

INSTRUCTION MANUAL

THEORY, GUIDANCE & GOOD PRACTICE FOR TRAINING

01



FEDEC

EUROPEAN FEDERATION
OF PROFESSIONAL
CIRCUS SCHOOLS

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SVEN DEMEY & JAMES WELLINGTON

01

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FEDEC

Created in 1998, the European Federation of Professional Circus Schools (FEDEC) is a network that comprises 52 members: 41 Higher Education Institutions and Vocational training Centres and 13 partner organisations in 24 countries in Europe and beyond (Austria, Australia, Belgium, Canada, Chile, Colombia, the Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Norway, Poland, Portugal, Russia, Spain, Sweden, Switzerland, The Netherlands, Tunisia, United Kingdom and the USA).

FEDEC's main vocation is to support the development and evolution of training pedagogy and creation in the field of circus arts education with the following objectives:

- to improve the education provided in professional circus schools
- to reinforce the links between professional circus schools
- to represent these schools at European or international level
- to promote the work of young artists who have graduated from these schools

To this end the FEDEC sets up different activities:

- facilitating a network of schools, allowing the organisation of numerous bilateral and multilateral exchanges of students, teachers and administrators each year
- assembling and distributing information of all kinds in the circus arts education sector
- designing and coordinating European projects that aim to improve the teaching practices of its members (in particular through the production of teaching aids, seminars, professional exchanges, dissemination of best practice)
- intervening with the authorities on a European or national level, according to the demands and needs of the Fedec or one or more of its members
- organising and implementing events or demonstrations that aim to increase the influence of creation and training in circus arts or to improve contacts with associations and organisations working in the fields of art, education, sport, economy, and the social sector
- equipping the federation with regulations and a Code of Ethics for professional training in circus arts

PREAMBLE

The European Federation of Professional Circus Schools (FEDEC) accepted its fiftieth member in autumn 2010 and is now established in 24 countries both within and beyond Europe.

It is the first and only network for international exchange and cooperation in the field of vocational training of circus artists, with a unique mission to develop circus arts pedagogy.

Between 2005 and 2007, FEDEC coordinated a series of European Pedagogical Exchanges that, for the first time ever, allowed teachers of different nationalities and from different schools around the world to meet together to focus on 6 circus disciplines (or groups of specialisms). These weeklong meetings were synthesised into the chapters that now make up the Basic Circus Arts Instruction Manual.

The development of this Manual was undertaken with the intention of creating a guide to best practice for Higher Education, vocational and preparatory schools, including the most thorough requirements in terms of injury prevention. Transdisciplinary issues such as rigging and safety, physical conditioning, and artistic development are therefore dealt with as key cross-cutting elements in the context of the disciplinary chapters, and in the case of rigging & safety and physical conditioning, treated as separate chapter topics in their own right. .

The innovative nature of this series of exchanges was recognised by the 2009 Creativity and Innovation Golden Award from the European Commission.

On the strength of this acknowledgement and keen to further develop the range of pedagogical circus arts tools available, the FEDEC network has formed a focus

group comprised of experts from a variety of schools, aiming to identify the educational challenges faced today and to consider how solutions to these challenges might be implemented.

Based on the work of the previous years and the issues subsequently raised by teachers, the focus group has begun to conduct an analysis and evaluation of the existing chapters,. Between 2010 and 2014 the focus group's task is to coordinate the revision of the original chapters, as well as to address emerging and innovative circus arts disciplines.

Like any educational publication, the manual must be continually revised and adapted. The focus group has therefore developed a methodology for revising the Manual and ensuring that core elements of circus training are covered.

Throughout the Manual, FEDEC considers the acquisition of circus techniques as an artistic discipline in its own right, complementary to the technical standards required by particular circus specialisms. As well as focusing on specific disciplines, the Manual is committed to exploring artistic codes of practice such as intuition and perception and the various fundamental relationships of circus arts (the artist's relationship with his/her partner, the apparatus, the space and the audience).

FEDEC does not wish to impose any specific aesthetic approach, but instead hopes to lead teachers to develop educational methodologies that integrate artistic considerations into a holistic training programme. It's up to

each teacher to put this into practice as he/she sees fit when devising his/her own methods for supporting his/her students' progress.

For each chapter, teachers specialising in the relevant discipline will be involved in the assessment of the current content and invited to make suggestions for improvements based on a grid summarising basic chapter structure and content, prepared by the focus group. . This predefined common pattern will ensure a homogeneous structure from one chapter to another, and provide a guideline as to the necessary aspects to be included. The focus group will support this work to ensure a harmonized editorial approach.

These educational tools are the result of the pooling of the know-how and knowledge of many teachers. The way the chapters have been produced and the wide distribution from which they benefit demonstrate FEDEC's intrinsic values of sharing and transmission.

Having defined these prerequisites, the focus group began the revision of the existing chapters in 2010, and is pleased to present this first additional chapter: a transdisciplinary approach to the physical conditioning of the future circus artist.

In the years to come, the Manual will be enriched by new chapters addressing different circus disciplines, with the shared aim to contribute to the improvement of future circus artists' education in both quantitative and qualitative aspects. We hope that this effort will ultimately contribute to the better recognition of circus arts and the affirmation of the significant place of this form within performing arts landscapes in Europe and worldwide.

FEDEC





01

INTRODUCTION TO PHYSICAL TRAINING

1 Fundamental training principles

A fundamental training principle is that performance improvements occur through the stimulus of exercise.

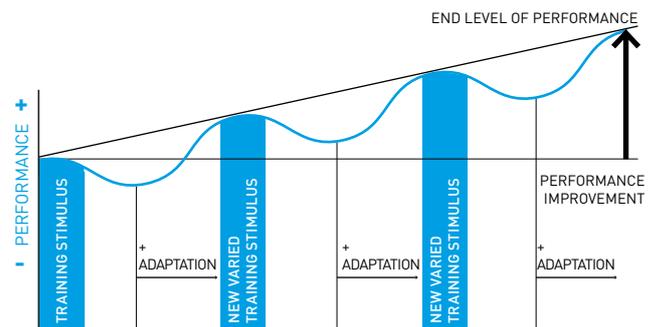
1.1 Overreaching & progressive overloading

Positive physiological adaptations occur using the *overload* principle (a deliberate, methodical and progressive increase in training intensity and/or volume). Exercising at intensities that impose an adequate physical stress on the body is necessary for such adaptations to take place.

This type of vigorous exercise deliberately imposes an *over-reaching* phase on the body (a short term decrement in performance, which is reversed after a short period if given adequate recovery time). Improved performance will then follow as a result that exceeds the initial pre-exercised state (see Fig. 3).

Progressive overload is the gradual increase of stress placed upon the body during training and in physical preparation/conditioning classes. In order to continually make improvements in circus skills, the varying elements of physical preparation must be increased and altered systematically.

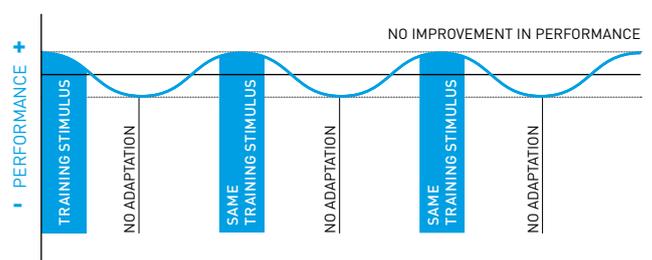
01 Positive adaptation and performance gains with correct training stimulus



This diagram shows that with regular new and varied training stimuli, adaptation will occur, causing a positive improvement in performance.

If the training stimulus remains the same or insufficient to challenge the adaptation threshold, no improvements in performance will be made (see Fig. 2).

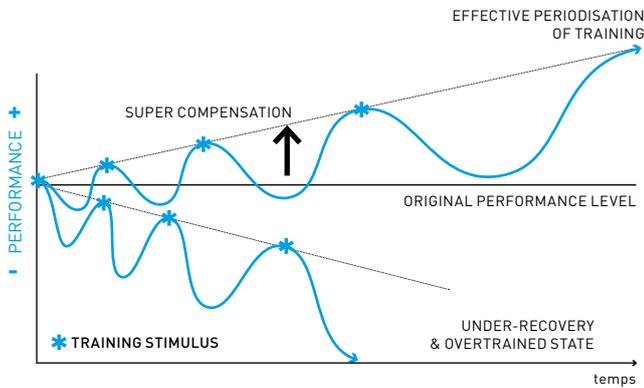
02 No adaptation or performance gains with insufficient training stimuli



Periodised training programmes incorporating adequate rest phases should therefore minimise the temporary decrements that over-reaching or over-loading incur.

03

Progressive overloading theory



1.2

Periodisation

As stated previously, the stimulus of exercise causes the body to adapt to the load or stresses placed upon it. The goal of periodisation is to optimise the principle of over-load. Training variables such as load, repetitions, sets, volume, and task can be manipulated to maximise the training adaptations and prevent the risk of overtraining and/or injury.

In order for adaptation to occur, the training load or stress needs to be sufficient. The neuromuscular system will adapt to these stressors, so the training stimulus must constantly be changed/varied in order to create further adaptations. Periodisation should therefore prevent plateaus in performance because the load/stressors/training parameters are constantly changing.

To make performance improvements, training should not have the same structure all of the time. There should also be some *variation* in the programme. In circus there is a huge variety of approaches that trainers & students can take to prepare themselves physically.

Frequently an ad hoc approach is taken when implementing physical conditioning, which is often unplanned and with no sound justification. Physical preparation should not rely so heavily on guesswork and luck.

Although there are a multitude of opinions on various training methods, there are many benefits to personalised *periodised* training, some of which are outlined below:

- no area of training (flexibility, strengthening, injury prevention, etc.) is ignored, but one aspect may receive more emphasis than another in any particular training session;
- the body needs constantly varying stimuli and challenges to enhance overall performance, and these are provided by periodised training;
- periodised training considers the end goal (both short, medium and long) and may run over a duration of months/years;
- it considers all aspects of physical development from general conditioning and fitness level to muscle strengthening and refinement of technique;
- it considers the age and level (novice, intermediate, professional) of the participant;
- it considers his/her current condition / injury status / psychological state;
- it considers his/her circus discipline(s) / specialisation(s).

1.3

Specificity (goal oriented)

Physical preparation for the huge variety of circus skills should be well planned. For example, the training programme for a tightwire artist will have certain differences to that of a Chinese pole artist. There will be some areas of overlap (flexibility, balance and coordination) but the specific strength skills needed for the pole differ from the fine motor control needed to maintain balance whilst on the wire.

Consideration should be made in order to define the end goal and how it can be achieved and subsequently supported with the correct exercise choices.

Remember that training adaptations are *specific* to the stimulus applied, and physiological adaptations are specific to:

- muscle actions involved;
- speed of movement;
- range of movement;
- muscle groups trained;
- energy systems involved;
- intensity & volume of training.

* see Basic definitions (p. 60)

1.4

Overtraining ⚠️ and rest

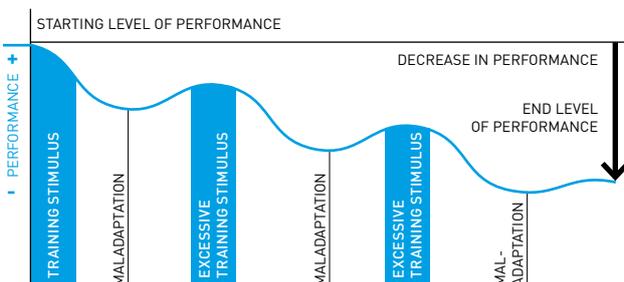
The human body cannot tolerate high levels of stress indefinitely.

When the correct amount of stress is imposed, the body will respond positively. If adequate rest periods are not built in to physical preparation, the positive effects of training can be reversed.

Signs of being in an overtrained state may present with various physical or psychological conditions. These can include: more fatigue than usual & unexpected sense of effort, frequent minor infections, loss of energy, unexplainable decrease in performance, change of sleep quality, altered mood, lack of concentration, and increased resting heart rate.

04

Negative effects of overtraining on performance



If the training stimulus is too great, or insufficient rest is taken between training bouts, maladaptation will occur and result in a decrement in performance.

It is well documented that training at least 2-3 times per week is necessary to notice an improvement in performance. Beginners may even find that one session of training per week is initially sufficient to make some progress. If heavy strength training is carried out many times per week, it is necessary to build in a rest day before exercising the same muscle group(s) again.

In the world of circus training schools, it is not always possible to add in a rest day if the timetable dictates a 5 day per week training programme. It is therefore important to pace oneself and reduce the exercise intensity at times if certain muscles or body parts feel over fatigued or injured.

Figure 5 graphically represents the different training states. The aim is to stay in the middle or green boxes!

05

Training states continuum

(Adapted from Armstrong et al, 2002)

	Overtraining 	Physiological maladaptation, performance decrement & overtrained state
ZONE OF ENHANCED PERFORMANCE 	Overreaching 	Optimal physiological adaptations & performance
	Overload 	Positive physiological adaptations & minor improvement in performance
	Undertraining 	Minor physiological adaptations & no improvement in performance

Remember that rigorous physical preparation and conditioning programmes are a destructive process. The body's cells are damaged and energy is depleted. Always remember that *rest* is needed for regeneration and recovery following heavy bouts of exercise. The rate of recovery is unique to each individual.

2

Definitions of basic training elements

2.1 Flexibility

The ability to achieve an extended range of movement in a joint or series of joints and to gain length in muscles.

2.2 Strength

The ability of muscles to exert **force** against a resistance at a specific velocity; like holding a flag position on Chinese pole. There are different types of strength: 1. large **force** generated for one strong contraction to overcome a heavy load; and 2. repeatedly expressing **force** many times over and over (see endurance).

2.3 Balance, coordination & agility

Balance is the body's ability to maintain an equilibrium by controlling the body's centre of **gravity** over its base of support. This is achieved through three systems (see Chapter 3.3, Section c).

Coordination is a complex process where a smooth pattern of activity can be produced by the body by a number of muscles working in synchrony with exact timing and the correct intensity. Perception, feedback, repetition and performance adjustment are all components of coordination.

Agility is the ability to control the body during bouts of rapid movement. Balance, coordination, flexibility and strength contribute to this skill. The ability to rapidly change direction is a key element of agility.

2.4 Power

Power is another description of muscular performance. It is defined as "work done per unit time (work/time)" or "**force** x velocity". The two main components of power are strength and **speed**. It describes the ability to exert a maximum muscular contraction instantaneously in an explosive sudden burst; like the catchers' role in pitching in banquine, or jumping as high as possible from stationary to achieve a backward somersault. Strength (**force** output) and power (work/time) are related but are separate qualities of muscle that can be measured in all dynamic muscle contractions, fast or slow.

2.5 Endurance

Describes the ability to resist fatigue. A circus student is required to:

- Repeat actions many times (muscular endurance)
- Perform complete acts → 5 minutes (cardio-vascular endurance)

Endurance can therefore be divided into two sub-categories:
a. Cardio-respiratory (heart-lung) endurance
b. Local muscular endurance

Cardio-respiratory endurance is the ability of the oxygen transport system to carry and to continue carrying oxygen to the working muscles.

Local muscular endurance is the ability of the muscle to continue contracting (working) under a certain load (e.g. holding a handstand for 3 minutes). Muscular endurance has a positive transfer to cardiovascular endurance.

