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Commission



‘Gymnastics Movement Patterns’

A Biomechanical Taxonomy for All Gymnastics & Arobatic Sports

Keith Russell PhD
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What is a taxonomy (taxonomia) ?

Kingdom Reino

Phylum Filo

Class Classe

Order Ordem

Family Familia

Genus Genero

Species Especie

Gymnastics Sport Disciplines

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Gymnastics Sport Disciplines

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Gymnastics Sport Disciplines

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Gymnastics Sport Disciplines

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Gymnastics Sport Disciplines

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**Gymnastics
Sport Disciplines**

**Gymnastics
for All**

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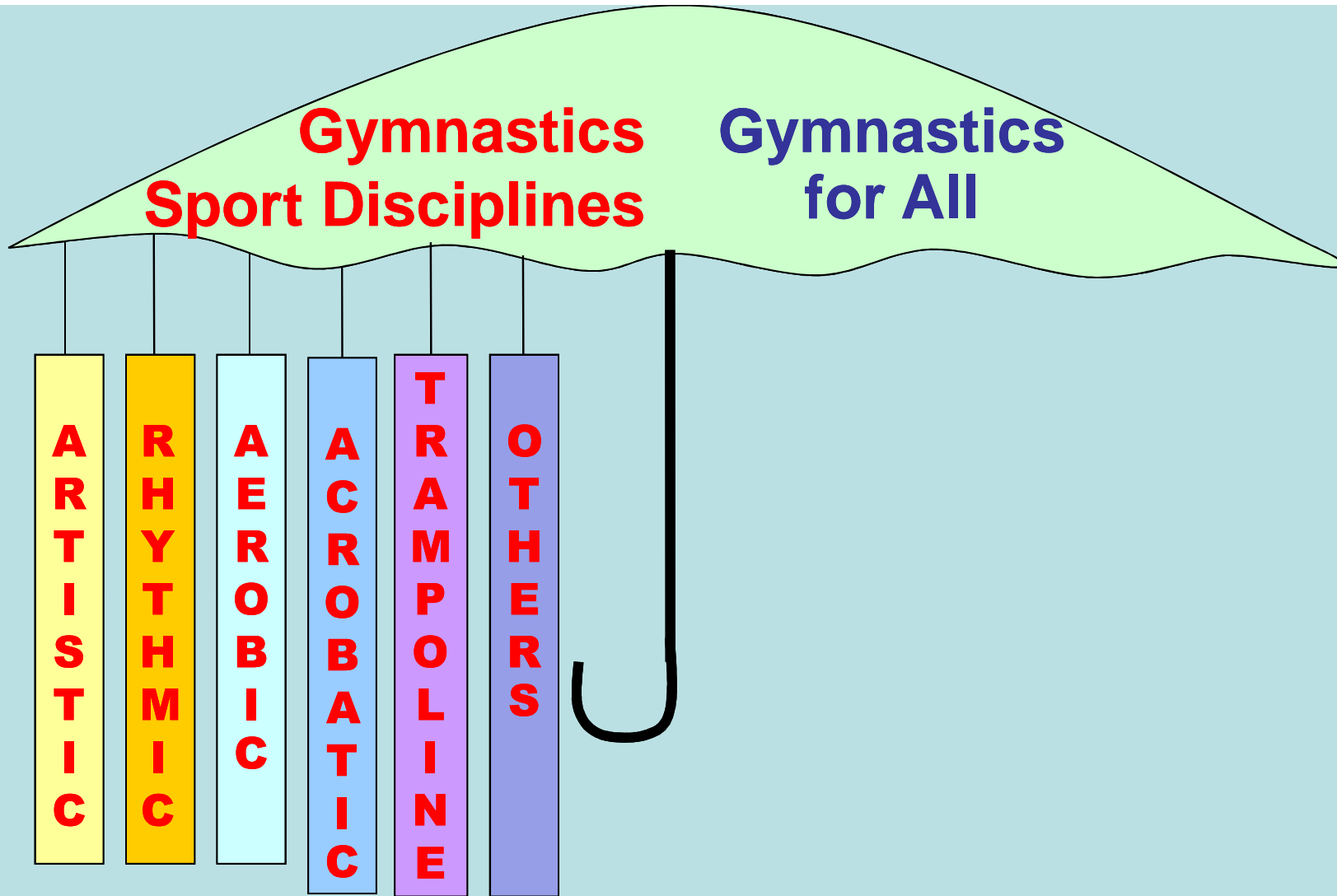
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Gymnastics Sport Disciplines

Gymnastics for All

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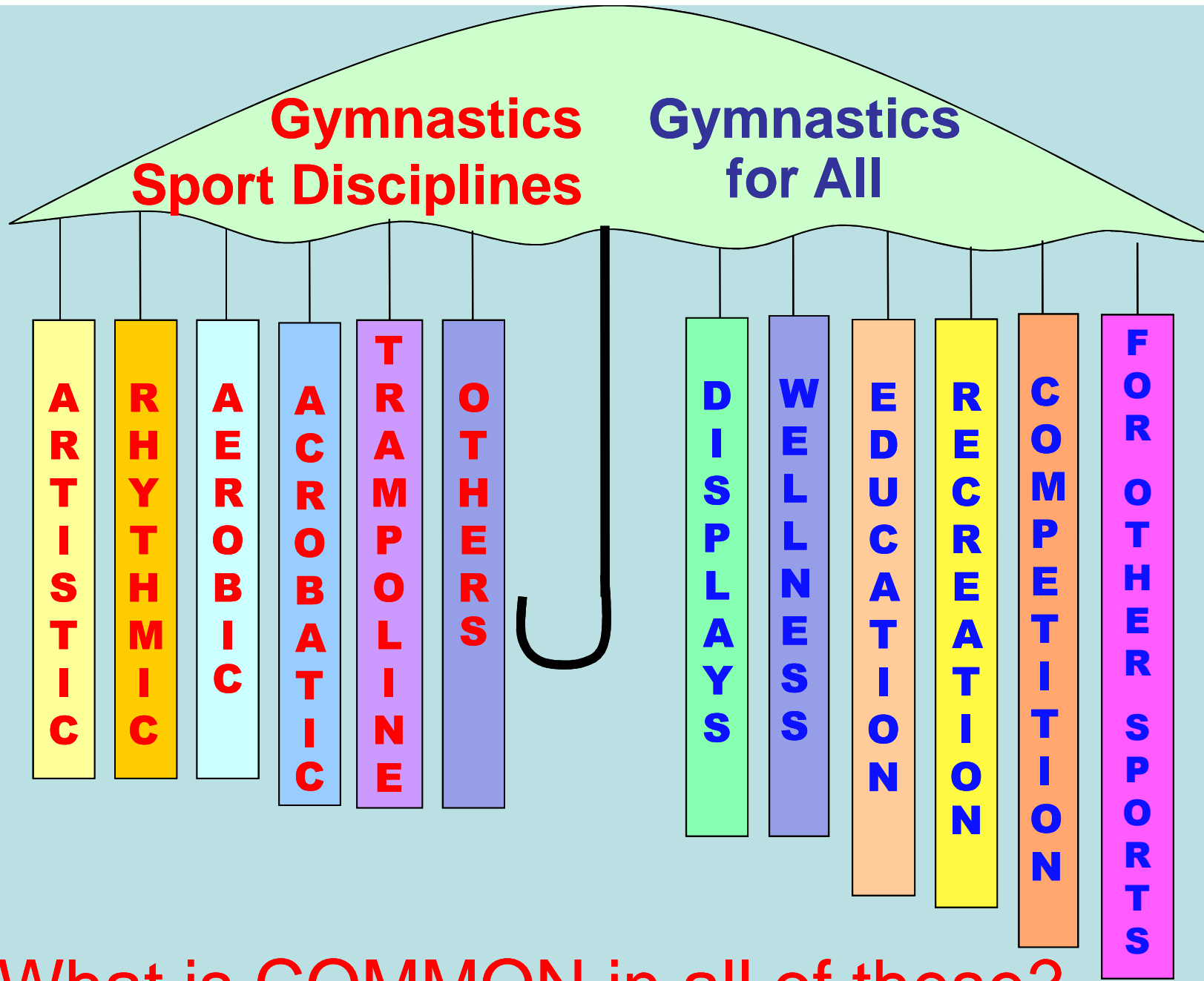
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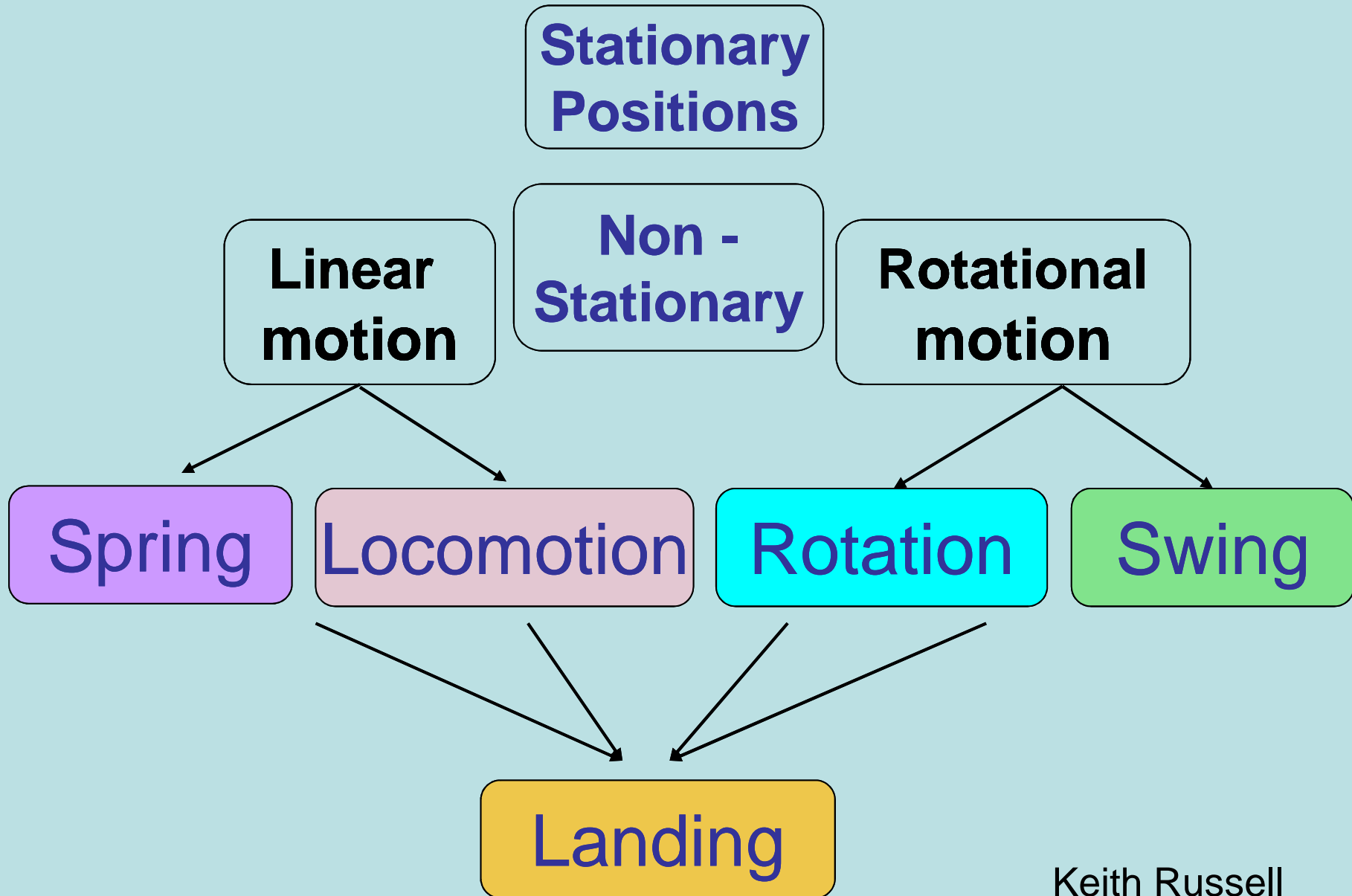
What is COMMON in all of these?

