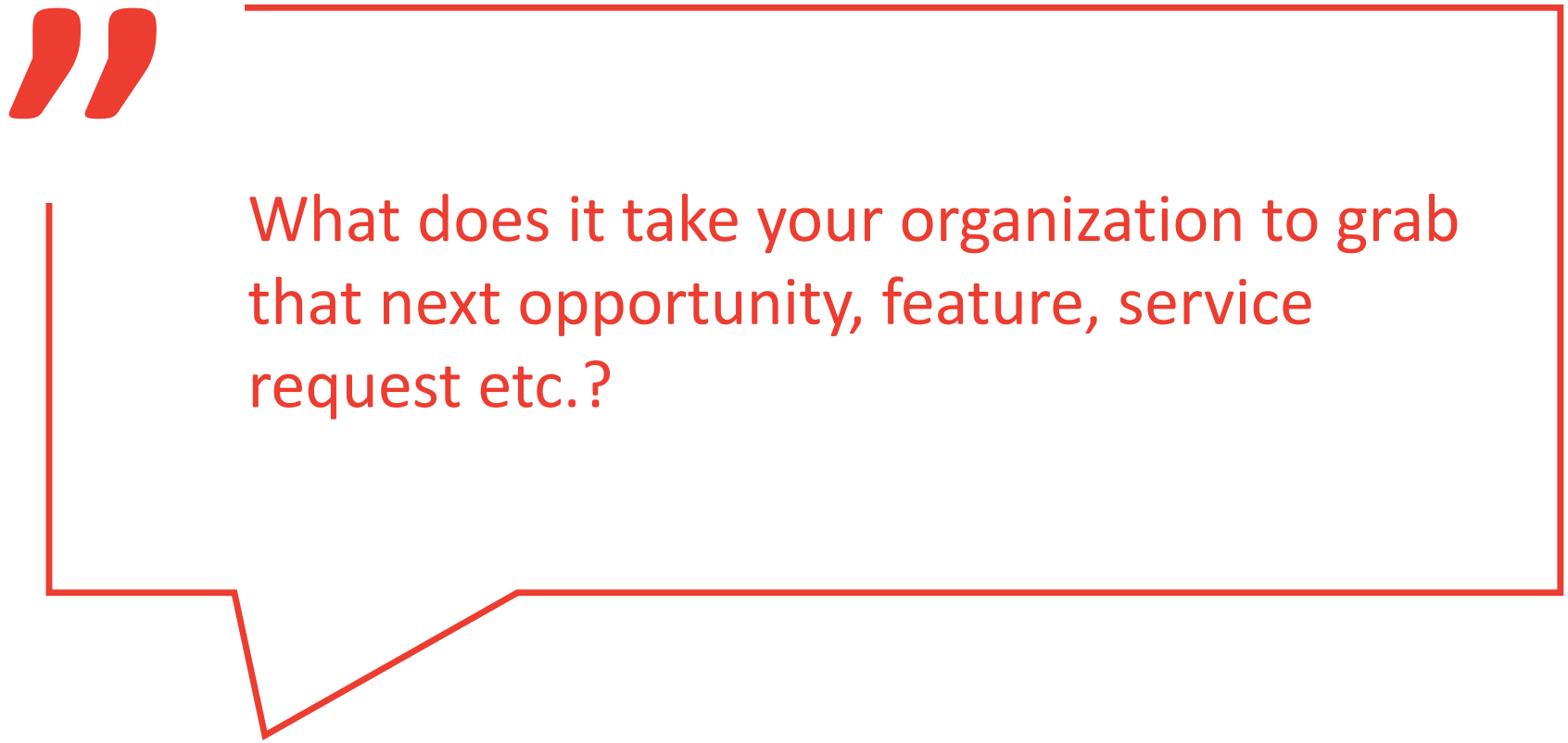
One last thing …



It’s your Identity!

Dopamine wins!

Thank You!



@trichromacy

http://www.flow.hamburg

PLAN SYSTEMS. MANAGE WORK. LEAD PEOPLE.

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