3

Theory of basic training elements



Other factors that govern flexibility are:

- Genetic;
- hypermobility (some people are naturally much more flexible);
- specific laxity in certain joints;
- laxity in joint(s) following injury;
- gender;
- age;
- skeletal asymmetries/abnormalities e.g. Scoliosis.

HOW DO WE BECOME MORE FLEXIBLE?

The process of stretching increases the muscle-tendon visco-elasticity which results in reduced muscle stiffness. This means that less **force** is required to produce lengthening of muscle.

Muscle spindles are nerve receptors located inside skeletal muscles, sitting parallel with the muscle fibres. They are responsible for registering changes in muscle length.

When stretching a muscle quickly, the spindles send signals to the spinal cord via a “reflex-arc” that causes the muscle being stretched to contract – the opposite of what is desired! (See Fig. 6.) This is the body’s natural defence mechanism to prevent overstretching and damage to muscles. However, the spindles have the ability to adapt to stretching if it is gradual and progressive.

When stretching regularly, this so-called “stretch reflex” is inhibited or overcome. This subsequently reduces the resistance felt when applying a stretch to a muscle or group of muscles. The nervous system becomes more tolerant and gets used to stretching at the end of available ranges with added repetition.

3.1

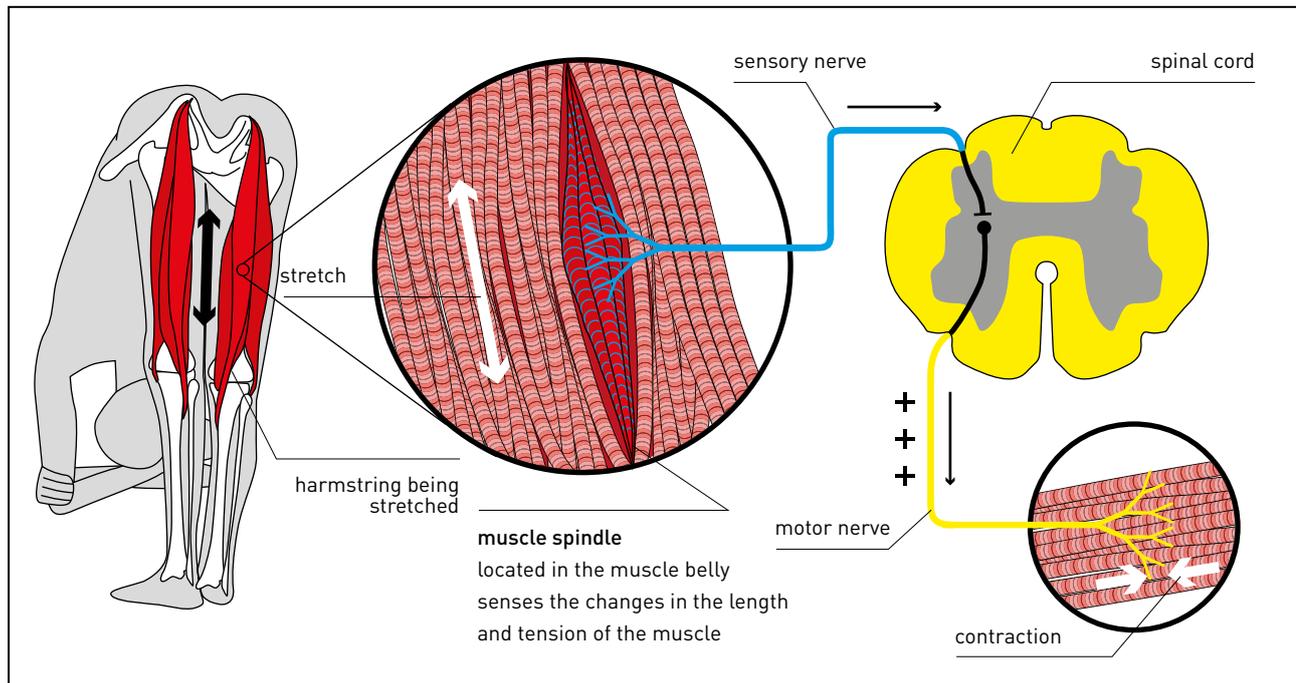
Training for flexibility

WHAT SETS THE LIMITS OF FLEXIBILITY?

It is obvious that for some joints the limits of mobility are dictated by the bony structure of the joint itself. For example, in a joint such as the knee it is impossible to extend much beyond 180° because of the position of the bones. In ball and socket joints like the shoulder, the limitation of range of movement is imposed by the soft tissues:

- The muscle and its fascial sheath;
- The connective tissue such as tendons, ligaments, joint capsules;
- The skin.

The stretch reflex and muscle spindles inside the muscle



There are 3 commonly used stretching techniques:

- **static:** Sustained pressure applied to a muscle/muscle group in a lengthened position.
- **dynamic/ballistic:** Repeated bouncing movements are made at the end of range of the muscle length (stimulating the stretch reflex).
- **PNF** (proprioceptive neuromuscular facilitation): Combines a series of isometric contractions and static stretches that use the nervous system to an advantage to gain flexibility gains.

Research suggests that to produce long-term improvements in flexibility, stretching should be done daily (when warm), held for at least 30 seconds and repeated at least 5 times.

3.2

Training for strength

A circus student is required to:

- Hold static shapes (isometric strength)
- Make slow strong movements (maximal strength)
- Make dynamic movements (strength-power)

Adaptations with resistance-type training enable greater **force** generation in the muscle. The adaptations that take place through resistance-type training are increased muscle size, better neural function, metabolic changes, and subtle changes in the muscle shape.

Strengthening programmes should consider that muscles contract concentrically (shorten), eccentrically (lengthen) and isometrically (no length change) in the transverse, frontal and saggital planes; and at varying velocities! Strength training programmes should therefore consider type of contraction and **speed** of contraction necessary for the desired performance outcome.

It is important that *sufficient load* is applied to make strength gains. This can be done by using a *high load* with *small number of repetitions* (see chapter 3.6 – Oddvar Holten diagram).

In untrained individuals, loads of 50% of 1 repetition-max (1RM) are sufficient to make strength gains. However, in trained and fitter individuals, greater loading is needed in the region of 80% of 1RM. Research suggests that training with loads with repetitions between 6-12 is most effective for improving strength.

Training *volume* is the total number of repetitions multiplied by the resistance used. It is important to choose the right number of exercises per exercise session. Low volume (medium-high load, low repetitions, moderate number of sets) is characteristic of strength training. Three sets can be used as a rough guide.

Both *single and multiple joint exercises* can be used effectively for increasing muscle strength. Ideally, multiple joint and functional exercises should be chosen that are specifically transferable to the circus discipline in question.

Rest periods between sets of between 1-3 minutes should be incorporated depending on the intensity of the exercises and the goal of the exercise session.

The *velocity* of the muscle contractions should reflect the goal of the exercise and a continuum of velocities can be used (from slow to fast) to add variation to a training session. Remember that proper technique must be maintained to reduce injury risk.

The *frequency* of training for increasing strength depends on how many muscles or groups of muscles are exercised and how much other training occurs alongside. As a rough guide, specific strength training should be included 2-3 times per week.

When constructing a physical conditioning programme you must consider how much pushing and pulling strength is required for the discipline or speciality. E.g. rope artists need lots of pulling strength in the shoulders and arms and a handbalancer needs a lot of pushing strength.

A **generic** strengthening training session normally consists of 6 to 12 exercises (See figure 54: Circuit training) It must include exercises targetting most muscular groups and focus on the development of trunk muscles over limbs. It is equally important to choose exercises that work both agonists and antagonists to avoid muscle imbalance and risk of injury.

Specific muscle training especially targets muscle groups involved in the specialisation. This should not be embarked upon until after an adequate generic strength programme (see specific programmes in the specialisation chapters).

3.3

Training for balance, coordination and agility

Balance, coordination and agility are vital skills for all circus performers regardless of their discipline.

The ability to maintain equilibrium by controlling the body's centre of **gravity** over its base of support is an essential skill to develop. There are 3 different systems that are important for achieving balance. These are outlined below:

A. PROPRIOCEPTIVE SYSTEM (receptors)

Proprioception is the term used to describe:

- the ability of the body to transmit information about the body's position and joint movement;
- how well this information is interpreted;
- the response that is subsequently made either consciously or unconsciously through movement or changes in posture.

Proprioceptors are specialised cells that transmit the information about the body's position to the brain. The major proprioceptors are found in skin, muscle, tendon, ligament and joint. The brain and spinal cord process this information and send appropriate signals to the muscles. These proprioceptors can be trained through specific exercises. Agility, balance and coordination are considered components of proprioception.

07

Illustrates the proprioceptors originating from tendon/muscle, skin and joint and travelling to the brain for processing.

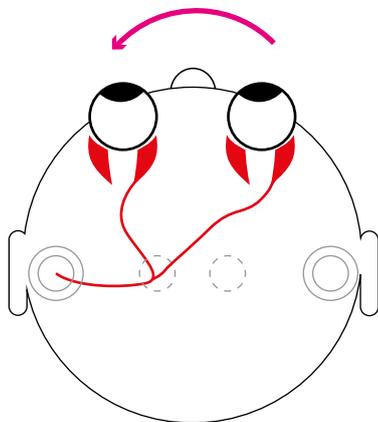


B. VESTIBULAR SYSTEM (inner ear)

The inner ear monitors the vertical and horizontal position of the head

08

Vestibular system

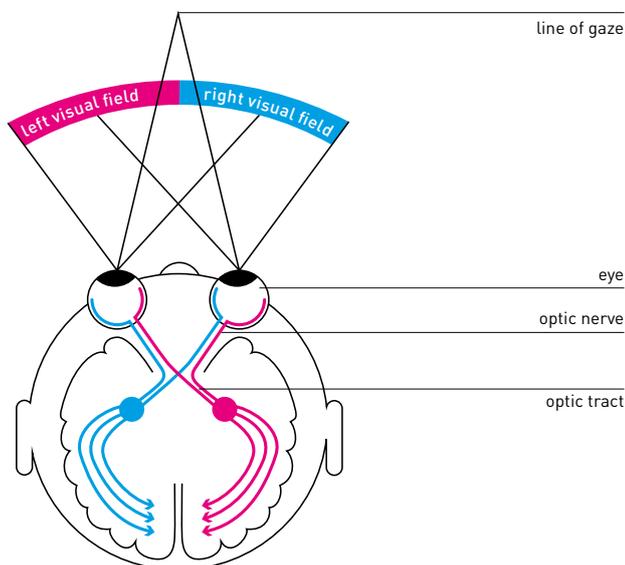


C. OCULOMOTOR (visual system)

Eyes give input into the brain indicating the environment around us and movements we are making. Information is picked up about our environment from the left and right visual fields and sent via the optic system to the brain. Many different parts of the brain process this information and give the performer lots of information about his/her environment and stimuli around him/her (see Fig. 9). When balancing on a tightwire, the brain rapidly processes information from the proprioceptors, vestibular system and the visual gaze (oculomotor system) contributing to maintenance of balance on the wire (Fig. 10).

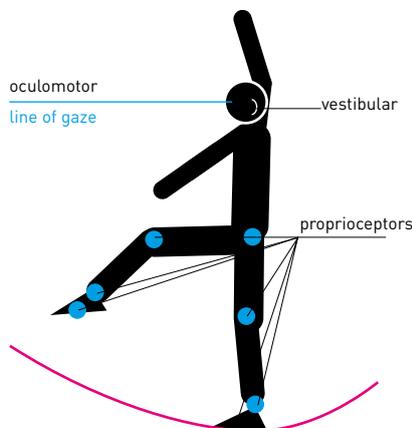
09

The visual fields of the eyes; the optic system sending information to the brain; and the line of gaze.



10

A tightwire artist using proprioceptors, the vestibular system and the oculomotor system to remain balanced.



Balance can be lost in a number of ways:

- movement out of one's base of support (standing on legs or hands; loss of front support balance on hoop);
- accidental slip or fall;
- external force.

Remember that instability devices like Swiss Balls and BOSU balls create balance challenges with an unstable surface moving underneath you. Think about how the balance is challenged according to the discipline. If the surface is fixed then the balance exercises should reflect this. If your balance requirements require more dynamic control then the exercises should reflect this.

Example (static balance):

- Rapid changes of movement and posture whilst holding a position.
- Standing on one leg and rapidly moving the other leg out and back.

Example (dynamic balance):

- Jumping from side to side, forward, backward, random directions and controlling the landing phase carefully to develop better control of joint position and forces acting on the body.
- ⚠ After an injury (e.g. ankle ligament sprain), the proprioceptive system will not work as efficiently and balance may worsen temporarily. It is important to seek expert advice for appropriate rehabilitation following injury to re-establish good balance again.

- To train balance effectively, the body's centre of mass must be displaced from its base of support. Proprioceptors are more active at the end of the joints' range and in circus, performers are normally challenged at these extremes. Unplanned and unanticipated movements challenge the balance systems to a greater degree and should be an important part of physical preparation too.

General principles and progression considerations:

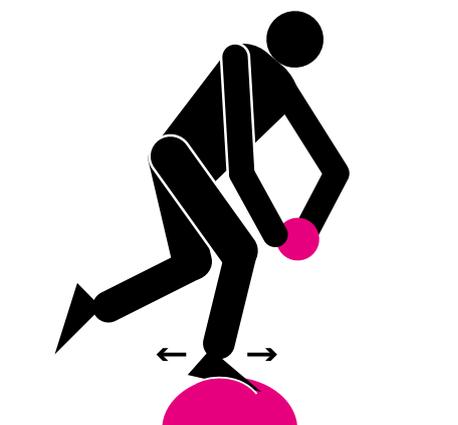
- Exercises progress from simple to complex;
- Initial exercises are performed slowly and deliberately in controlled and safe situations;
- Advancement is made only after the activity is mastered;
- Make activity gradually more complex;
- Progress to more difficult and complex activities and progress to specific performance activities;
- Perform simple activity at a faster pace;
- Perform more than one task simultaneously;
- Perform exercises with eyes closed;
- Challenge balance on discipline apparatus with spotting;
- Lengthen duration of balance task and link with endurance training.

11

Balancing on BOSU ball

A BOSU Balance Trainer, or BOSU® ball as it is often called, is a fitness training device consisting of an inflated rubber hemisphere attached to a rigid platform. It is also referred to as the "blue half-ball", because it looks like a stability ball cut in half.

This combination of stable/unstable allows a wide range of training exercises to improve balance and coordination.



By incorporating decision-making training into specific training sessions, a performer's attention, concentration, anticipation and problem-solving skills have been shown to be enhanced.

The goal is to enhance a performer's ability to make split-second decisions in a high pressure performance setting

More recent research into perception, cognition, neuroscience, vision, gaze control, dynamic systems and motor control has opened up exciting and new ways to influence a performer's decision-making skills. Highly skilled performers are able to focus, remained balanced and make split-second decisions when needed. Performers "see" many things when in training or performing. This is influenced by not only their visual-motor system as previously outlined but also by the level of understanding of the task that they must carry out.

By incorporating decision-making training into specific training sessions, a performer's attention, concentration, anticipation and problem-solving skills have been shown to be enhanced. The goal is to enhance a performer's ability to make split-second decisions in a high pressure performance setting. For more information about designing training sessions with a decision-making focus please refer to Vickers 2007 (see page 64 for references).