We can reduce all gymnastics skills into
6 mechanically determined
Gymnastics Movement Patterns
from which all gymnastics skills evolve

If we understand the mechanics of
these 6 GMP's,
we understand **ALL** gymnastics skills

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Overview - Gymnastics Movement Patterns



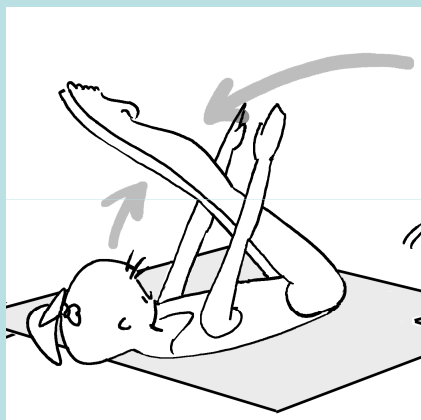
Biomechanically, we can divide all gymnastics skills into 2 groups.

1. The **STATIONARY** group **do not** move outside gymnast's base of support:
2. The **NON-STATIONARY** group **do** move outside base of support:

Gymnastics Movement Patterns

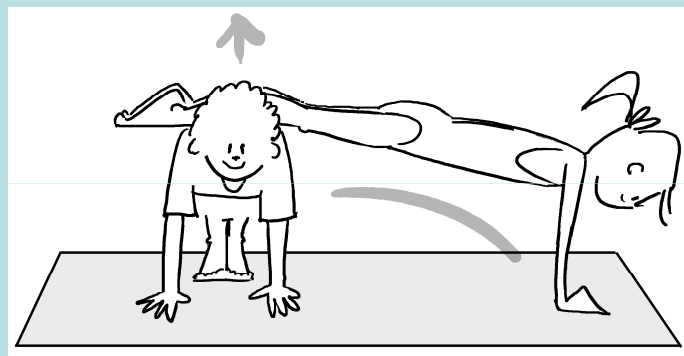
Stationary
Positions

Posições
Estacionárias



Supports

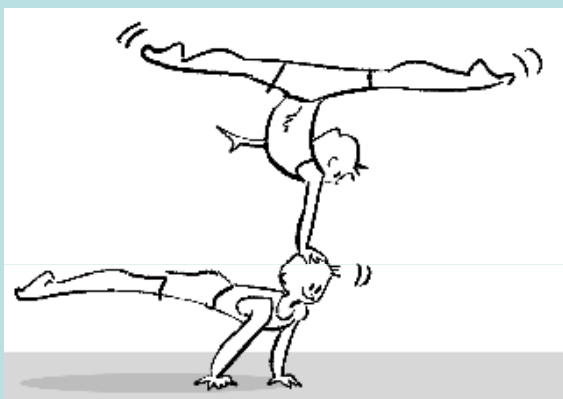
Apoios



- centre of mass is **well inside** base
- **stable** positions
- centro de massa **bem dentro** da base
- posições **estáveis**

Gymnastics Movement Patterns

Stationary Positions



Balances

Equilíbrios



- centre of mass is **on the edge** of base
- **un**stable positions

- centro de massa **no limite** da base
- posições **instáveis**

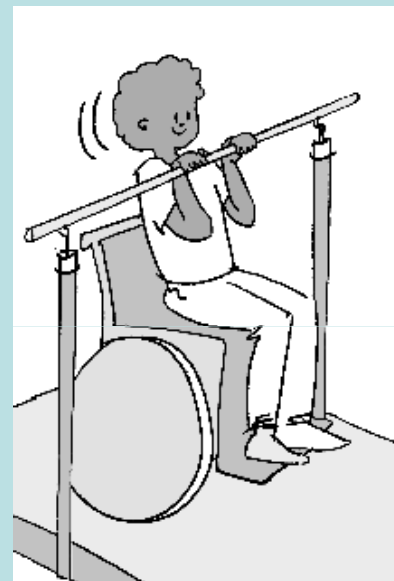
Gymnastics Movement Patterns

Stationary
Positions



Hangs

Suspensões

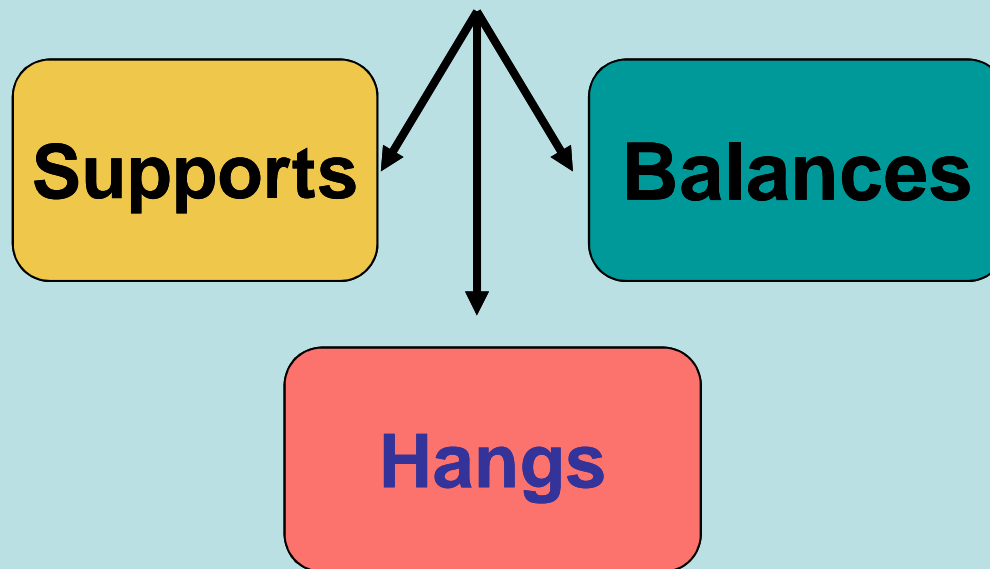


- centre of mass **below** base
- **very** stable

- centro de massa **por baixo** da base
- **muito** estável

Gymnastics Movement Patterns

**Stationary
Positions**



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Gymnastics Movement Patterns

**Linear
motion**

**Non -
Stationary**

**Rotational
motion**

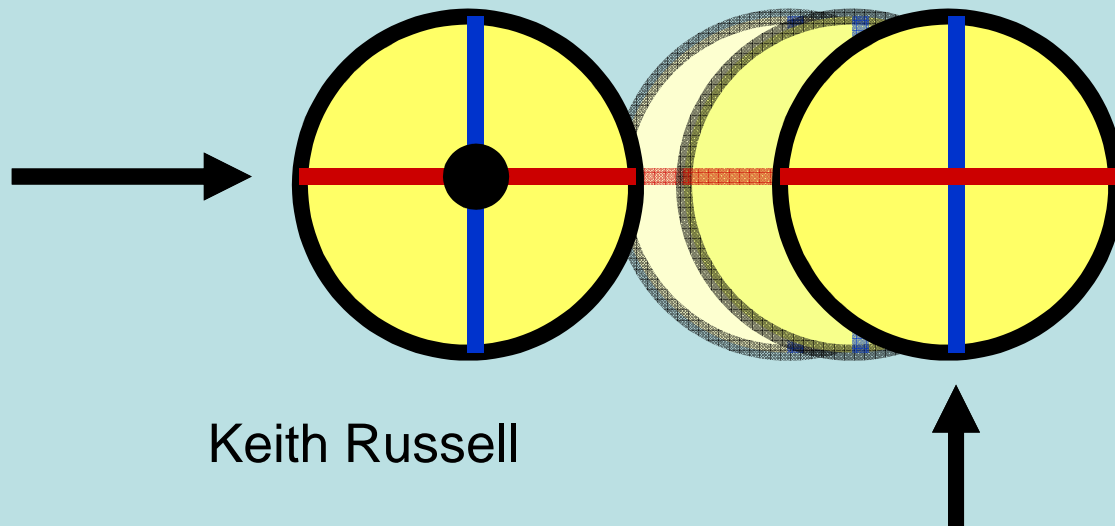
**Movimento
Linear**

**Não
Estacionários**

**Movimento
Rotacional**

Linear motion

If forces pass directly through centre of mass, they cause linear motion (displacement).



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Linear motion

Skills moving **from** a base of support in a **single explosive movement** are called **SPRINGS**

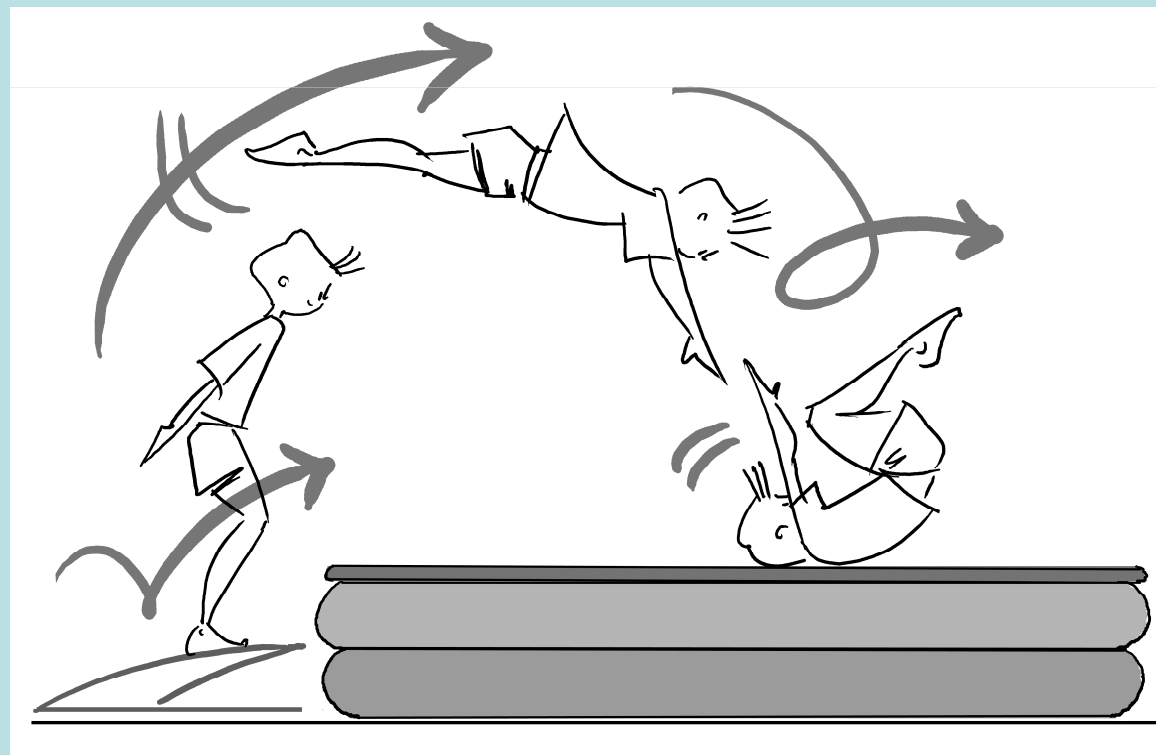
take-off, leap / hop (1 foot), jump (2 feet)

Skills saindo da base de suporte num movimento único e explosivo chamam-se **SALTOS**
chamada, pulo, salto

Linear motion

SPRINGS

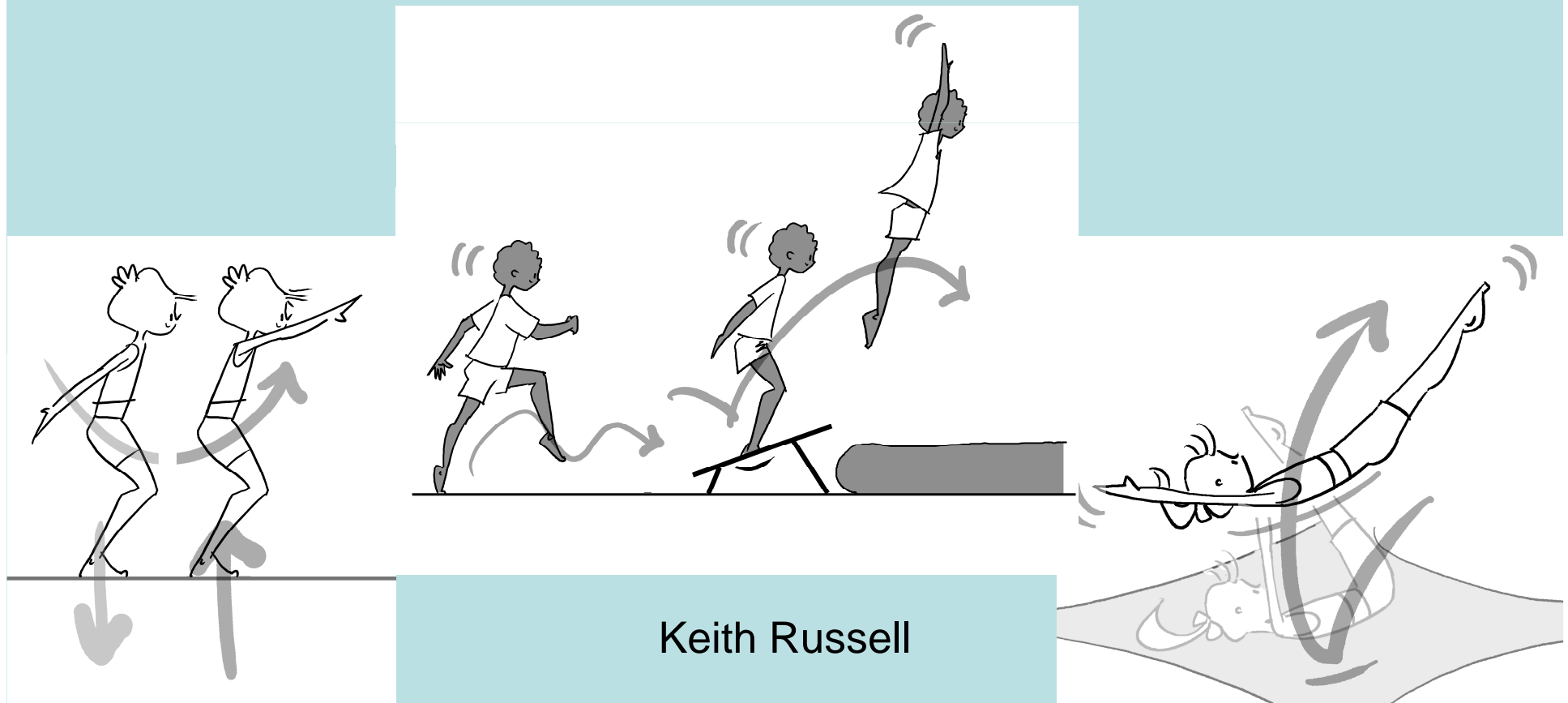
- Ground Reaction Force of Contact Limbs = direct GRF