3.4

Training for power

As stated earlier, more power is produced by a muscle or group of muscles when a larger amount of work is achieved in the same time period.

$$\text{POWER} = \frac{\text{FORCE} \times \text{DISTANCE}}{\text{TIME}}$$

or

$$\text{POWER} = \text{FORCE} \times \text{VELOCITY}$$

Therefore to train for an improvement in power, time is an important element to consider. The **speed** at which **force** is developed (the capacity to do work) corresponds to the rate of strength increase. This process is partly a neural adaptation that is very important for circus performers to acquire. Circus performers cannot be powerful without being strong. These two components of training are interlinked.

Power training involves high-**force** training and rapidity of movements.

The aim of power training is to improve the ability of muscles to make rapid **force** production. Ballistic or plyometric exercises (explosive movements throughout a movement range) are very useful to make gains in power (e.g. a loaded jump squat, or an explosive press up from the floor). Plyometrics make use of the stretch-reflex properties of a muscle (see Fig. 6).

The principles of rest periods, volume and training frequency are similar to those of strength training. Sufficient rest should be given in between sets to allow for maximum effort on subsequent sets. Plyometric training is very demanding on the body and beginners should have a good basic strength foundation before rushing into a plyometric programme. As a rough guideline, power training can be carried out 2-3 days per week for more advanced individuals and 1-2 at novice level.

3.5

Training for endurance

Moderate to low resistance training with high repetitions and volume has been shown to improve muscular endurance. Characteristics of endurance training are to perform sets of longer duration and to minimise the rest phase between sets.

The aim of endurance training is to induce an acute metabolic response. During endurance training specific physiological adaptations take place. The number of mitochondria increase (the power plants of the muscle cell) & the number of capillaries increase (more efficient blood supply to the muscle).

When performing large numbers of repetitions (15-25 or more) a moderate or fast velocity of movement is recommended, as well as a longer duration, so that the muscle is placed under tension for longer periods. Larger repetitions from 30 up to 150 can even be implemented depending on the load percentage of 1 Repetition Maximum.

Circuits or longer duration steady state cardiovascular exercise like cycling or jogging will improve the efficiency of the heart and lungs and overall fitness levels.

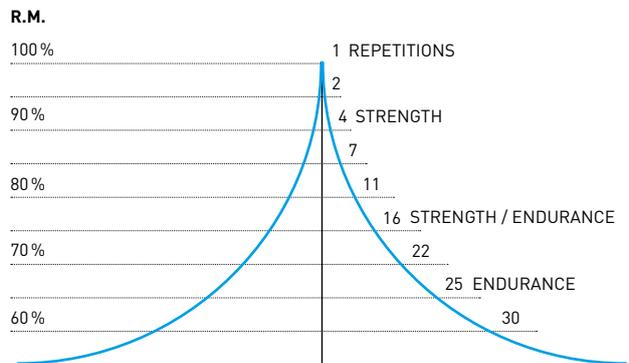
More specifically, endurance is characterised by the ability to move a relatively weak load, for the highest number of times. A regular training involving many repetitions of the same exercises results in better endurance. Other exercises that consist of keeping a certain position for a length of time also help improve endurance.

3.6

Oddvar Holten Diagram

12

Oddvar Holten curve



A useful method of determining training intensity was devised by a Norwegian physiotherapist in the 1950s. It is called the Oddvar Holten principle. The left-hand side of the diagram represents the **RM** (repetition maximum) and the right-hand side of the diagram represents the number of repetitions. Firstly the 1-repetition maximum (1RM) must be determined (the maximum amount of weight that can be lifted once). This is not always possible in people that are rehabilitating from an injury but estimates can often be made by lifting increasingly heavy weights until the person is no longer able to lift, and then making a simple calculation.

This diagram shows the inverse relationship between load lifted and the number of repetitions performed. Assigning the correct load for a particular training session depends on the outcome desired, and the current level of fitness of the individual. The Oddvar Holten curve dictates that specific training loads are required for specific training effects.

Examples:

- For high intensity - strength training & stimulating hypertrophy of muscle - the load should be targeted at the 80% **RM** point, which represents roughly +/- 10 reps (lower repetitions).
- For medium intensity - strength-endurance type training - the 60-70% **RM** can be used, which represents roughly 16-25 repetitions (higher repetitions).
- For activities that require higher levels of repetition to make movements become more automatic or flexible, the 50% **RM** can be used with 45-50 repetitions (very high repetitions).

13

Relationship between training load and number of repetitions performed

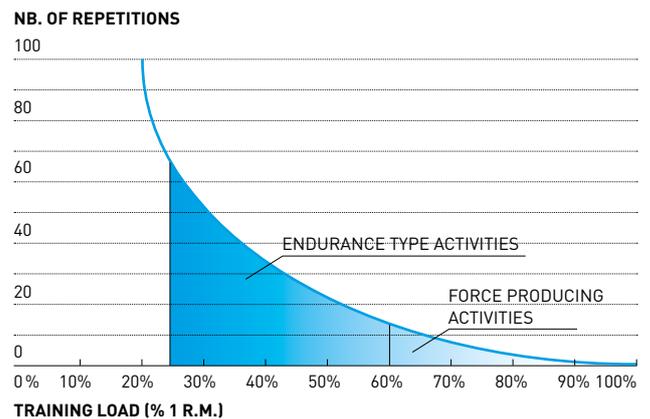


Figure 13 is a simplified version of the Oddvar Holten curve illustrating the relationship between higher repetitions (endurance-type activity) and lower repetitions (strength & higher force producing activities).

This diagram shows the inverse relationship between load lifted and the number of repetitions performed. Assigning the correct load for a particular training session depends on the outcome desired, and the current level of fitness of the individual. The Oddvar Holten curve dictates that specific training loads are required for specific training effects.



02

THE SKELETAL MUSCLE AND NERVOUS SYSTEMS

1

Anatomy and composition of muscle

1.1

Introduction

Skeletal muscle is the most abundant tissue in the human body and represents 40-45% body weight. There are approximately 600 skeletal muscles found in pairs on the right and left side of the body.

They:

- provide strength and protection to the skeleton by distributing load and absorbing shock;
- enable bones to move at joints;
- provide maintenance of posture, dynamic body shapes & maintain centre of gravity against various forces.

1.2

Muscle fibre types found in the body

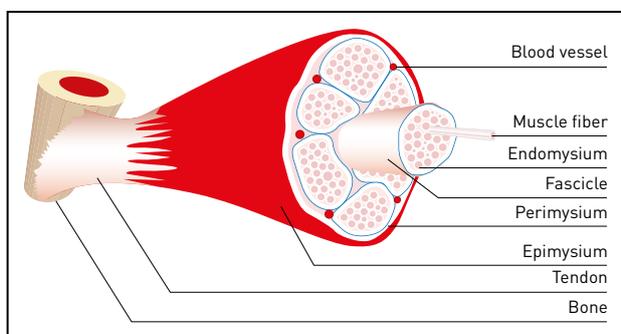
Muscle does not contain the same group of fibres throughout. Two distinct fibre types exist: they are called *Type I* & *Type II*.

TYPE I MUSCLES

(endurance activities, slow to fatigue)

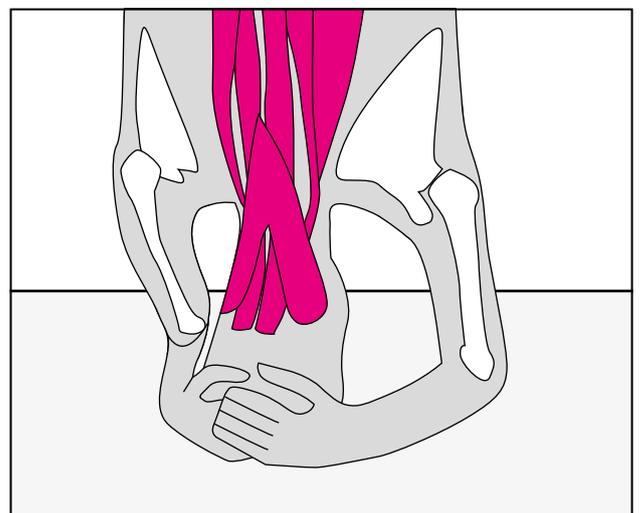
14

Structure of skeletal muscle



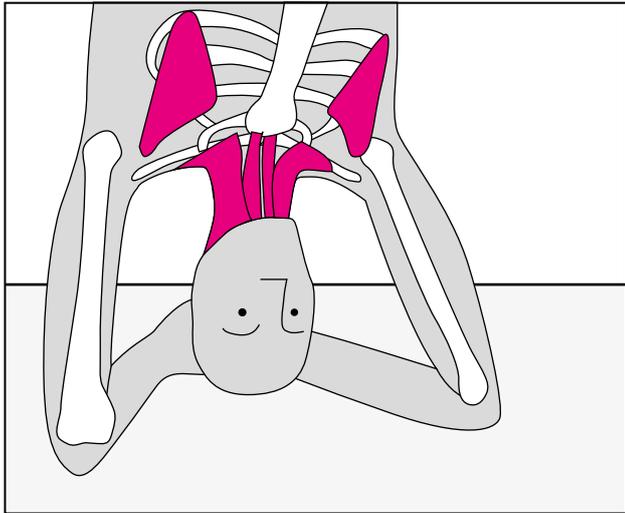
15

Deep spinal extensor muscles



16

Deep spinal flexor muscles



In this case, keeping the head and spine straight under the load of the body and gravity.

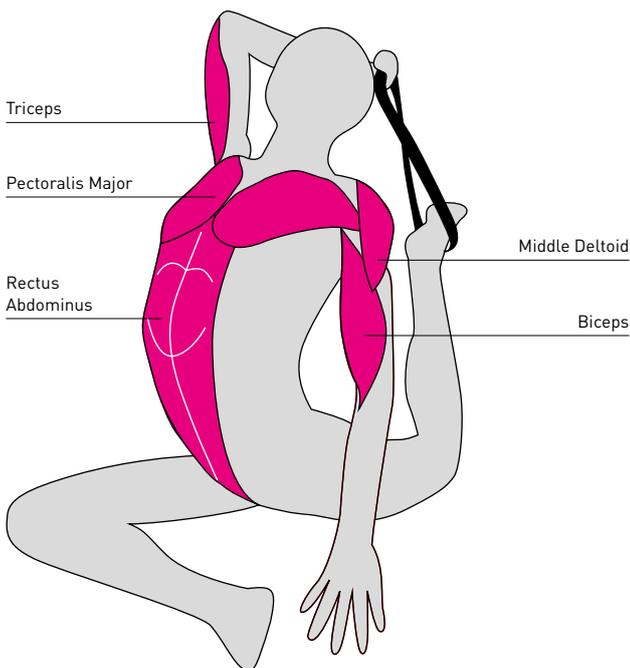
TYPE II MUSCLES

(short bursts of power and speed)

17

Examples of some Type II muscles found more superficially in the body

(anterior view)



In reality, individual skeletal muscles contain varying proportions of Type I and Type II fibres according to their function.

When we exercise, we use a combination of Type I and Type II muscles fibres. The Type I muscles (also known as slow twitch) are more efficient at using oxygen (aerobic metabolism) to generate energy for longer-lasting, continuous muscle activity over prolonged duration. They are much more fatigue-resistant and are useful for endurance type activities like marathons or long bicycle rides.

Type II muscles (also known as fast twitch) are better at producing short bursts of activity using anaerobic metabolism (without oxygen). The disadvantage of this type of muscle is that it fatigues much more quickly. On the plus side, they can activate rapidly and can quickly generate a lot of force when required instantly. Examples in circus include jump climbs on Chinese pole, and pressing from a crocodile position to a one-arm handstand.

For more information about the differences between muscle fibre types, please refer to the table below:

18

Examples of some Type II muscles found more superficially in the body

(posterior view)

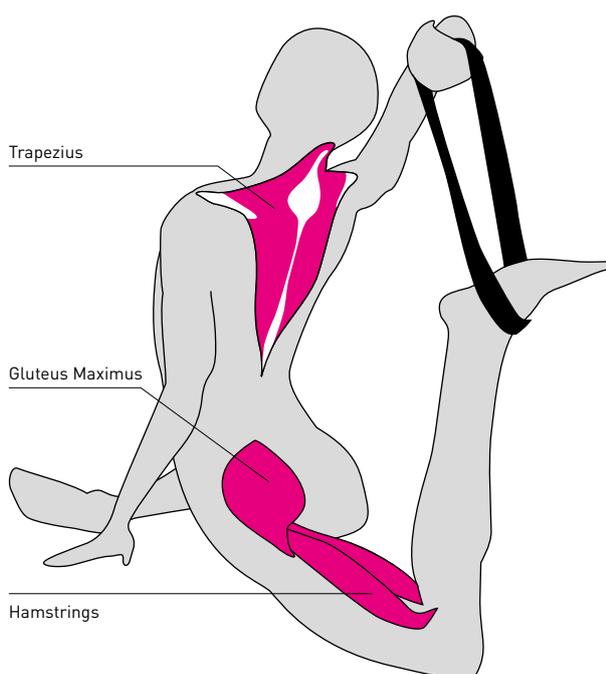


TABLE 01
Difference between muscle fibre types

	TYPE I	TYPE II
SPEED OF CONTRACTION	Slow	Fast
ACTIVITY USED FOR	Aerobic	Short-term anaerobic
NB. OF MITOCHONDRIA	High	Low
RESISTANCE TO FATIGUE	High	Low
EFFICIENCY	High (less energy needed)	Low
CAPILLARY DENSITY	High	Low
OXIDATIVE CAPACITY	High	Low
GLYCOLYTIC CAPACITY	Low	High
COLOUR	Red	White

A person's individual muscle fibre composition and cross sectional area can dictate to which activities they may be better suited. Some individuals have more "explosive" type muscles (sprinter), whereas others have more "endurance" type muscles (long-distance runner).



2

Function and characteristics of skeletal muscle

The main function of skeletal muscle with reference to a circus performer is to produce fine or gross body movement. Muscles also provide support by stabilising joint positions, produce heat during exercise and training, and provide a degree of protection to the body.

Skeletal muscle tissue is attached to the bones via tendons. Tendons transmit the **force** produced by the muscle to the bone resulting in movement, and are well designed to withstand high **forces**. Tendons also act as a damping tissue to absorb shock and limit potential damage to the muscles. They also have a degree of extensibility, so that during a lengthening period, elastic energy can be stored and used as elastic recoil.

Skeletal muscle works in antagonistic pairs and is voluntary (unlike cardiac muscle which is involuntary). It has a limited capacity for regeneration.

Skeletal muscle has the following characteristics:

Contractibility - the ability to produce **force**.

Excitability - the ability to receive an impulse or work upon it.

Elasticity - the ability to return to the normal length after contraction or extension.

Extensibility - the ability of a muscle to be stretched or elongated.

Conductivity - the ability of a muscle to conduct an electrical impulse throughout the muscle.

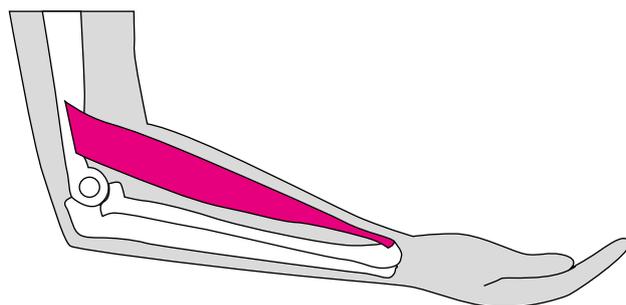
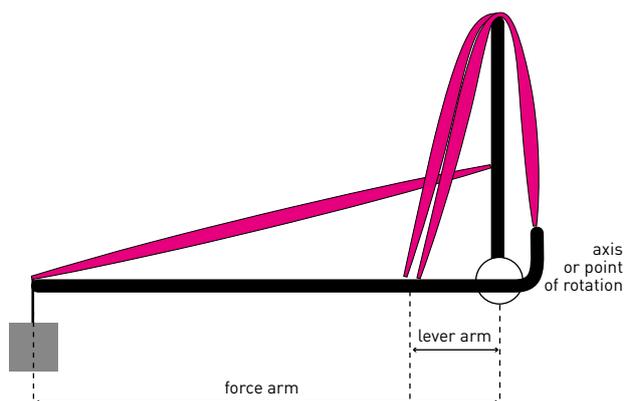
3

Types of muscle contraction

All human movement is caused by the system of working (contracting) muscles pulling the bones of the skeleton. The jointed bones change their position relative to one another by muscle contractions causing movement. This is made efficient through a system of levers that allow the bones to move through a great distance whilst the muscular contraction is small. There are many different types of lever systems that are present in the joints of the body, one of which is shown below: the hinged elbow joint.

19

Types of lever systems that are present in the joints of the body



For each movement there are one or two muscles that do most of the work and are called *prime movers*. However, there can be many other muscles assisting them, called *synergists*, which make the movement more controlled and stable. Each muscle contracts when the brain sends a message as an electrical impulse through the nervous system. It is the complex process of impulses telling some muscles to work and others to relax that coordinates the movement.

During muscle contraction, the **force** exerted on the bone(s) to which it is attached is known as *muscle tension*. The external **force** exerted on a muscle is called *resistance* or *load*. When a muscle contracts it generates movement in the body or a turning effect, otherwise known as *torque* (see Fig. 20).

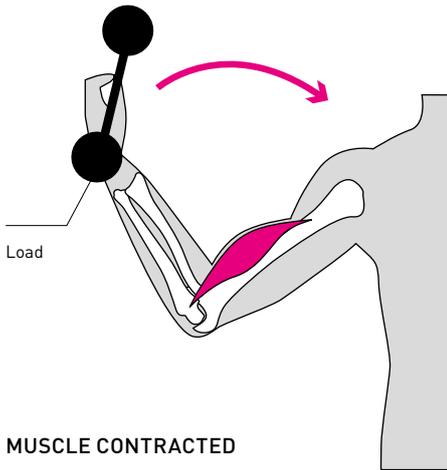
3.1

Concentric contraction

A muscle *shortens* and produces joint movement (e.g. the biceps during a pull up).

20

Biceps concentric contraction



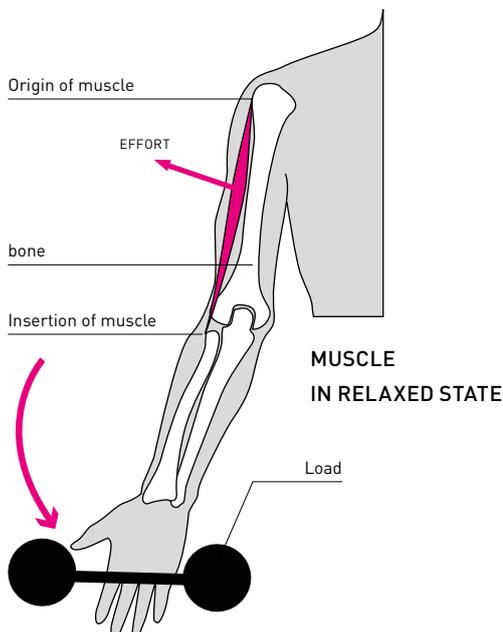
3.2

Eccentric contraction

A muscle *lengthens* under load. It is resisting lengthening (e.g. the biceps during the downward phase of a pull-up).

21

Biceps eccentric contraction



3.3

Isometric contraction

A muscle contracts *without movement*. In other words, the muscle does not shorten or lengthen but maintains resistance at a set length (e.g. the hip flexors when the legs are held in half lever position during a rope climb, or the triceps in a front support position).

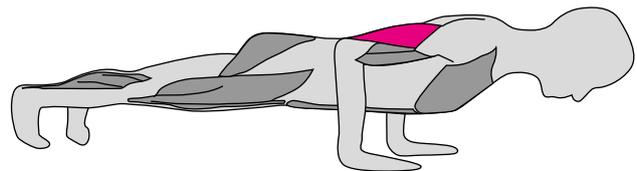
22

A girl working her hip flexors isometrically on a rope climb



23

Triceps working isometrically to maintain front support position



4

Aerobic and anaerobic muscle activity

The contraction and relaxation of muscles are both a result of chemical reactions. The complex reactions between proteins, oxygen and other chemicals cause the muscle fibres to contract and relax.

During exercise, in the presence of adequate oxygen, the muscles can contract repeatedly without fatigue. This is called “aerobic” metabolism (exercise in the presence of oxygen), such as going for a long walk.

However, during vigorous exercise, such as performing 20 press-ups in a row, the need for energy exceeds that which can be supplied by aerobic metabolism.

Therefore, a number of other chemical reactions that do not require oxygen must take place to fuel muscle contraction. This results in the production of lactic acid and is called “anaerobic” metabolism. This increased acidity in the muscles causes a deterioration in performance as it hinders important metabolic reactions, reduces the contractability of the muscles, and causes fatigue. The body then builds up an oxygen debt. When oxygen becomes available again, it is used to replenish systems from which it was borrowed (haemoglobin, myoglobin, etc.) and to metabolise the lactic acid into carbon dioxide and water.



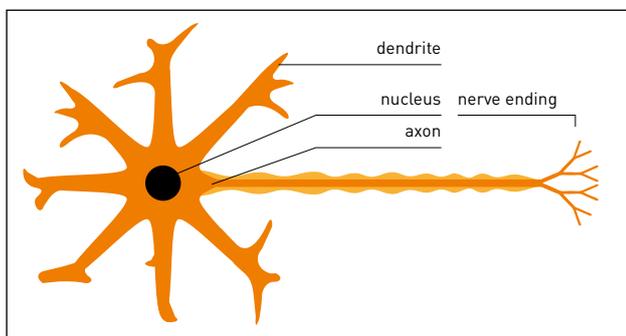
5

Anatomy and composition of the nervous system

The nervous system allows the body to respond to changes in the environment. This is a process coordinated by the brain.

5.1 The neurone

24 Neurone



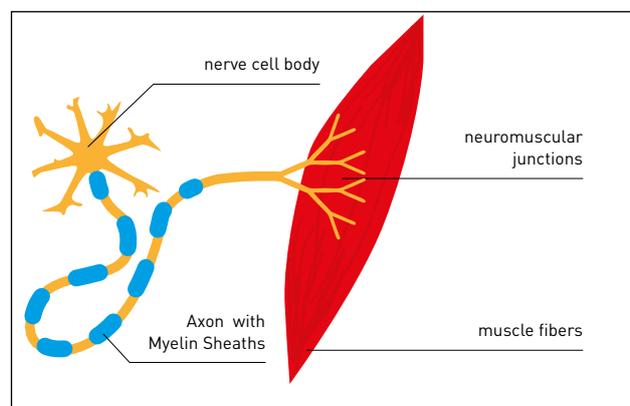
Nerve cells are called neurones (Fig. 24). They carry information as tiny electrical signals that bring about responses. Above is a motor neurone (a nerve cell that attaches to muscle). It has tiny branches at each end and a long fibre carries the signals.

The nervous system falls into two parts:

- The central nervous system (CNS) comprised of the brain and spinal cord;
- The peripheral nervous system (PNS) made up of the nerves that spring from the central system.

Every skeletal muscle in the body is connected by a nerve to the brain or spinal cord. Nerve fibres that connect to muscles are called motor fibres. An electrical impulse is sent down these motor fibres to the muscle, which causes a contraction. Every muscle fibre is supplied in this way (Fig. 25).

25 A motor nerve fibre



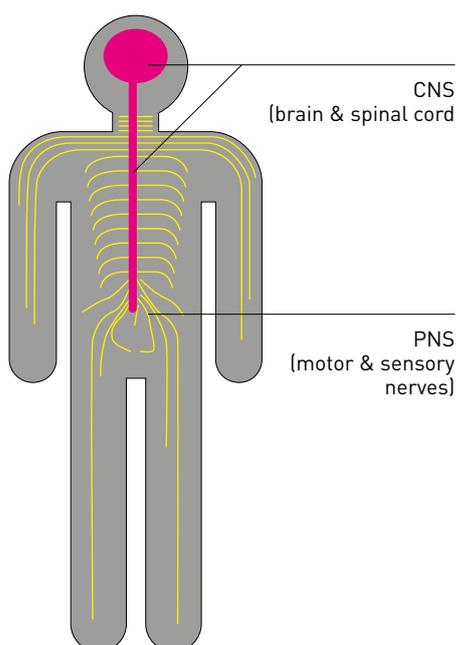
5.2

The Central Nervous System (CNS)

The CNS consists of the brain and spinal cord. When a receptor (specialised nerve cells that detect stimuli) is stimulated, it sends a signal along the neurones to the brain. The brain then co-ordinates a response. The CNS is protected to some degree by the skull and spinal column.

26

Organisation of the central nervous system (CNS) and peripheral nervous system (PNS) in the human body



5.3

The Peripheral Nervous System (PNS)

The PNS connects the CNS to the limbs and organs of the body. It has conscious and unconscious pathways and voluntary and involuntary pathways. Regulations of involuntary systems like the heart are an important function of the PNS.

Motor nerves are nerves that carry information from the brain to the muscles and organs, whilst *sensory nerves* carry information inwards from the outlying parts of the body. They convey information about the temperature, position, pain and touch.



03

BIOMECHANICS

1

Introduction

Biomechanics and its relevance in circus can be defined as: “the study of forces and their effects on the body during exercise”.

The subject of biomechanics is one that frightens and bemuses many circus professionals. In order to understand the basics of movement and of balance it is very important to understand the forces that are affecting the body and the physical principles of how the body moves.

When discussing mechanical terms, words such as acceleration, mass, inertia, momentum, velocity, power, speed, etc. will appear. Definitions of these terms can be found in the appendix.

An understanding or at least a basic knowledge of biomechanics is important to both students and teachers in circus for many reasons:

- improved performance by students;
- accelerated learning of new skills;
- reduction of injury rate;
- diagnosing cause of injury.

The subject of biomechanics is one that frightens and bemuses many circus professionals. In order to understand the basics of movement and of balance it is very important to understand the forces that are affecting the body and the physical principles of how the body moves.

2

Technique improvement

Knowledge of basic biomechanics can assist circus teachers to make appropriate corrections of a student's actions to improve their execution of a particular skill or trick.

Observation is key! It all starts with observation of the body's movement. E.g. a student is learning a back somersault. As the observer you may suggest three things that will help the student execute the technique better: *jump higher, tuck knees in quicker and tighter, and throw arms upward more vigorously.*

These three suggestions are based on biomechanical principles. Jumping higher will give more time in the air to perform the technique, tucking knees in quickly will allow the student to rotate more quickly in the air (conserving angular momentum) and throwing arms upward will result in a larger initial angular momentum to generate better rotation.

Observation by eye, or image-based motion analysis using a video camera and playback, can help identify the type of training that the student needs to improve by detailing his/her movement patterns. Current video cameras can now capture high quality image and high frame rates (to capture fast movements). They are relatively cheap, non-interfering, and provide immediate visual feedback for the teacher and student. Playback on a television screen/computer screen/mobile phone in real-time, slow motion, or frame by frame is easily achieved. Different views can be recorded for a more thorough analysis.

Consider the discipline of swinging trapeze. Timing of the beating phase is an essential requirement and can often be difficult for a student to learn. Playback of the student following a class or lesson may help identify timing, body shape and technique issues. This process may also highlight strength problems in particular phases of the swing, for example. The physical conditioning programme would then focus on particular strength elements that the student could be lacking. This concept of observation is applicable to all movements and disciplines undertaken by students in circus.

**Observation is key!
It all starts with observation
of the body's movement.**

3

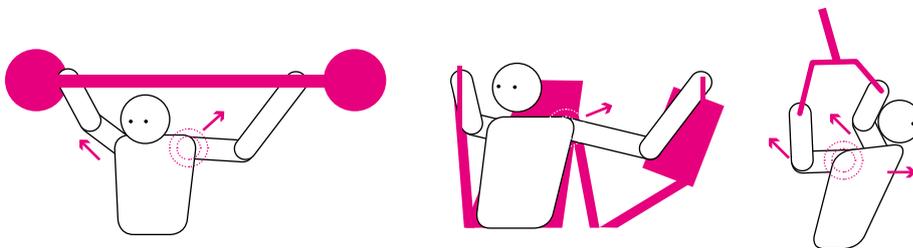
Reducing injury

An understanding of biomechanics can reduce injuries in circus. Observation by experienced teachers and/or physiotherapists can greatly benefit the student's training process.

A common example is a poor shoulder girdle positioning/posture during climbing. If the shoulder blade is constantly protracted (winging) with a combination of excessive internal rotation and anterior tilting, the excessive squeezing of tendons and other structures inside the shoulder may cause shoulder pain.

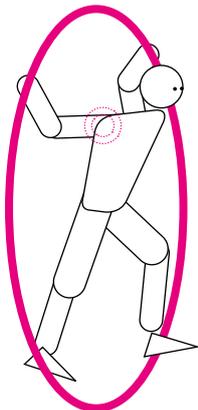
27

An example of weight training activities that can cause shoulder impingement symptoms



28

Man performing Cyr wheel



4

Axes of Rotation.

The body can rotate around any one of three different axes, all of which run through the centre of mass. These are known as:

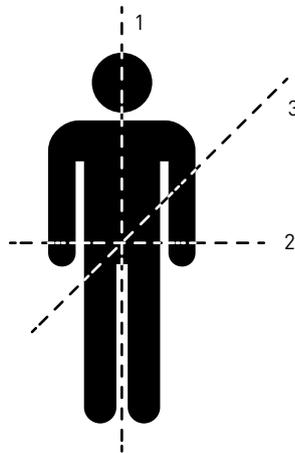
- 1 The longitudinal axis (twisting);
- 2 The transverse axis (somersaulting);
- 3 The saggital axis (cartwheeling).

The **longitudinal axis** runs through the centre of the body from the head vertically downwards to the feet. It is often referred to as the “twisting axis”.

The **transverse axis** runs from one side of the body to the other passing through the centre of mass and is often called the “somersaulting axis”.

Finally, the **saggital axis** passes through the centre of mass running from front to back, sometimes called the “cartwheeling axis”.

29
Axes of rotation



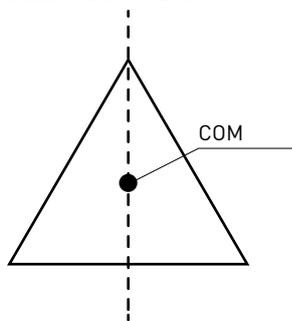
5

The Laws of Balance and Forces

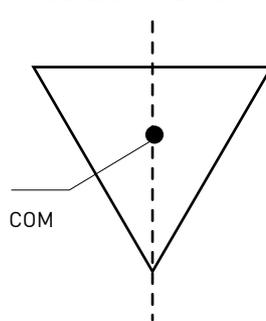
Forces are constantly acting on our bodies. Forces can be used to the advantage of a circus student to maintain dynamic postures and balance positions.