Linear motion

SPRINGS

- Ground Reaction Force non contact limb = indirect GRF



Linear motion

Skills moving **from** a base of support in a **single explosive movement** are called **SPRINGS**

- Resultant GRF



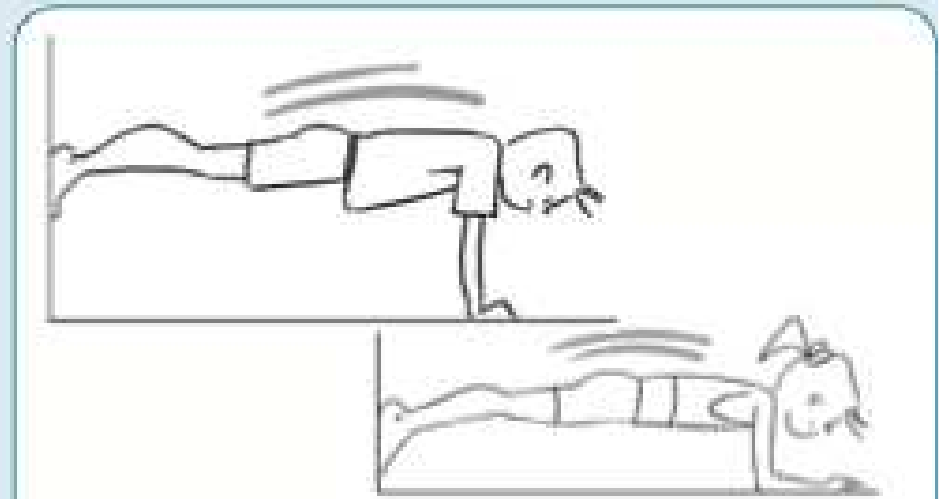
Linear motion

Skills moving **from** a base of support in a **single explosive movement** are called **SPRINGS**

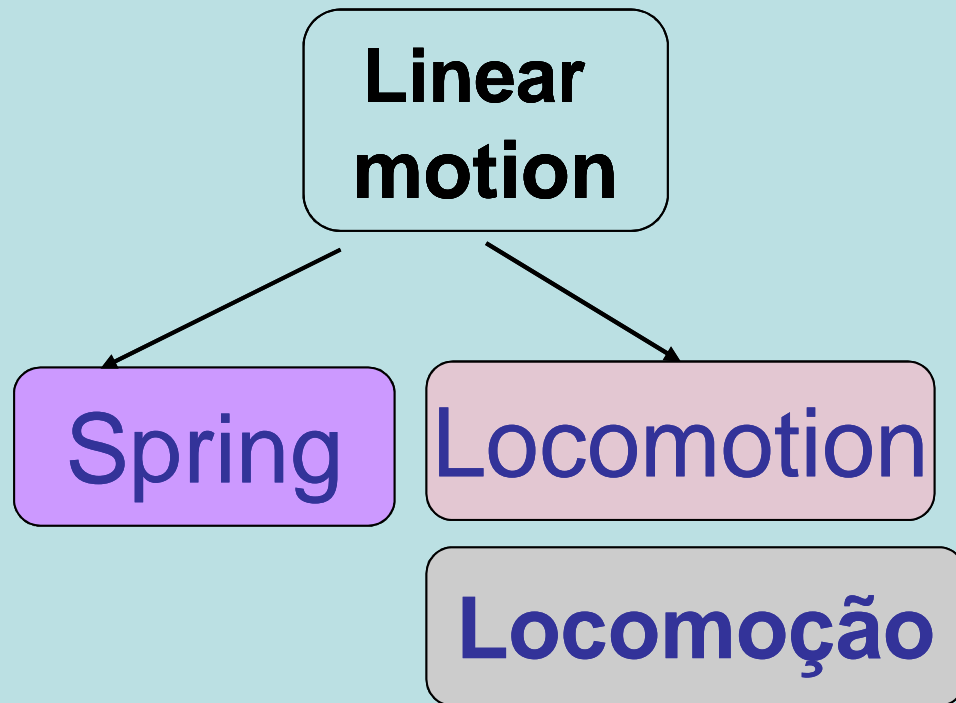
- Rigid Body

7. Apoio frontal suportado na parede

- Apoio frontal nas mãos, com os pés na parede à altura dos ombros;
- Apoio frontal nos cotovelos, com os pés na parede à altura dos ombros.



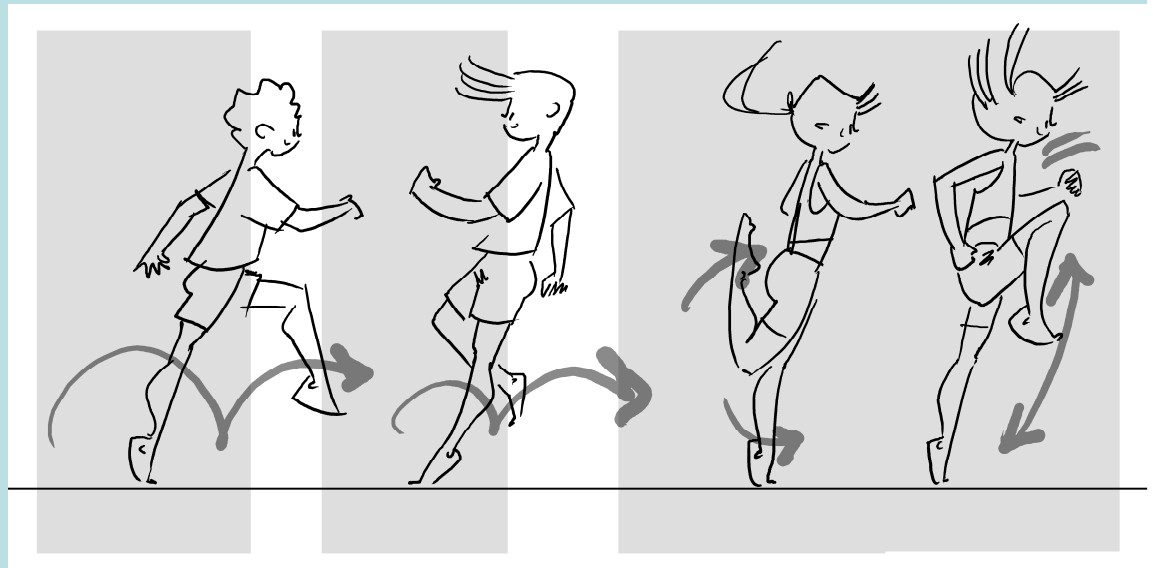
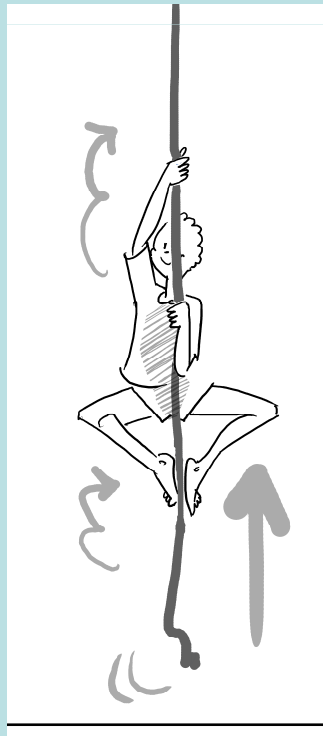
Gymnastics Movement Patterns



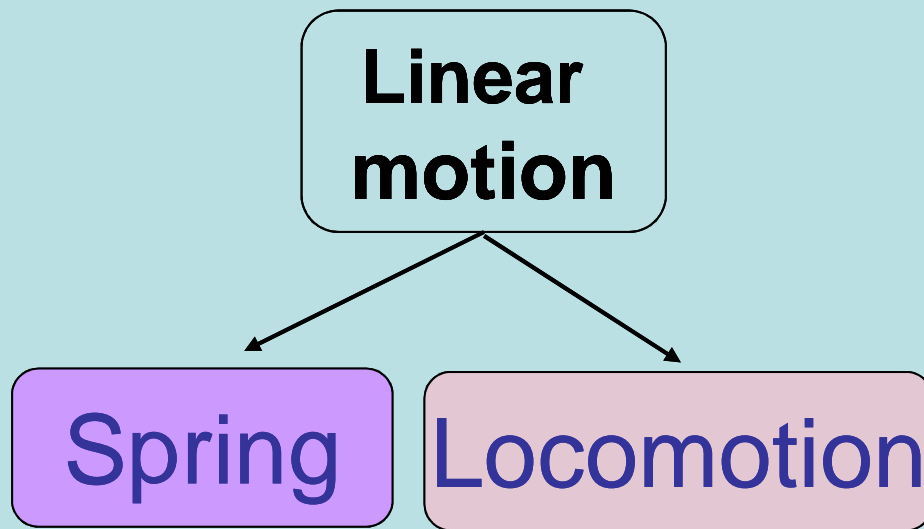
Linear motion

Skills moving from a base of support
repetitive movements are called
LOCOMOTIONS

run, skip, climb, traverse

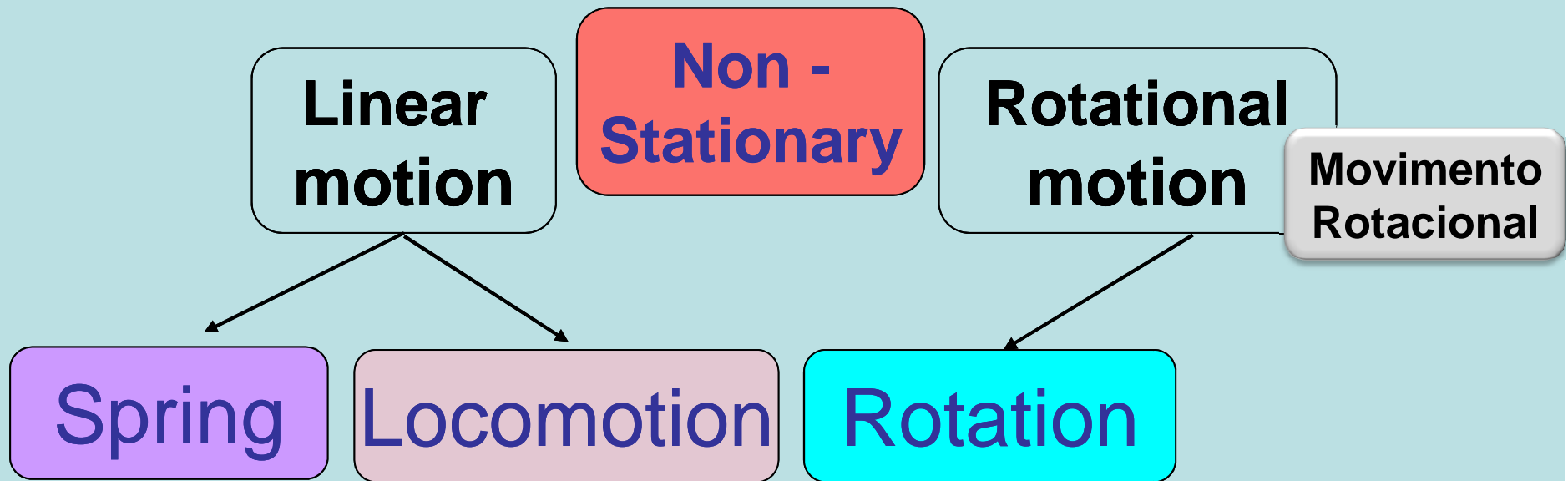


Gymnastics Movement Patterns



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Gymnastics Movement Patterns

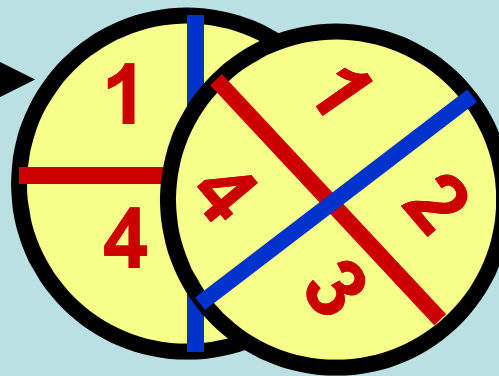


Rotational motion

Skills moving **about** one of the body's **internal axes** are called **ROTATION**

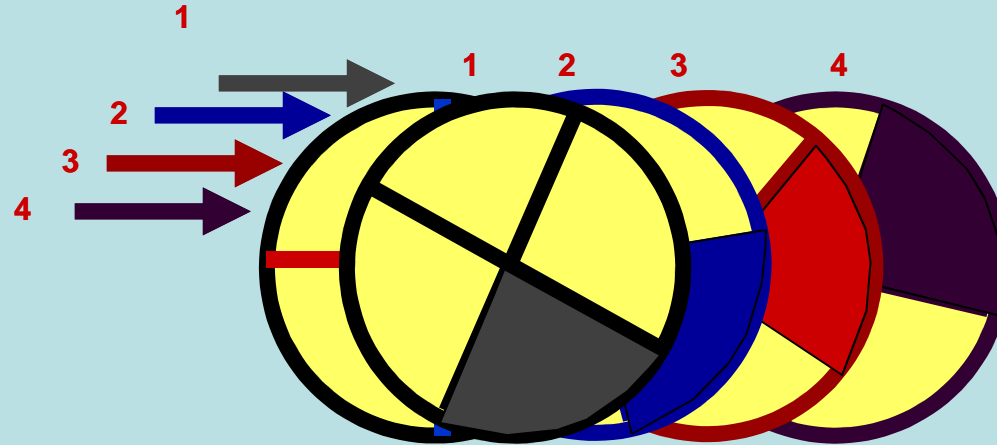
- Off centre (eccentric) GRF

“off centre” force



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“off centre” forces



The further “off centre” the force...

- the greater the rotation
- & the less the linear displacement

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Rotational motion

Skills moving **about** one of the body's **internal axes** are called **ROTATION**

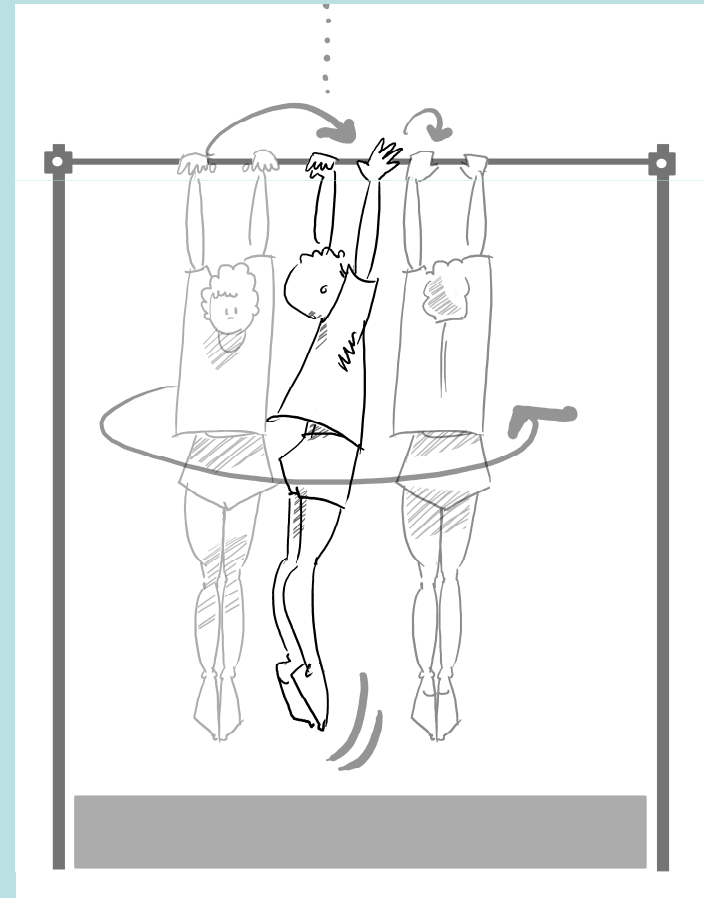
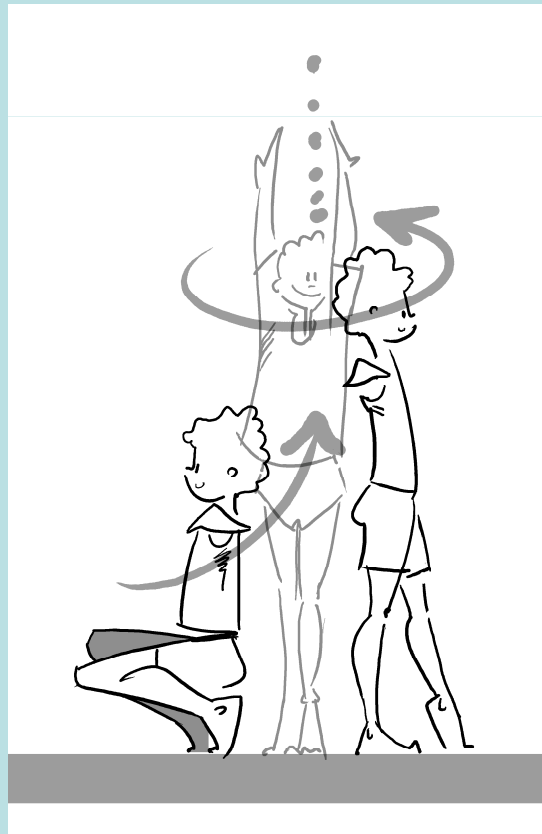
- **transverse**



Rotational motion

Skills moving **about** one of the body's **internal axes** are called **ROTATION**

- longitudinal



Rotational motion

Skills moving **about** one of the body's **internal axes** are called **ROTATION**

- Anterior / Posterior



Rotational motion

Skills moving **about** one of the body's **internal axes** are called **ROTATION**

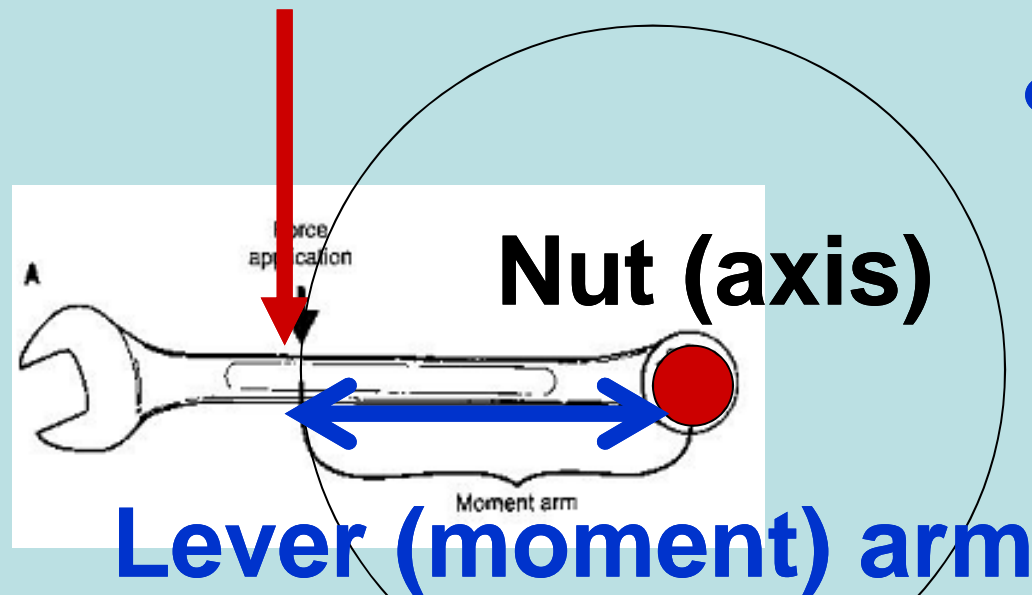
- transverse
- longitudinal
- Anterior / Posterior

somersaults, twists, spins, pivots,
turns, rolls, pirouettes, etc.

Rotational motion

Skills moving **about** one of the body's **internal axes** are called **ROTATION**

“off centre” force

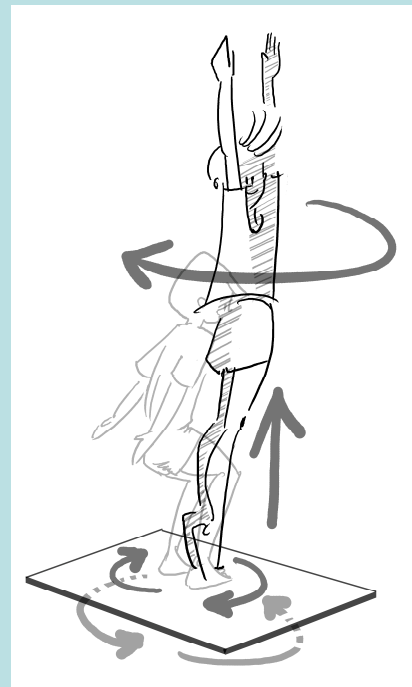
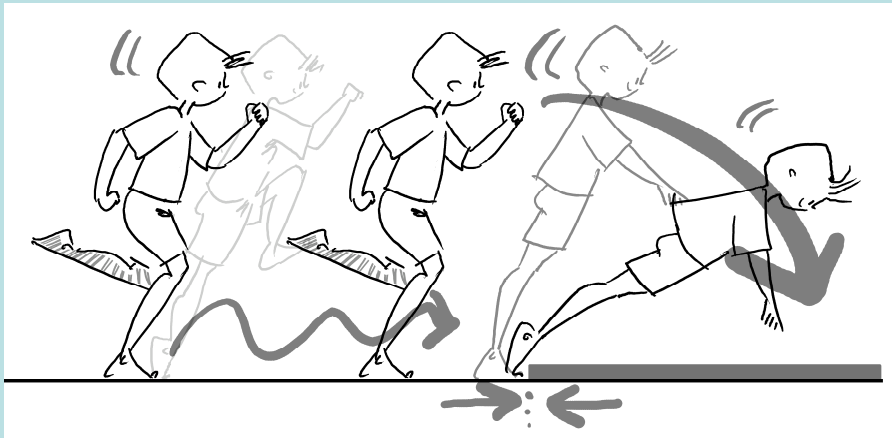


- the force \times
- the lever arm
= torque

Rotational motion

Skills moving **about** one of the body's **internal axes** are called **ROTATION**

- Off centre (eccentric) GRF



force
couples

Rotational motion

Skills moving **about** one of the body's **internal axes** are called **ROTATION**