If a body is to remain stationary in a stable condition then the centre of mass must be within the area of its base. For instance, in Fig. 30 the pyramid is very stable because it has a wide base and therefore it is easy to keep its Centre of Mass (COM) within the confines of its base.

30
Stable structure



31
Unstable structure

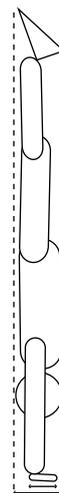


If we now turn the pyramid upside down as in Fig. 31 then the picture is very different!

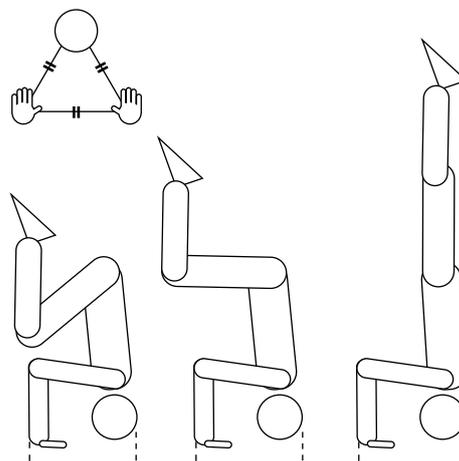
The base is now very small and the bulk of the mass is high up.

Equally, a headstand is easier to balance than a handstand. In the headstand we have a similar base to the pyramid with a triangular pattern between the hands and head. This allows a certain amount of body movement within the area of the base (Fig. 33). In a handstand the whole body is balancing on two small patches - the hands - and therefore it is much easier for the COM to move forwards or backwards out of the area of the support (Fig. 32).

32
Handstand (small base of support)

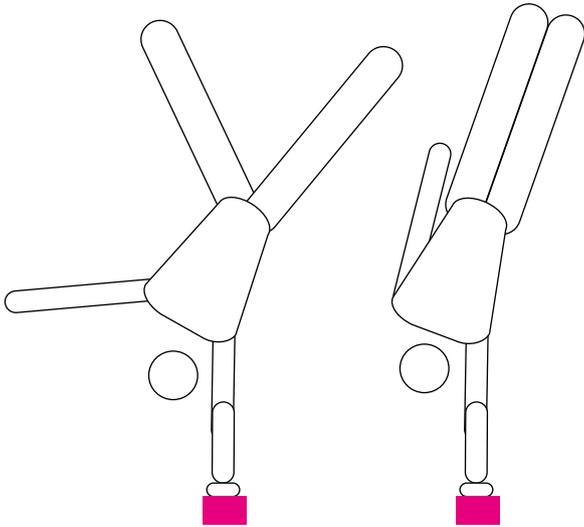


33
Headstand (larger base of support)



34

One arm handstand with wide legs or legs and free arm closed



Let us now consider the **forces** acting on a handbalancer maintaining a precarious balancing position on one hand (Fig. 34). How are these **forces** manipulated so that he/she can maintain equilibrium? A handstand position is mechanically an unstable position!

A coordinated response by the CNS must take place via proprioceptive, vestibular and visual feedback systems. Compared to the ankle, the wrist is a smaller base of support and is not able to produce as much torque. 'Proper handstand form' should be performed with straight arms, straight body, and pointed toes. This means that the ankle joint and elbow joint has only a limited range to contribute to overall balance.

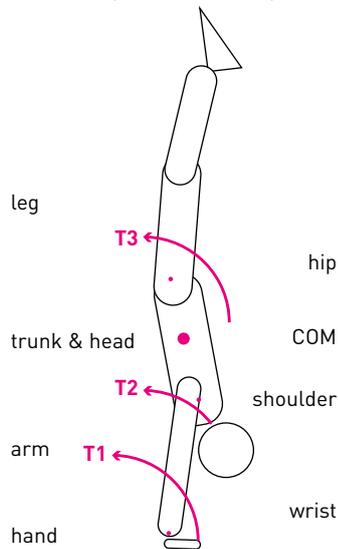
Joints and joint torques that are used to maintain a hand-balance can be analysed through biomechanics (see Fig. 35). This represents the joint strategies to maintain balance in the anterior-posterior (forward-backward) direction only, and does not take into consideration the medial-lateral (side-side) direction.

It is interesting to note that during a handstand, the body's **centre of mass** is slightly lower (nearer the hands and base of support than if the body was simply airborne). This is because **gravity** will exert a compressive effect on the body's internal organs.

35

This graphically represents a 4 section model of a handbalancer.

It shows the **centre of mass** (COM), and torques at the wrist (T1), shoulder (T2), and hip (T3).



Small amplitude movements and torques occur at the wrist, shoulder and hip joints to prevent displacement of the body's COM, which causes sway in a handstand. Generally speaking, the wrist joint is the most influential joint in maintaining COM in handstand. Despite the huge variety of shapes and positions that handbalancers can achieve, the body shape once chosen should be held fixed, with smooth transitions made between shapes. As the wrist is providing the base of support, it must provide torque around the point of contact and provide efficient control for the rest of the inverted body segments.

With increasing fatigue, hip movement and leg/ankle movement often occur to prevent loss of balance.

By dividing the body up into segments like this we can make generalisations about where movement is coming from. Another important factor to consider is which muscles are working to provide the different joint torques necessary for maintenance of COM. The muscles in the forearm exerting torque at the wrist joint may also be having an effect, producing joint torques further down the body to maintain balance.

A successful handbalancer must produce a series of muscular actions creating torques about joints that allow the body to be placed in various and often contortionistic body shapes to control their COM.

6

Newton's Laws

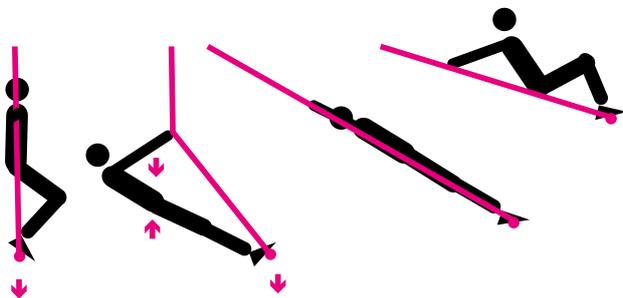
The physics of all the movements that occur in the world of circus can be explained by Sir Isaac Newton's three laws of motion.

Newton's **First Law of Motion** (also known as the Law of Inertia) states that an object or person maintains its state of rest or motion unless an external force is applied. This means that objects will just keep doing what they are doing (staying still or moving) unless acted on by other forces. So, if no outside force is applied, the velocity (speed + direction) of a person will remain constant. Consider a swinging trapeze artist standing on the bar at rest. A swing cannot be generated until a force is acted upon the bar by the body to initiate the swing.

Newton's **Second Law of Motion** states that the acceleration of an object depends on the force acting upon the object and the mass of the object. As the force acting upon the object increases, the speed of the object increases. This law is highly applicable to aerial skills. Consider a catcher releasing a flyer from the cradle. As he or she releases the flyer they may choose to give an extra impetus (force) to the flyer, who needs to perform a somersault before re-grasping.

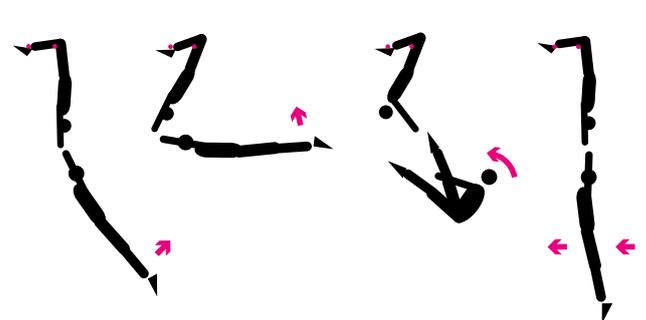
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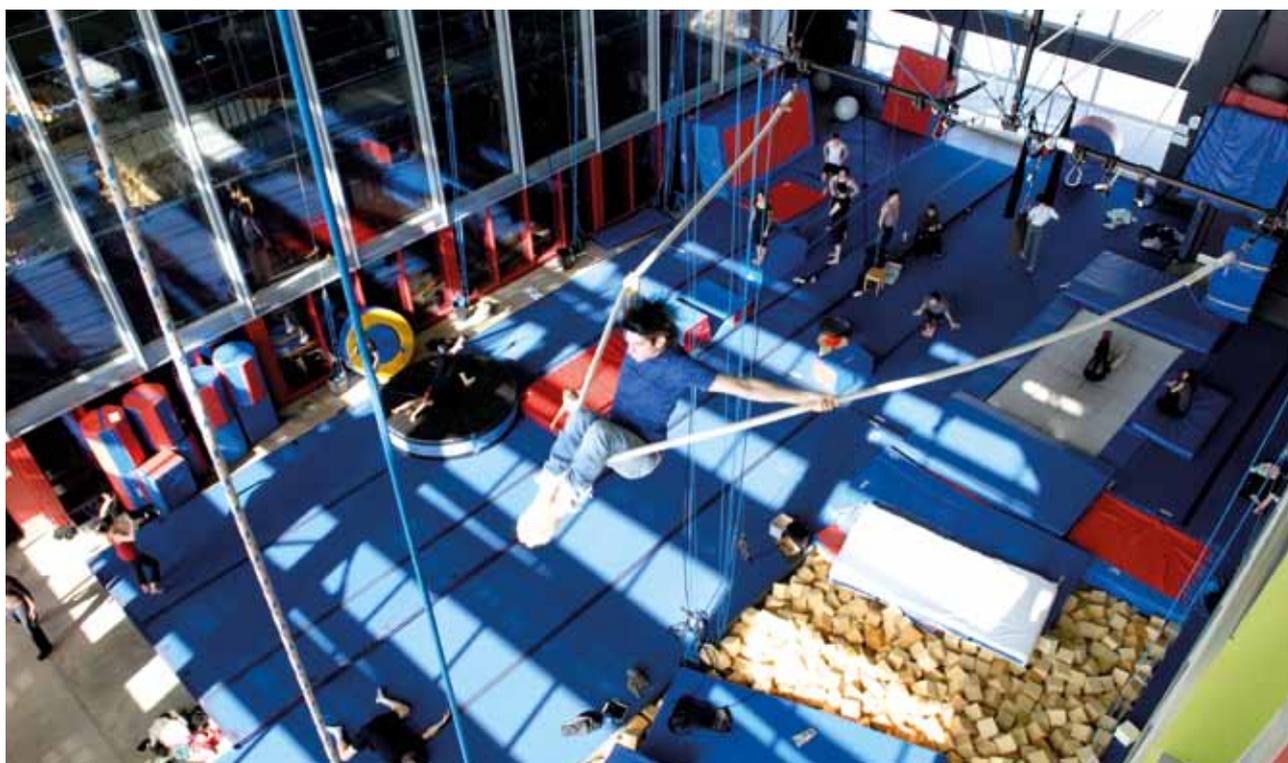
The First Law of Motion demonstrated on the swinging trapeze



37

The Second Law of Motion demonstrated by aerial cradle

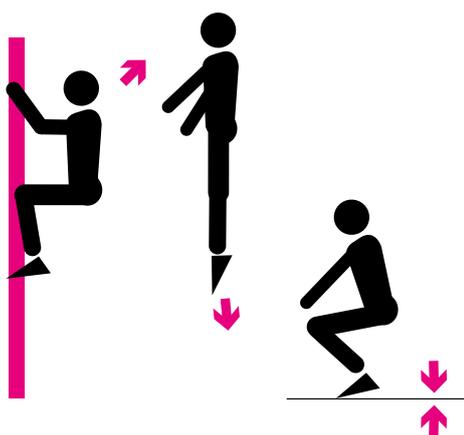




Newton's **Third Law** states that every action has an equal opposite reaction. When a man runs, his body exerts a downward and backward force on the earth. In reply the earth exerts a force against the man forcing him upwards and forwards. If you bounce a ball on the ground the ball exerts a force on the earth and the resulting reactive force from the earth propels the ball upwards. This applies to circus: e.g. the Chinese pole supports the weight of the performer and exerts an equal force against the performer. Similarly, when dismounting from the pole to the floor, the floor exerts a force equal to that of the performer hitting the floor, preventing the performer from disappearing through the floor.

38

The Third Law of Motion demonstrated on the Chinese pole



It is important to remember that the opposing forces are equal in size. This is sometimes difficult to accept, as in the case of the man running. The force exerted on the earth is equal to that which propels the man upwards and forwards but because of the vastness of the Earth's mass, the effect on the earth goes unnoticed. The angular equivalent of the third law can be expressed as:

“For every torque that is exerted by one body on another there is an equal and opposite torque exerted by the second body on the first.”

This effect is exemplified in the case of a performer losing balance on the wire. The circular motion of one arm causes the whole body to rotate in the opposite direction. Another example is when a diver stands backwards on the edge of a board. If he starts to topple backwards he circles his arms vigorously backwards. This induces a forwards rotation of the whole body and the diver regains balance.

“For every torque that is exerted by one body on another there is an equal and opposite torque exerted by the second body on the first.”

7

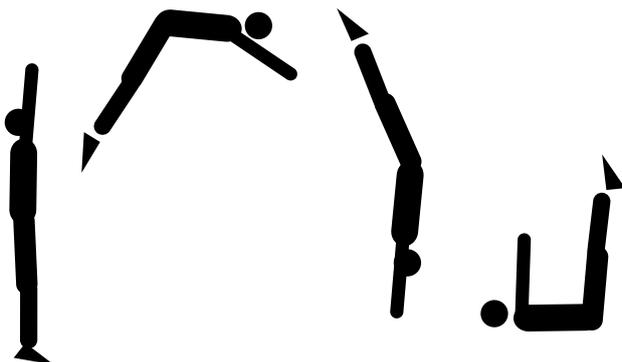
Transfer of Momentum

A transfer of momentum occurs when momentum is taken from one part of the body and transferred to another.

When in flight, if the angular momentum of one part of the body is decreased then another part of the body must experience an increase in angular momentum to conserve the total momentum of the body. Imagine a performer on a trampoline executing a bad 'crash dive'. In this case the performer takes off and lifts his hips (Fig. 29). At this point it seems that the legs have lost all momentum and stay still. However, as he begins to descend towards the bed, the momentum is transferred to his legs, his body remaining in place. The legs move upwards until the body is extended vertically and inverted. Following this, the momentum is again transferred to the upper body as it turns forwards for the landing on the back.