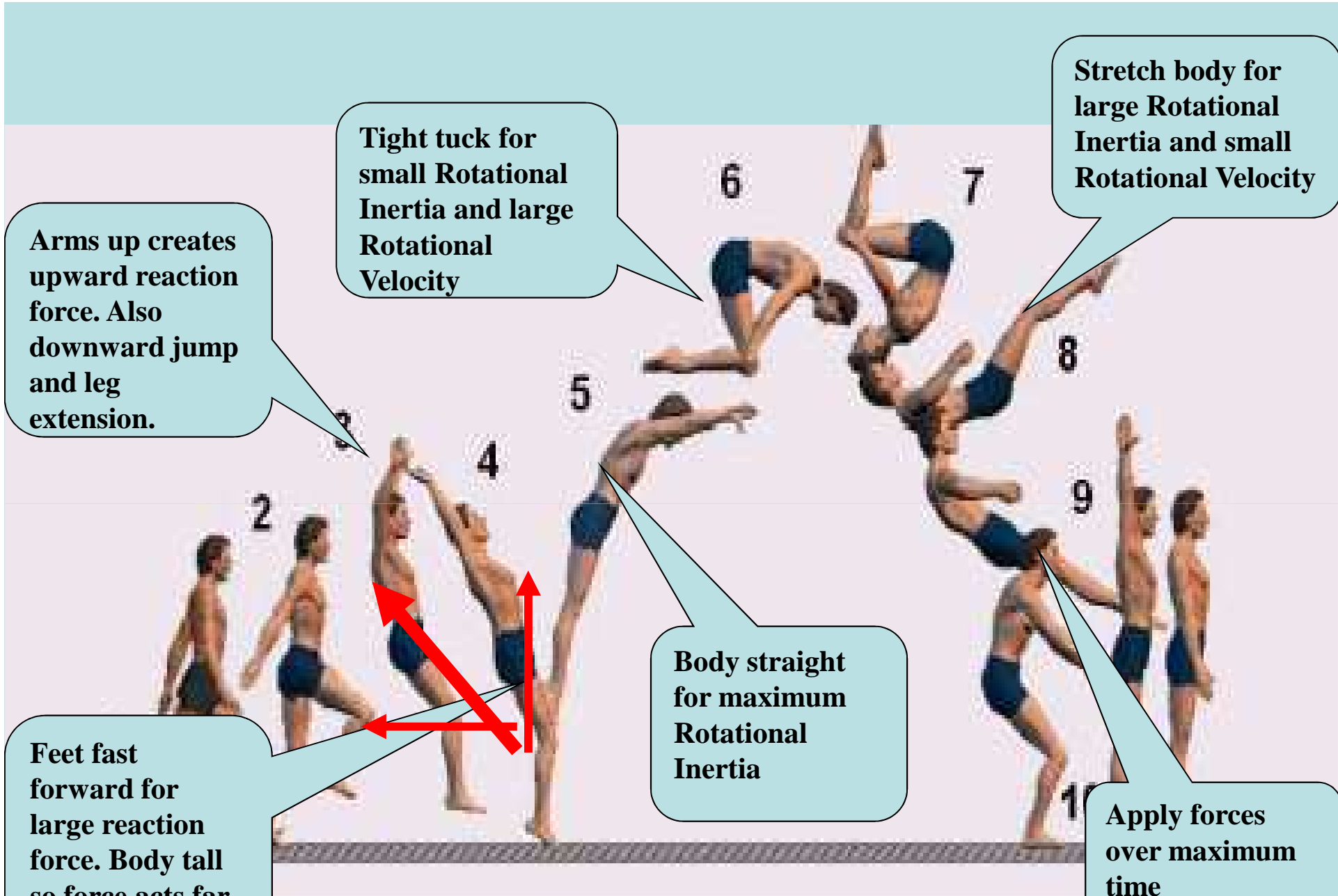
- Conservation of Rotational momentum

Mass closer to axis, increase speed of rot'n
Mass further from axis, decrease speed

Rotational motion

Skills moving **about** one of the body's **internal axes** are called **ROTATION**

Initiate Long. axis rotation with tilt...



Arms up creates upward reaction force. Also downward jump and leg extension.

Tight tuck for small Rotational Inertia and large Rotational Velocity

Stretch body for large Rotational Inertia and small Rotational Velocity

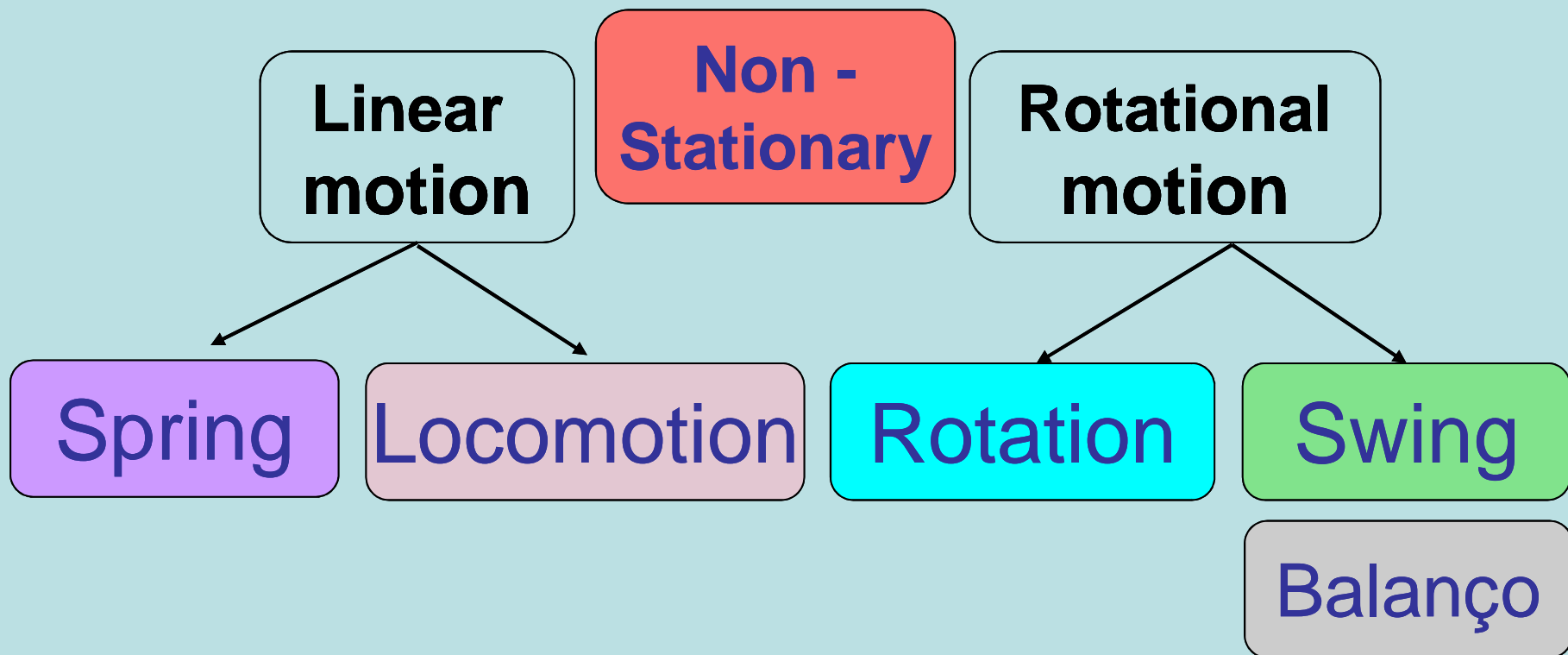
Feet fast forward for large reaction force. Body tall so force acts far from axis

Body straight for maximum Rotational Inertia

Apply forces over maximum time

from FIG Academy Course
H.Fink

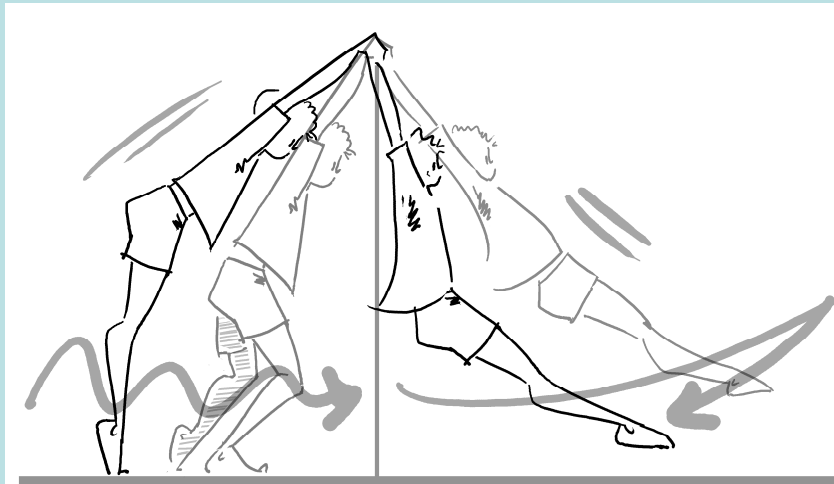
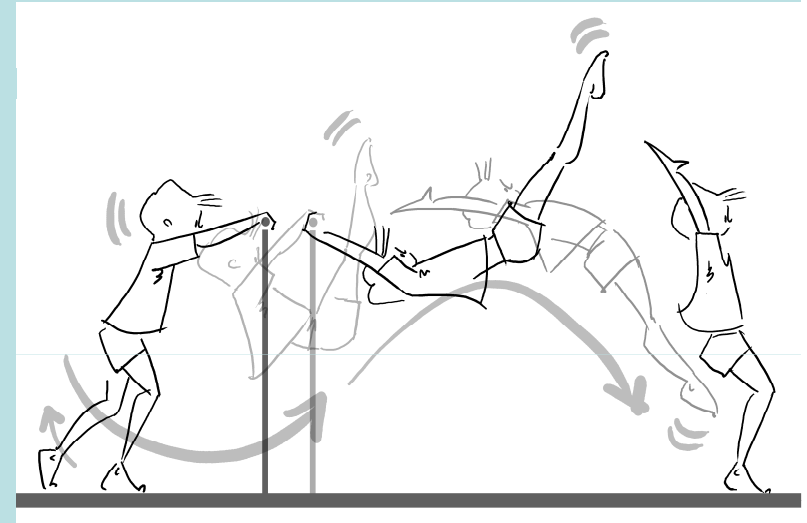
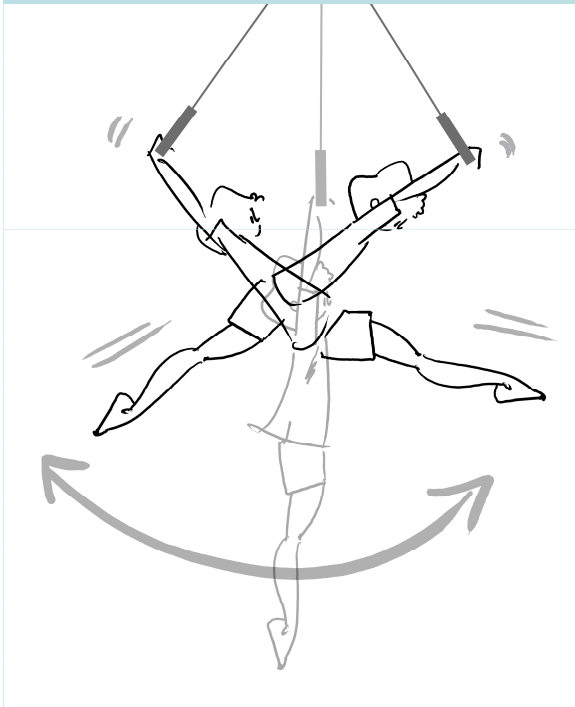
Gymnastics Movement Patterns



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Rotational motion

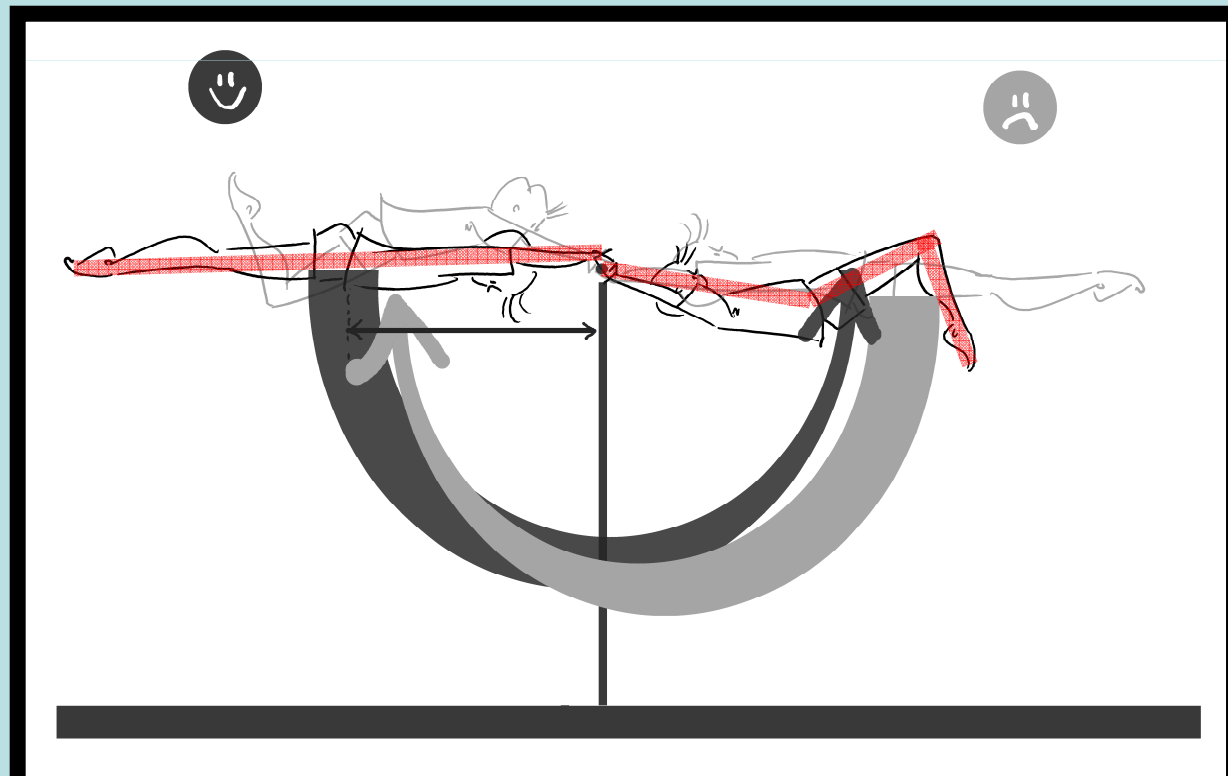
Skills moving **about** an **external axis** are called **SWING**.

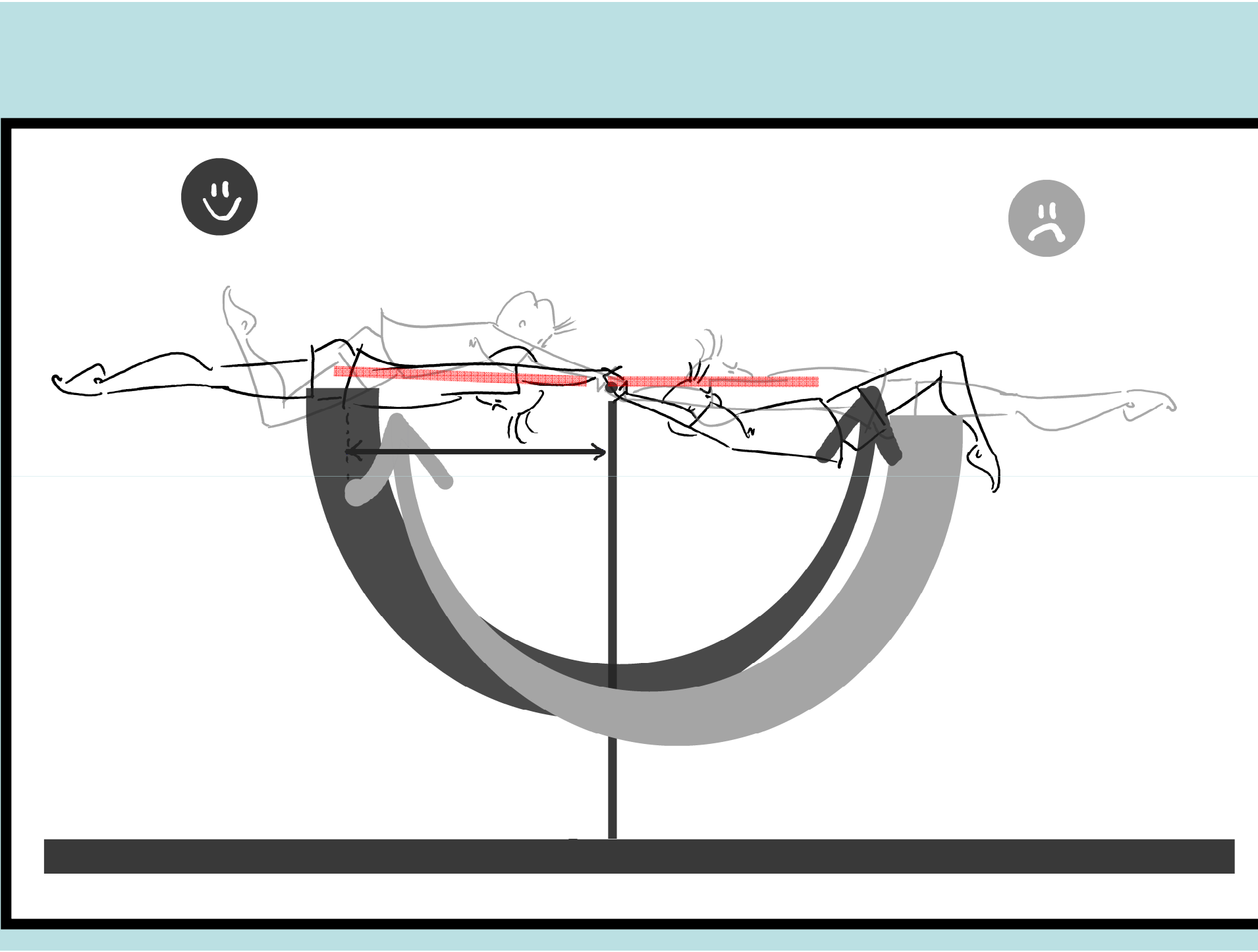


Rotational motion

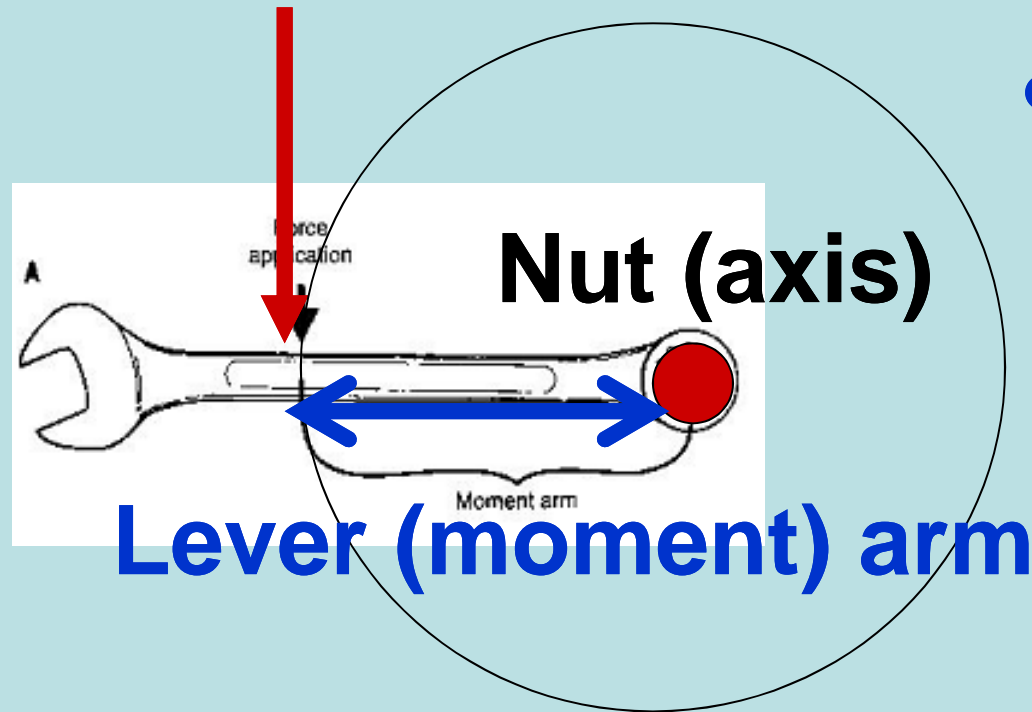
Skills moving **about** an **external axis** are called **SWING**.

- Descending phase
- Ascending phase





“off centre” force

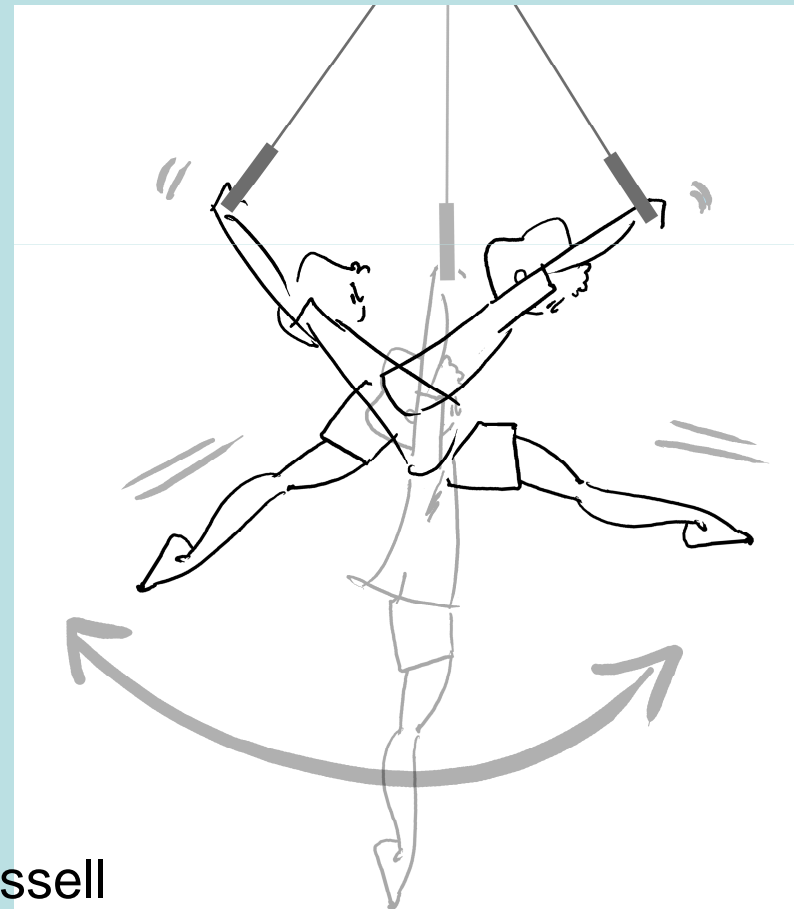


- the force \times
- the lever arm
= torque

Rotational motion

Skills moving **about** an **external axis** are called **SWING**.

- Descending phase
- Ascending phase

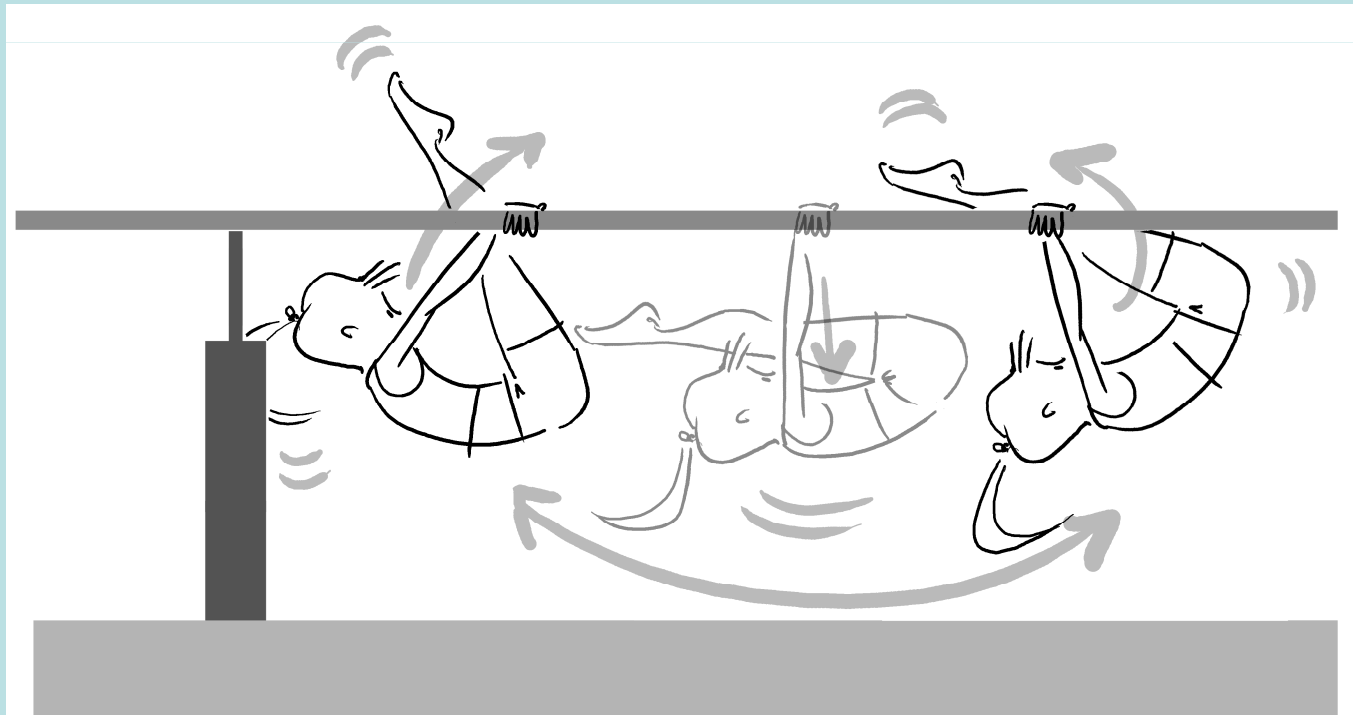


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Rotational motion

Skills moving **about** an **external axis** are called **SWING**.