39

Crash dive demonstrating transfer of momentum



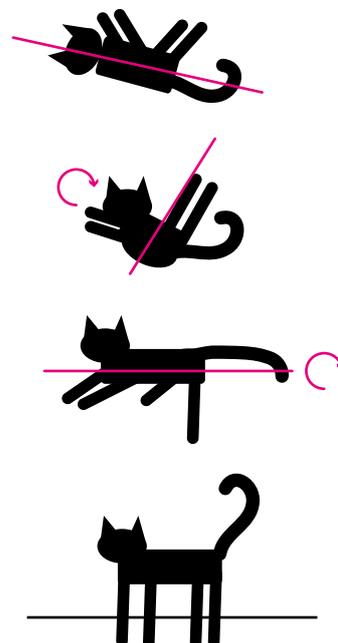
7.1

Initiating Twist in the Air

Consider the cat in Fig. 40. As it begins to fall it bends in the middle, bringing its front legs in close to its head. As it does this, it twists its upper body through 180°. This causes a reaction in its lower trunk, back legs and tail. However, because the moment of inertia of these parts is much greater than the upper body, the angular displacement is much less. To complete the turn the cat then brings its lower body in line and rotates through 180° to complete the twist. The reaction to this is small once again due to the disposition of the lower trunk and the greater moment of inertia of the upper body. This has become known as the "cat twist".

40

Cat twist

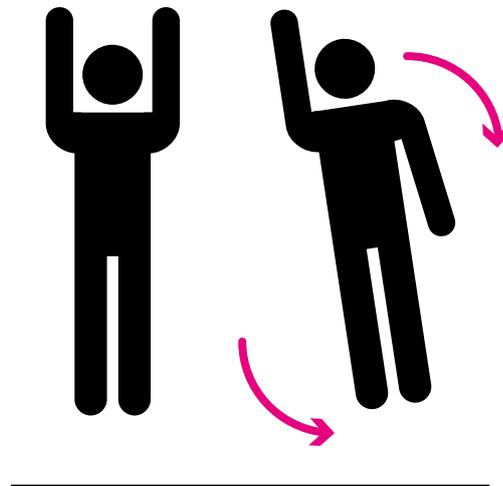


This type of twisting has been developed in aerial activities such as trampolining and is sometimes referred to as “pike, extension – hip rotation”. Like the cat, a performer can initiate a twist in the air by twisting the upper body whilst opening out of a pike.

This is not the only way to initiate twist in the air. Imagine a diver or a trampolinist somersaulting with a straight body. If he or she swings one arm downwards and sideways from above the head the reaction to this will be a small rotation of the whole body in the opposite direction (see Fig. 31). As the body has now rotated there is a decrease in the moment of inertia around the somersaulting axis because of the sideways rotation. According to the law of conservation of angular momentum, the body’s momentum must stay the same, so this momentum has to be transferred somewhere else; in this case, to rotation around the longitudinal axis, or twisting. Consequently, the simple act of swinging one arm downwards and sideways during a somersault will initiate a twist in the air.

41

Initiating rotation by using arm swing





04

DEVISING A CONDITIONING PROGRAMME

1

Warm-up

A warm-up is the exercise you do before the main exercise. It is an act of preparation both physically and mentally, and safely prepares the body for the increased demand of exercise in a gradual manner.

A warm-up should be discipline-specific, which means that it mimics the activity you're about to do, but at a lower intensity, lower impact, and/or slower speed. For example, you'd walk before bursting into a sprint.

In the initial stages of a warm-up, the intensity should start low and then the degree of activity should progressively increase as the participant warms up.

A typical warm-up has the following characteristics:

- Participants should be constantly active;
- It should normally last between 10-15 minutes depending on the temperature and the clothing the participants are wearing;
- A warm up should include some basic skills and techniques that are related to the exercise for which they are preparing.

The benefits of a warm-up are summarised below:

THE JOINTS

- Weight-bearing activity through joints facilitates diffusion of lubricating fluid into the joint spaces;
- Increases range of joint motion for stiffened joints.

THE MUSCLES

- Increases blood flow to muscles;
- Increases oxygen and nutrients to muscles;
- Increases available energy and prevents the person from getting out of breath too easily/early;
- Improves muscle contraction;
- Increases temperature - muscles warm and more pliable - less risk of injury;

- Improves metabolic reactions required for exercise;
- Prepares heart for increase in activity, preventing rapid increase in blood pressure;
- Stretching in a warm-up will affect the power output of muscles and their pliability. Dynamic, ballistic type stretching is advised in a warm-up. Slow, passive stretching held for long periods will reduce the muscles' ability to generate explosive power.

THE NERVES

- Wakes up and enhances nerve-to-muscle pathways;
- Increases blood flow to brain - enhanced alertness and cognitive function;
- Enhances coordination and reaction times;
- Enhances proprioception (balance mechanisms);
- Prepares mentally for upcoming exercise.

HOW DO YOU APPLY THIS TO A WARM-UP?

Think of the **E-FITT** principle

Environment - Think about the environment you are in

Frequency - How often should you warm-up?

Intensity - How intensely should you warm-up?

Time - How long should your warm-up last?

Type - What type of activities are suitable for warming up? (and which body parts?)

SUMMARY

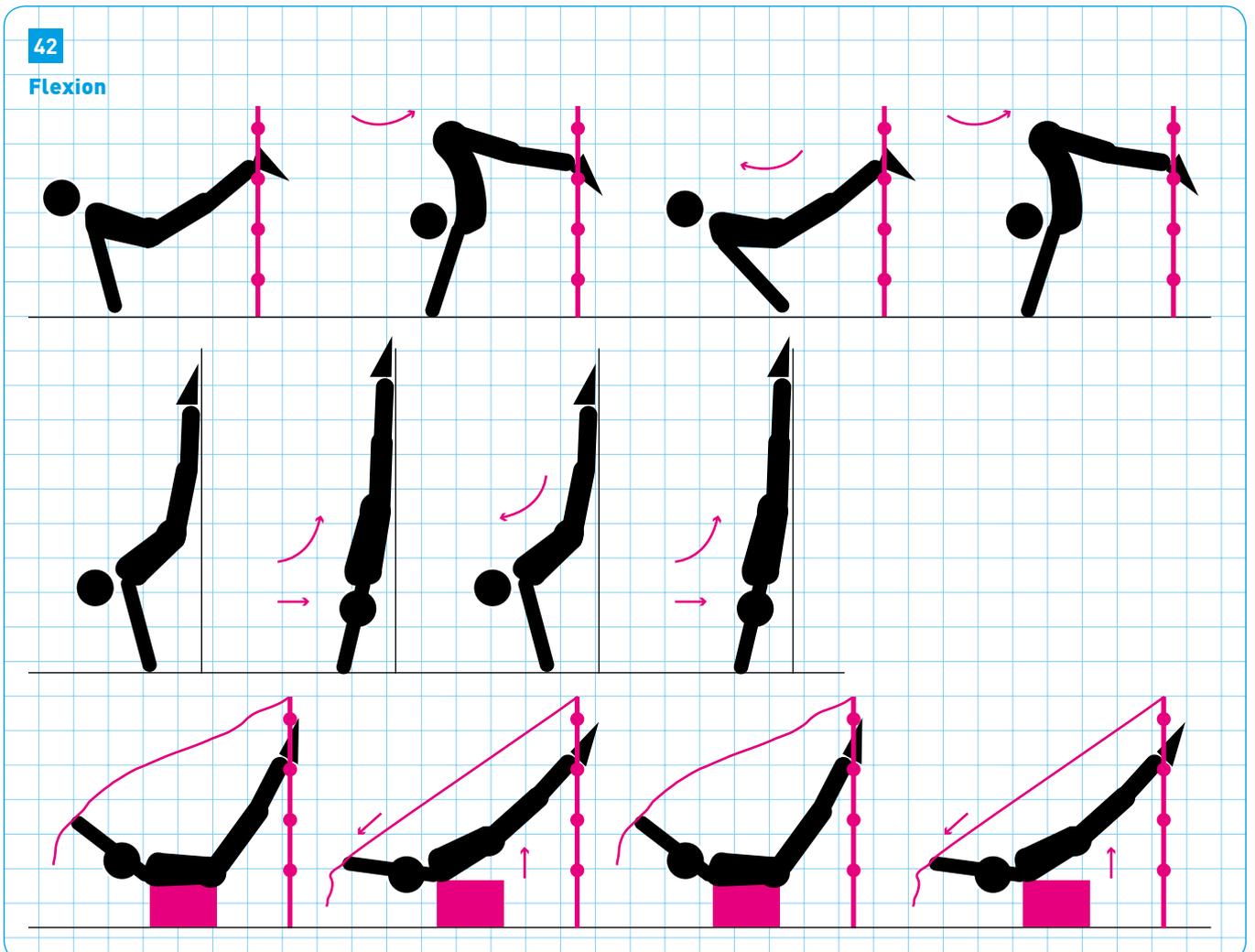
There is no specific right or wrong way to do a warm-up, but *make sure it is appropriate for your body type and the activity that follows*. Don't misuse the warm-up. It is not the right time to be developing flexibility. Avoid too much static stretching immediately before intense exercise.

2

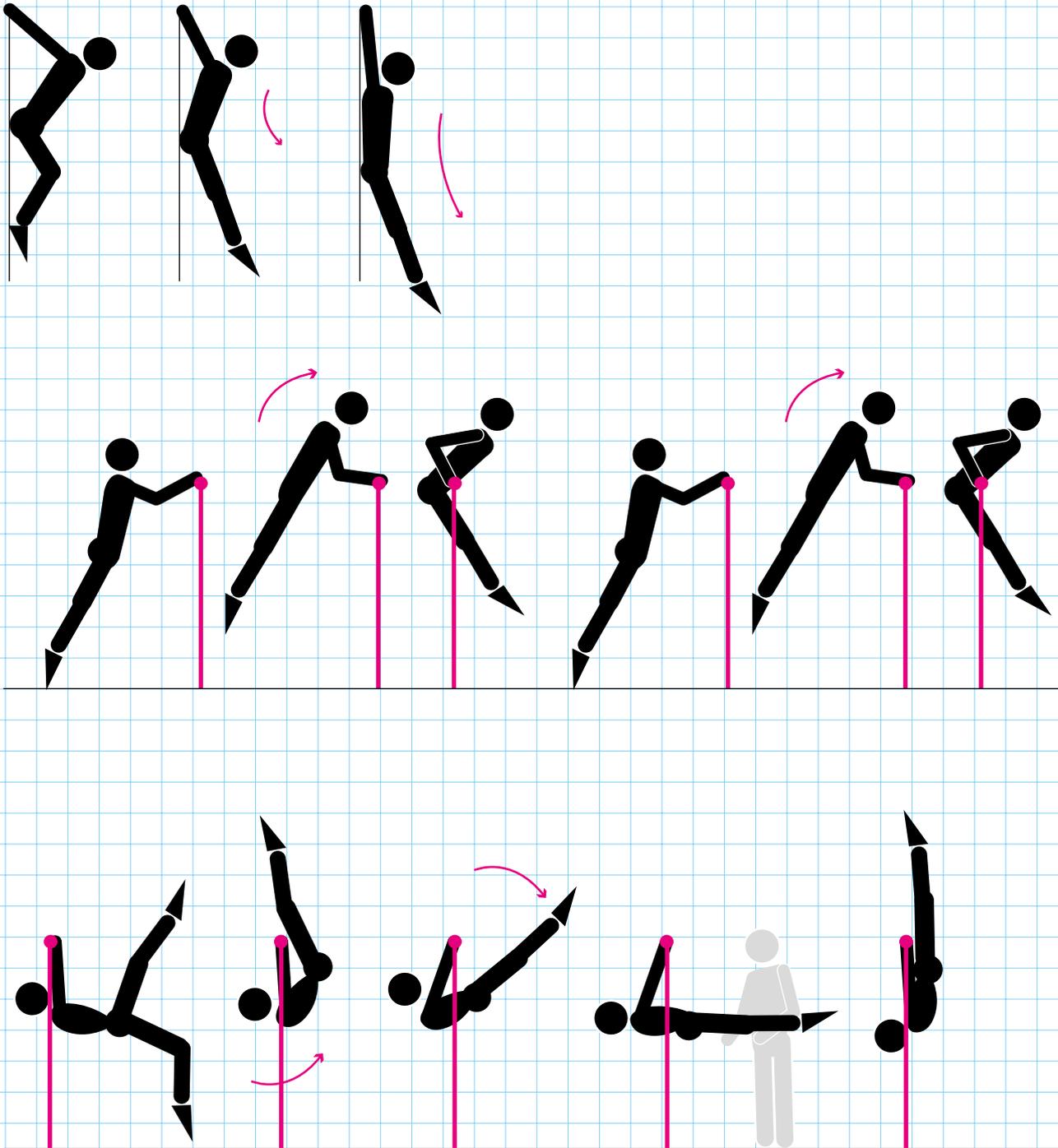
Considerations when devising conditioning programmes

Obviously each individual has different strengths and weaknesses and this must be taken into account when devising individual training programmes. However, it is possible to analyse each discipline and work out which actions the body is making and therefore what needs to be strengthened.

All forms of acrobatic movement can be broken down into the following categories:

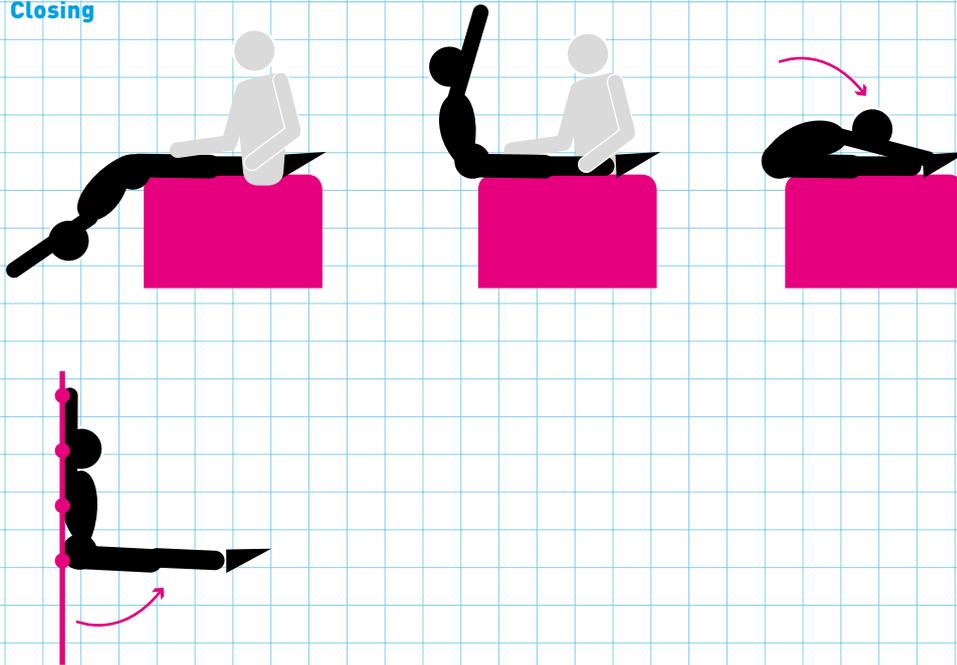


Extension



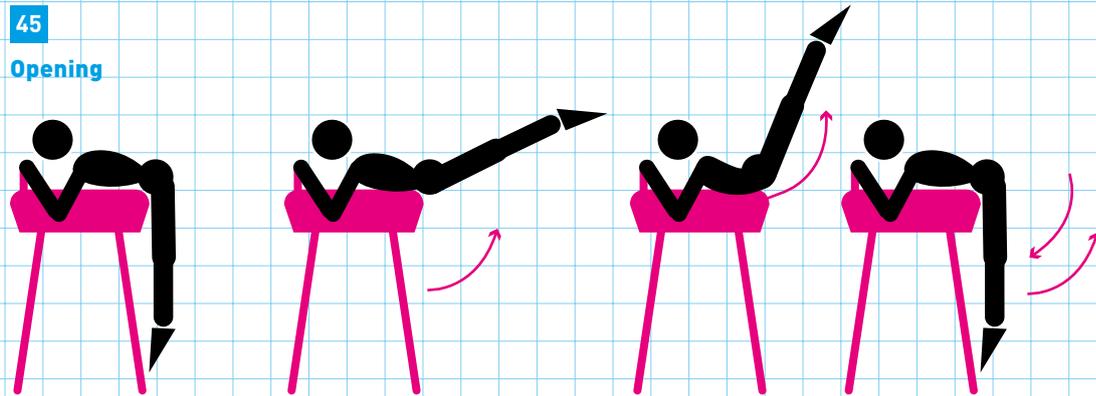
44

Closing



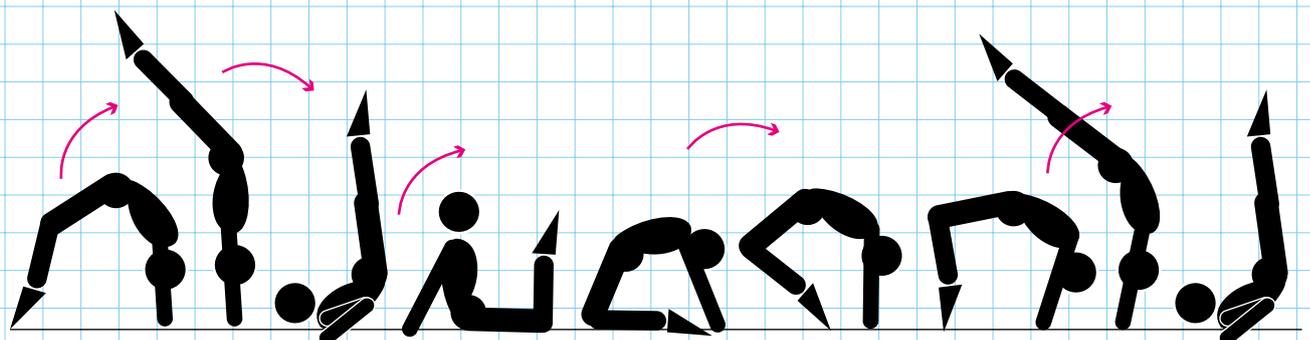
45

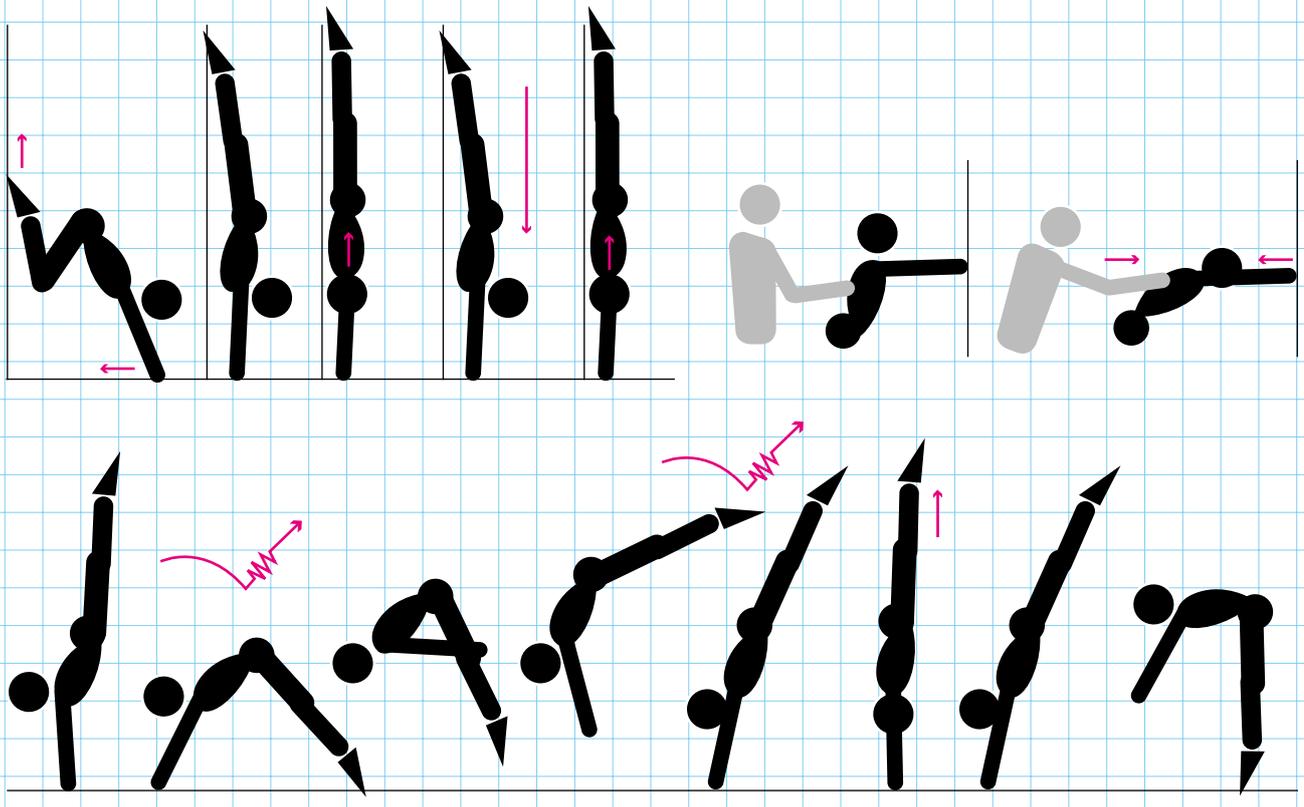
Opening



46

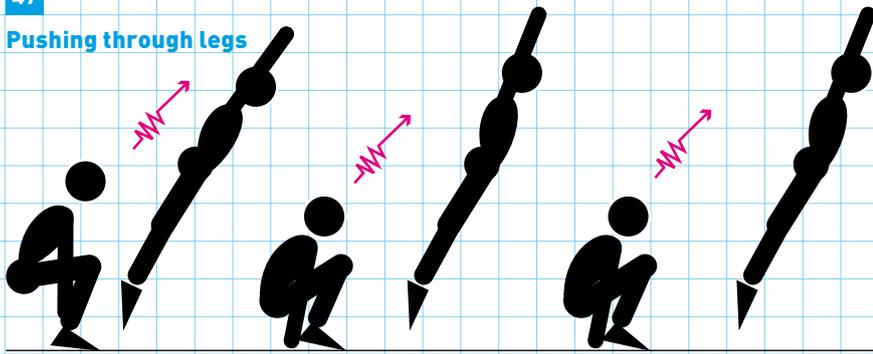
Pushing through shoulders





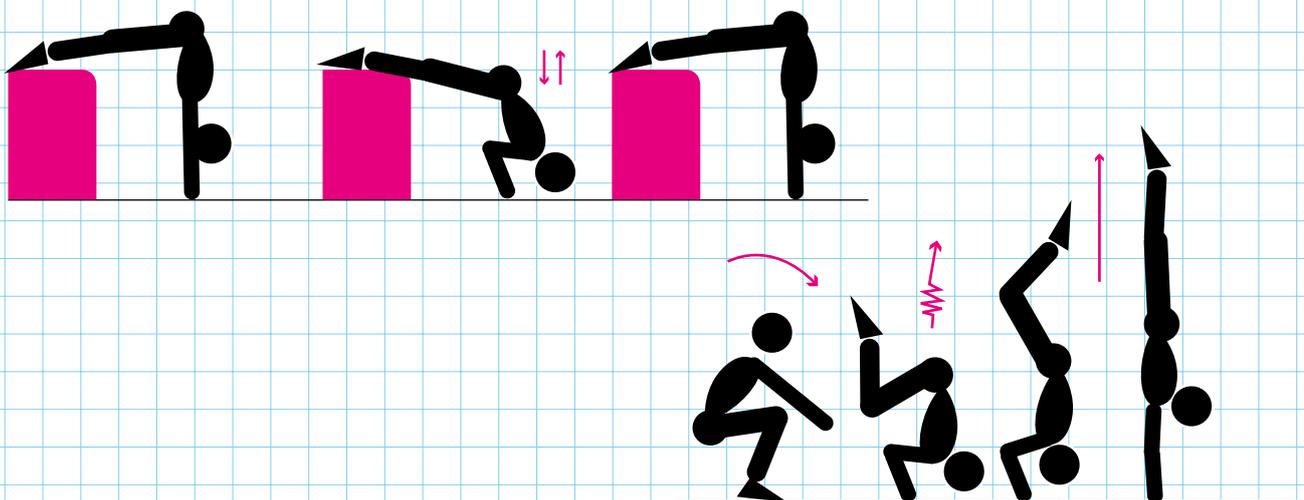
47

Pushing through legs



48

Repulsion



3

Examples of exercises for training individual components

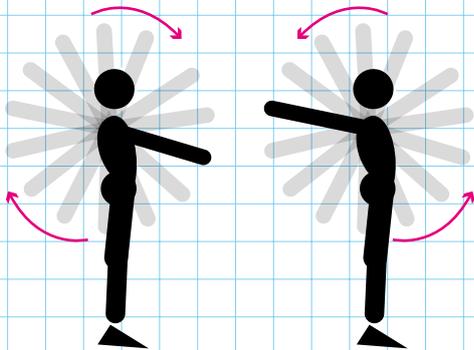
3.1

Training for flexibility

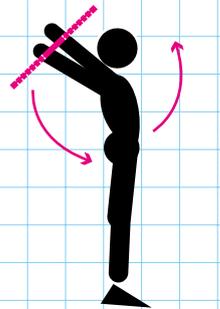
49

Warm-up and basic stretching exercises to increase shoulder mobility

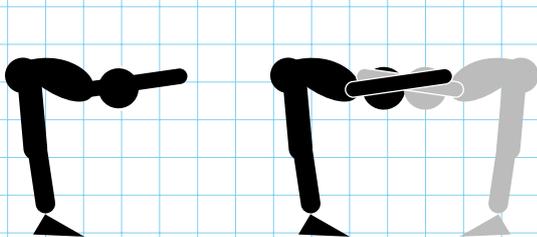
01 Start with arm circles both ways.



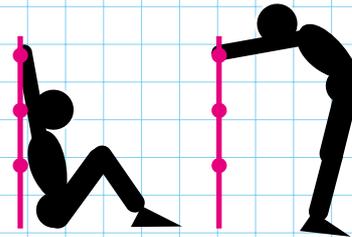
03 Use a stick to increase mobility. Place tape marks on the stick. Try to get progressively closer..



02 Extending the shoulders. This can be done with a partner or on wall bars.



04 For upper back and shoulders. Extend through the shoulders and upper back, not the lower back.

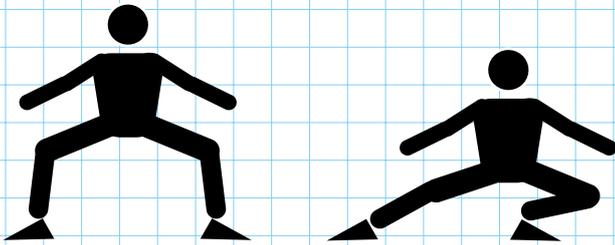


Warm-up and basic stretching exercises to increase hip/leg mobility

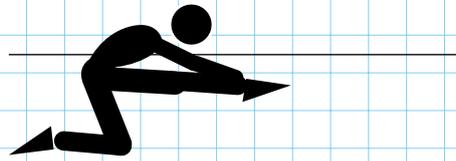
- 01** Straddle stand, stretch forwards to sideways to each leg.
Bounce and hold.



- 02** Lunge to each side from horse-riding position (demi plie).



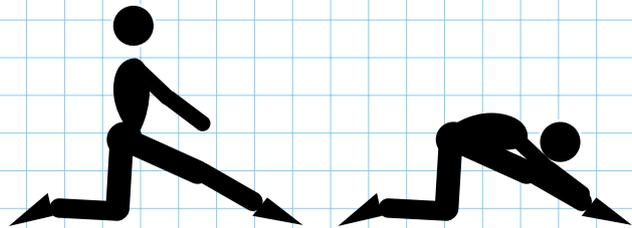
- 05** Hurdle sit fold forwards.
Keep back straight.



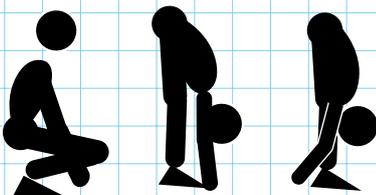
- 03** Lunge forwards on each leg.



- 06** Kneeling lunge, stretch forwards on each leg.



- 04** Crouch, straighten legs.
Start with finger tips on floor.
Progress to hand flat.
Then hands facing backwards.



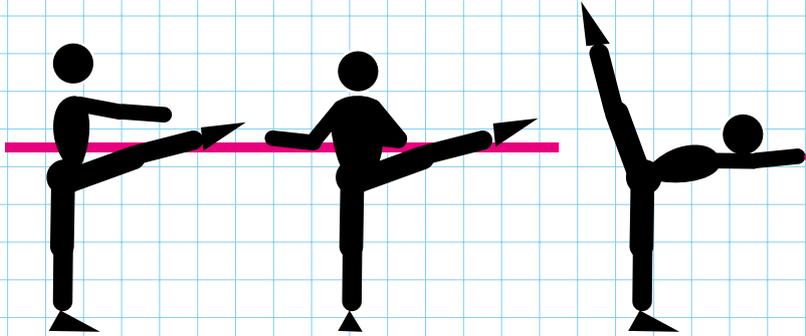
More advanced stretching for improving range of movement

For all these exercises students should work in pairs so they understand the principles and can help each other.

01 Grande Battement.

X 10 forwards, sideways and backwards.

Each time the student should touch a hand at maximum stretch height.

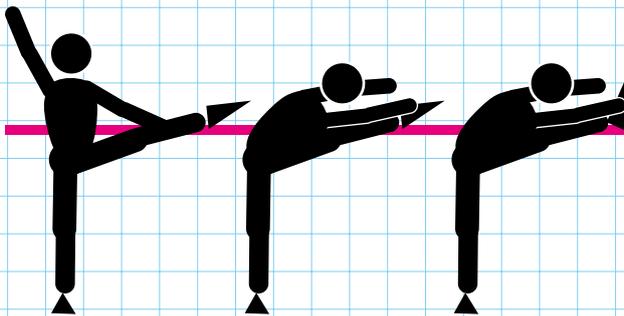


02 Stretch to side.

Fold x 8 then the teacher applies pressure.

Progressively increase the height of the leg.

Finish by holding leg free of the bar using muscles.

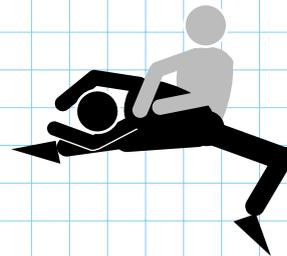


04 Side fold, foot in front of knee.

Fold to side opposite bent leg.

Knee must remain on the floor.

Teacher applies pressure and fixes bent leg with his/her foot.