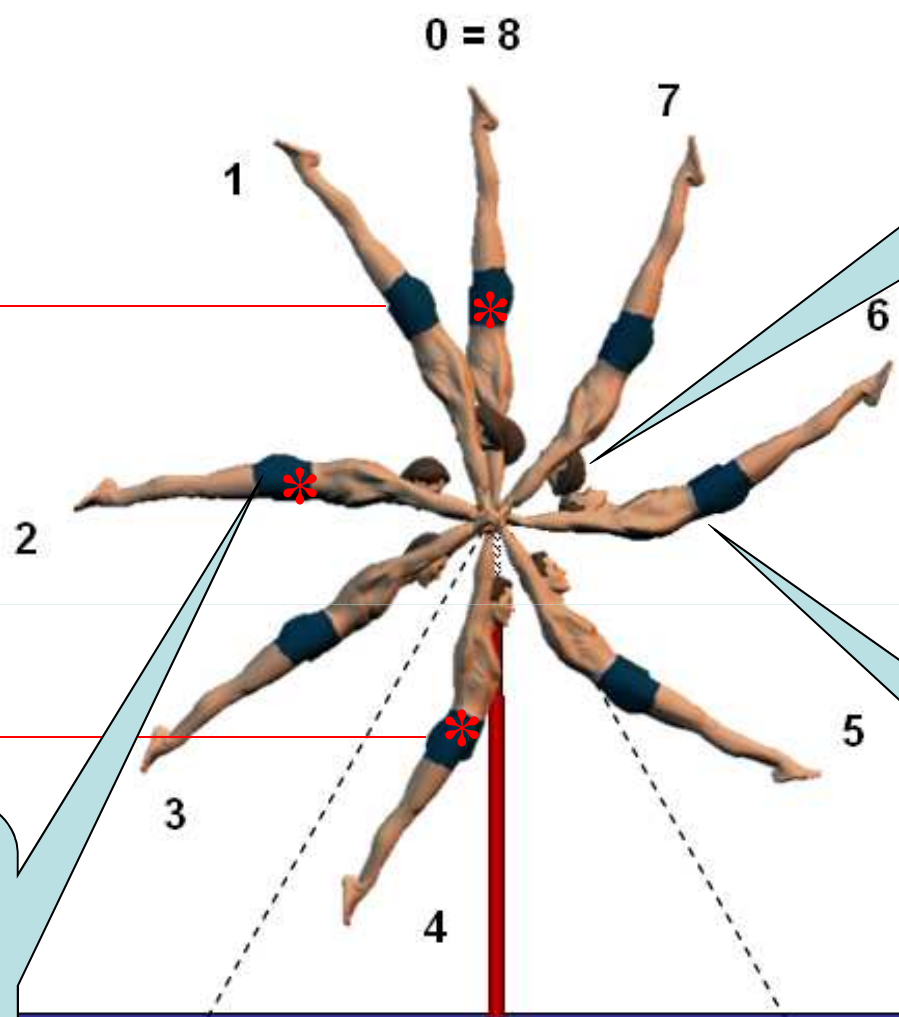
- Descending phase
- Ascending phase



Rotational motion

Skills moving **about** an **external axis** are called **SWING**.

- Descending phase
- Ascending phase



Bar acts as a spring and returns elastic energy

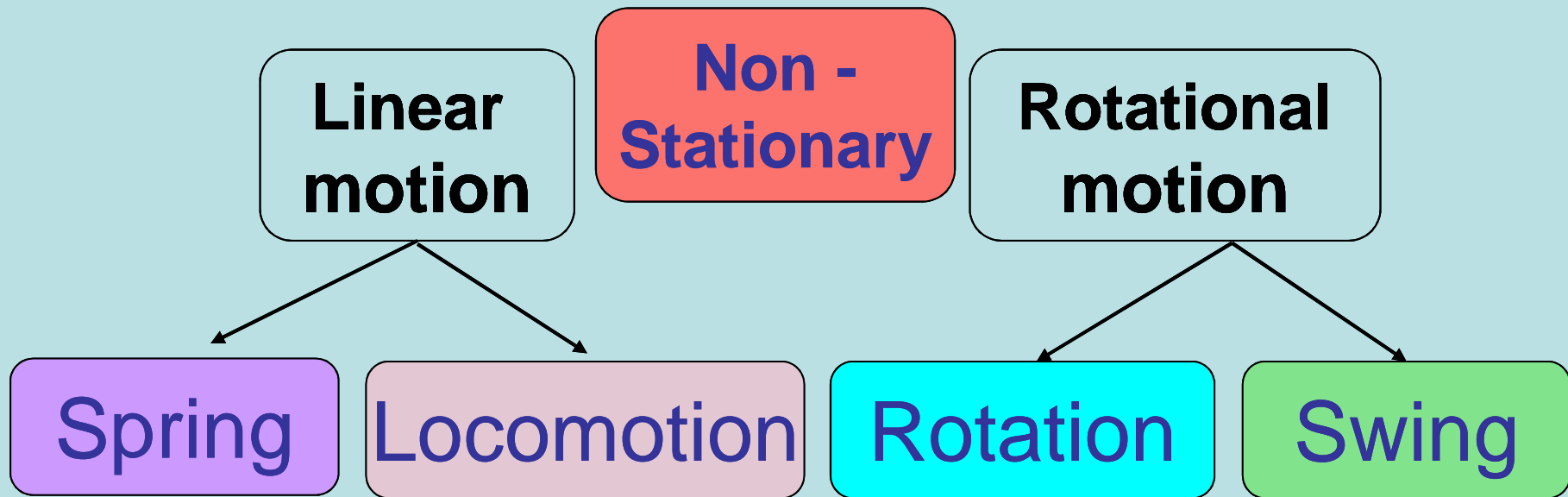
Bring C of G closer to bar to increase angular velocity and overcome friction

Max stretch = longest time and distance for gravity to act for max RM

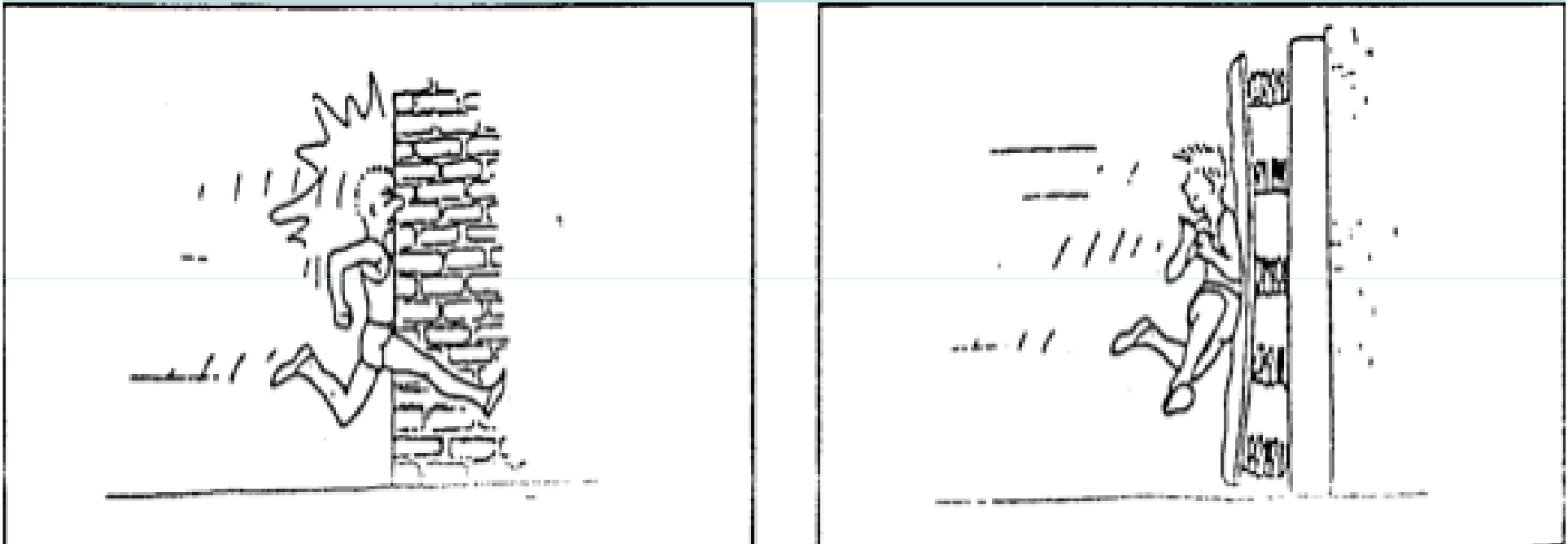
Max stretch = gravity acting max distance from axis = max torque at every instant

from FIG Academy Course –

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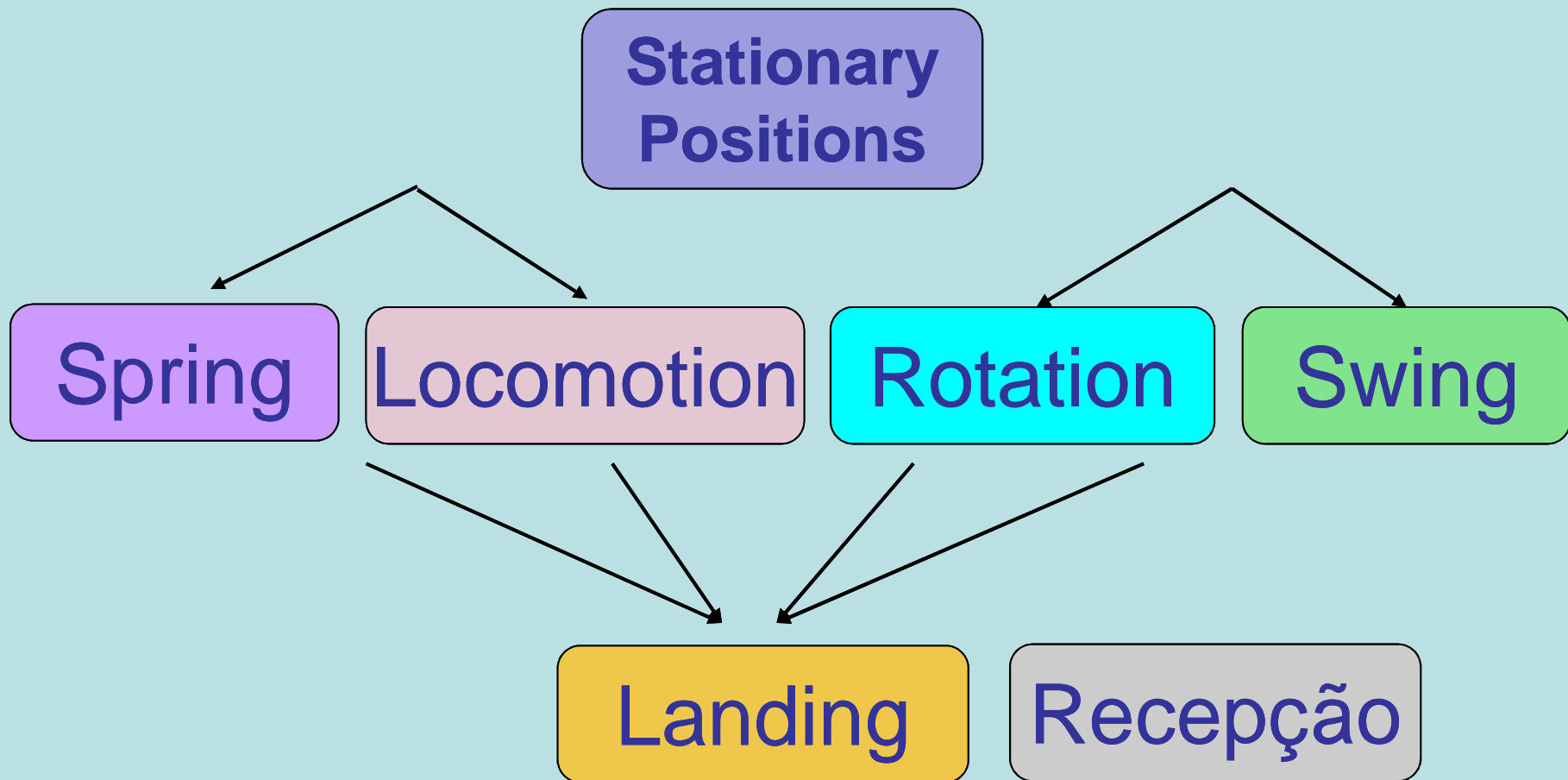


Finally, From Motion to Stationary



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Gymnastics Movement Patterns



Finally, From Motion to Stationary

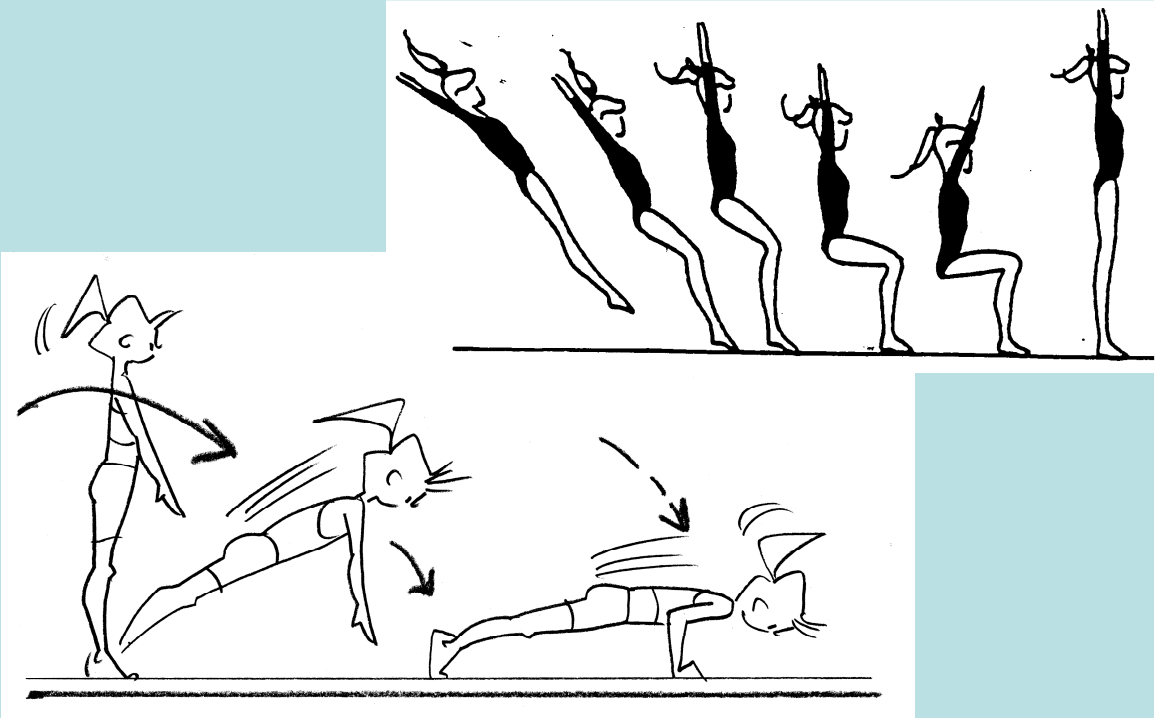
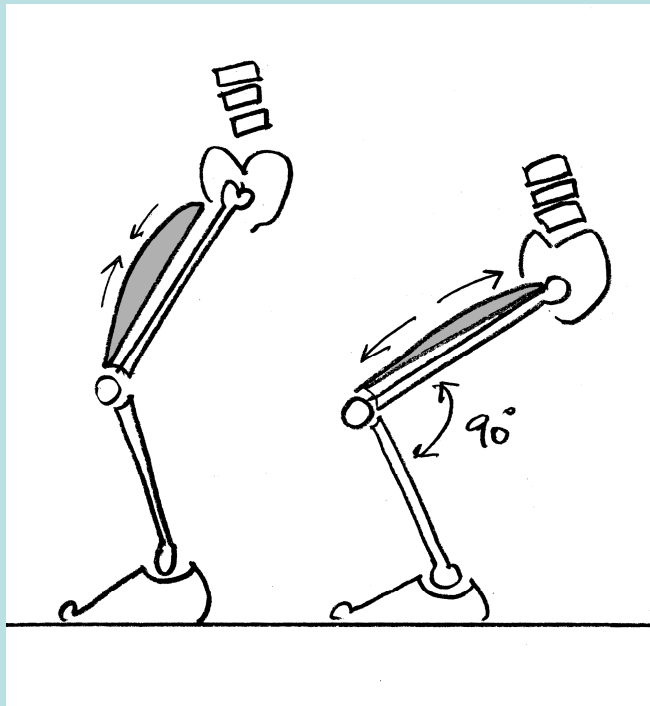
LANDINGS are mechanically the opposite to **SPRINGS** since they absorb energy.

- Decelerate, instead of accelerate

Finally, From Motion to Stationary

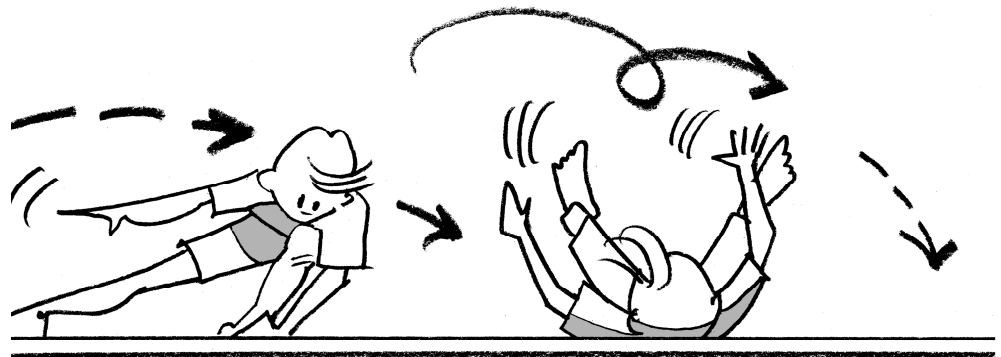
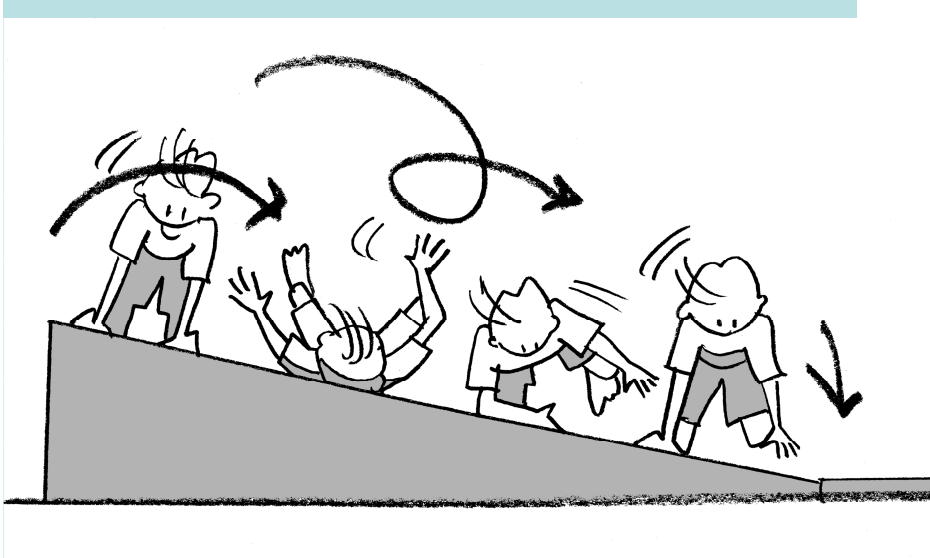
LANDINGS are mechanically the opposite to **SPRINGS** since they absorb energy.

- Attenuate energy over time...



Finally, From Motion to Stationary

- Attenuate energy over **body surface**...



Gymnastics Movement Patterns

Stationary
Positions

Spring

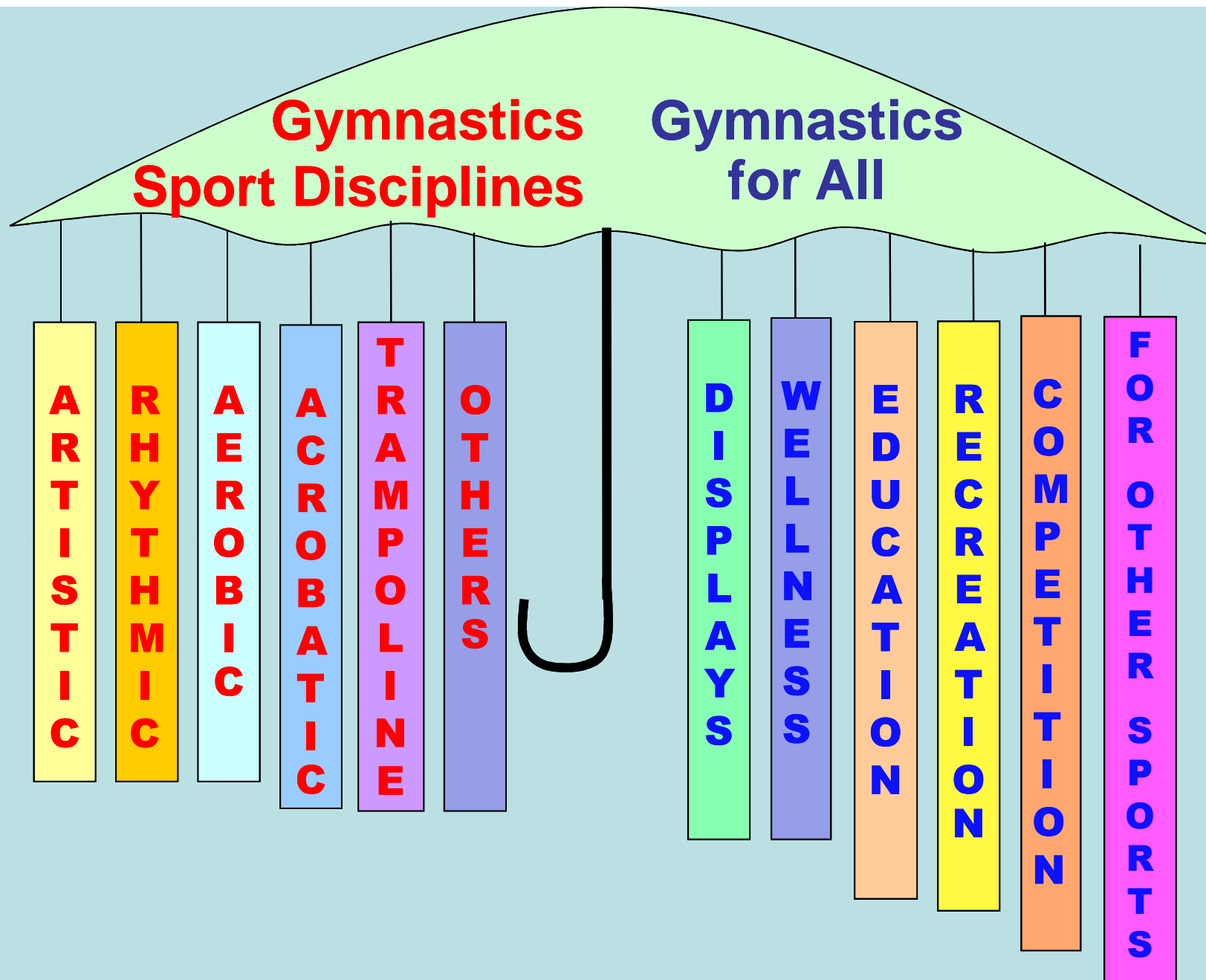
Locomotion

Rotation

Swing

Landing

While Manipulating Hand Apparatus



There are **6 Movement Patterns** common to all these



**Gymnastics
Sport Disciplines**



*These 6 'mechanically determined'
'Movement Patterns'*

*are the technical basis for all
'gymnastics & acrobatic' activities*

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Disciplinas Gímnicas

Estes 6 ‘Padrões de Movimento’

‘determinados mecanicamente’

São as bases técnicas para todas as actividades ‘gímnicas & acrobáticas’