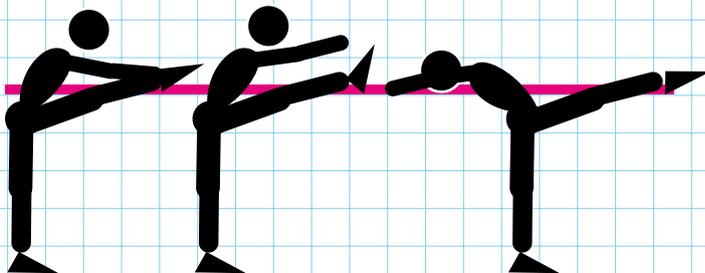


03 Forwards and Backwards Fold.

Alternate lean forwards with lean backwards as per ballet class.

Begin with extended ankle and then flex.

Lean forwards with straight back.

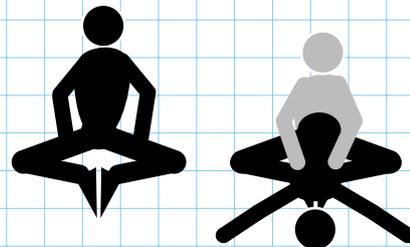


05 Fold forwards, knees wide, feet together.

Knees should be pressed to the floor.

Teacher applies pressure to back.

Back should remain straight.



06 Back rotation and buttock stretch.

The student applies backwards pressure to the bent knee whilst actively rotating the shoulders in the opposite direction.



07 Lumbar fold.

Head lifted.
Back straight.
Start with feet extended, then flex.



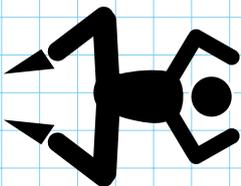
08 Straddle fold.

Start with narrow split and then widen.



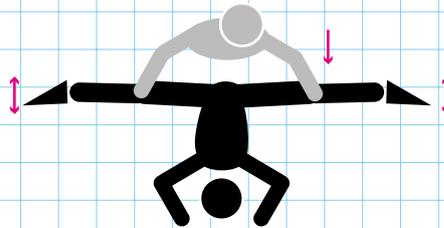
09 «Frog position» hip stretch.

Hips are pressed to the floor.
The knees can rest on the teacher's feet to allow greater range of movement.
Repeat with straight legs (side split).



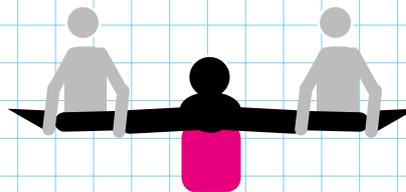
10 Side split lying on back.

Lie on back press knees to floor.
Bent knees first and then straight.
PNF stretching can be used.
Student applies pressure back on teacher for a few seconds and then relaxes to allow stretch.
The legs can be moved backwards and forwards while the teacher applies pressure.



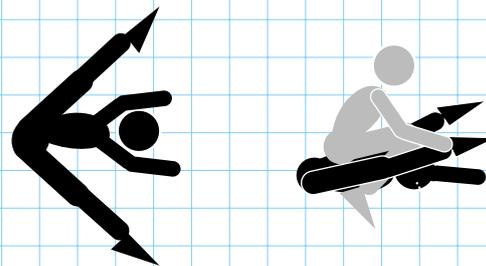
11 Side split over box (needs 2 people to stretch).

The pressure should be applied to the leg above the knee, holding the ankle with the other hand.



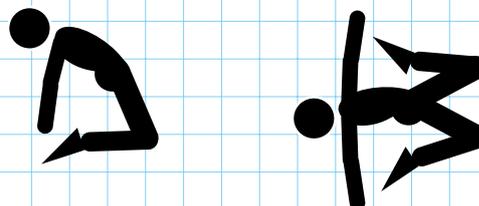
12 Further Stretch in Straddle.

Lift the legs before sitting on the back.



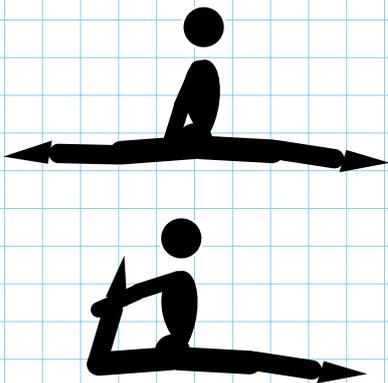
13 Stretching the feet and ankles.

First with knees and feet together.
Then split legs and sit between feet.
Lastly lean back and press back to the floor (this will take some time to achieve).



14 Splits to front. Keep the hips square.

Turn the front foot out.
Lift the front off the floor min. 3cm.
Bend the back leg and lift the foot towards the head to ensure the hips are square, leaning the upper body back towards the foot.
The teacher can manipulate the student into the correct position.



15 Further exercises for splits.

Against wall, pull the foot towards the buttock.



16 Splits, bend back.

Ensure that the hips are kept square.



17 Splits folding forwards.

Straight back.
Teacher applies pressure to back.



52

More advanced stretches

Blocks can be placed below the student's feet in front and side splits to increase the range of movement.



Leg stretch from kneeling

The teacher can control twisting of the hips.
Use the knees in the back to extend the hips forwards.
Repeat to the side.

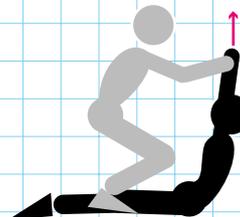
53

Back and Shoulder Stretches

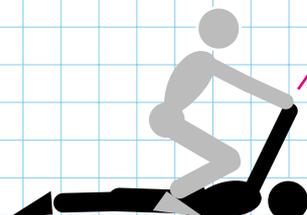
01 Repeat with straight and bent arms



02 Stretch for lower and upper back



03 Shoulder flexion stretch



Training for strength

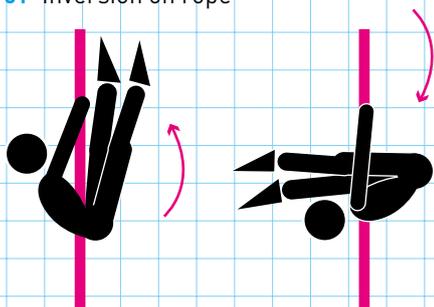
54

Circuit Training

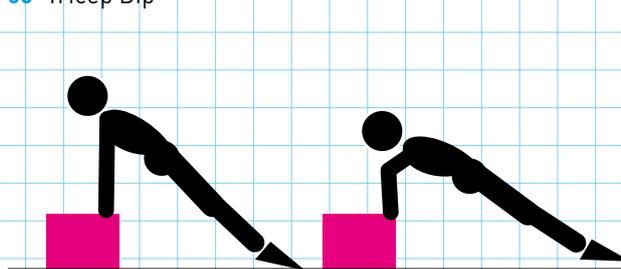
Begin with 20 seconds' work intervals and 40 seconds' rest, increase intensity by:

1. Lengthening the work interval
2. Shortening the rest interval

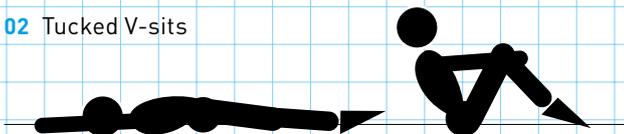
01 Inversion on rope



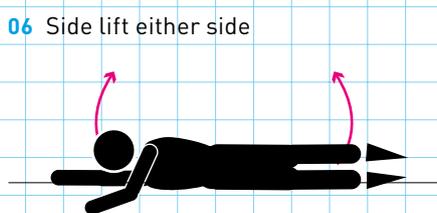
05 Tricep Dip



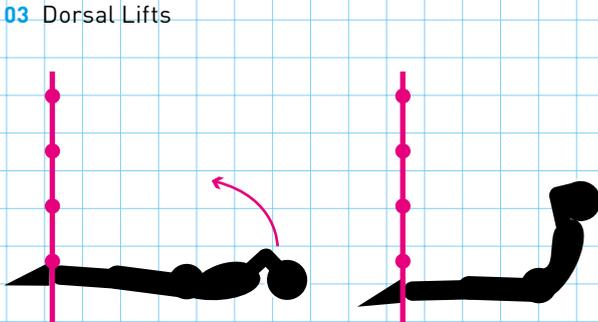
02 Tucked V-sits



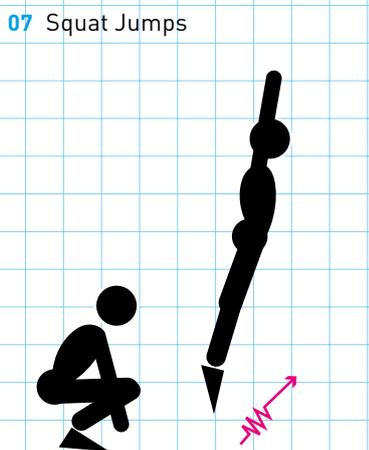
06 Side lift either side



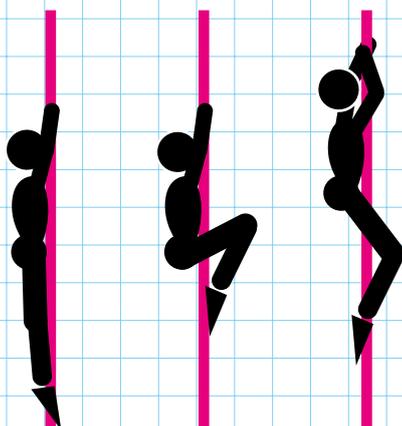
03 Dorsal Lifts



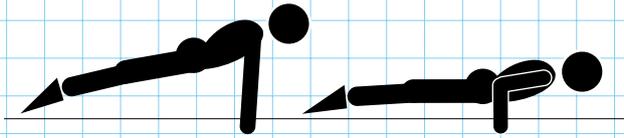
07 Squat Jumps



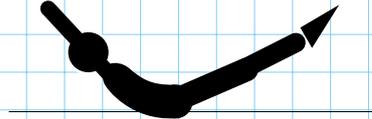
04 Rope Climb



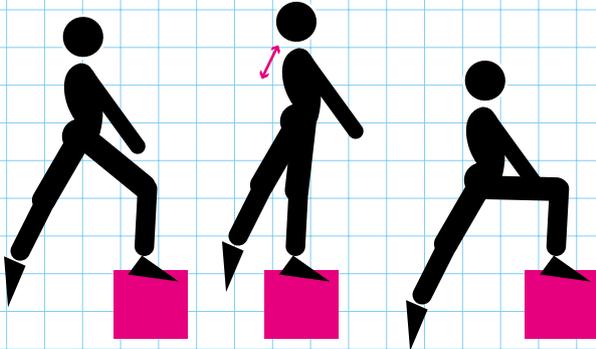
08 Press ups



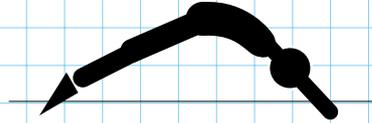
13 Dish on back



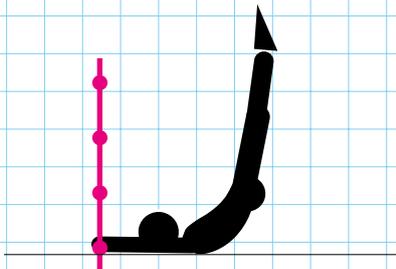
09 Step ups on bench



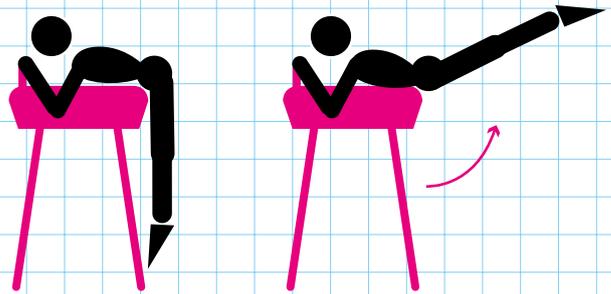
14 Tension Bridge



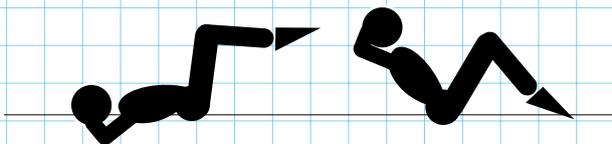
10 Shoulder stand tilt



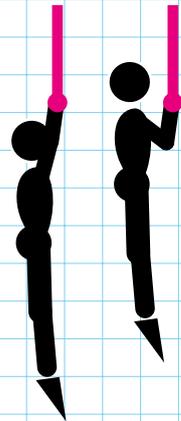
15 Lumbar lifts



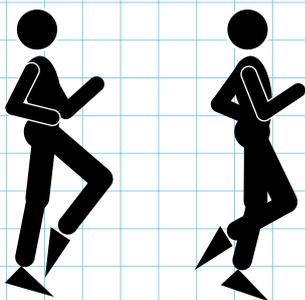
11 Abdominal Crunches



16 Chins on trapeze



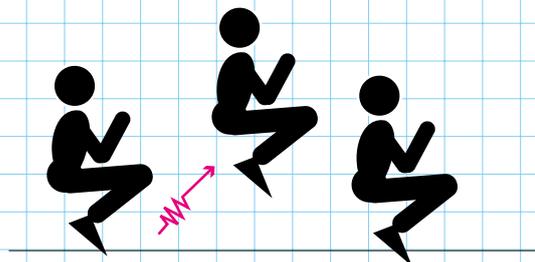
12 Running on the spot



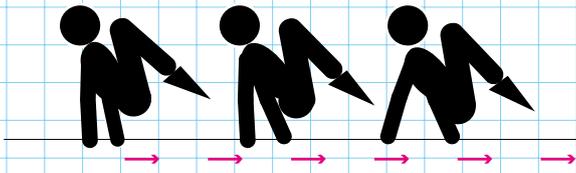
17 Squat thrusts



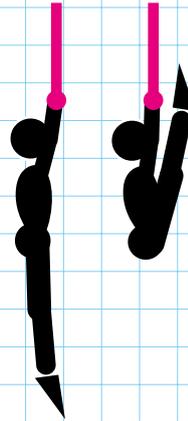
18 Jumps in squat



19 Russian walks



20 Leg lifts on trapeze

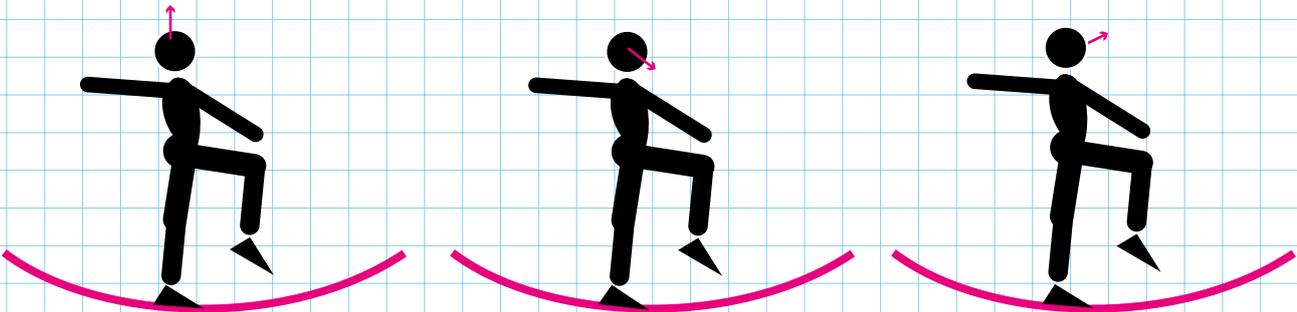


3.3

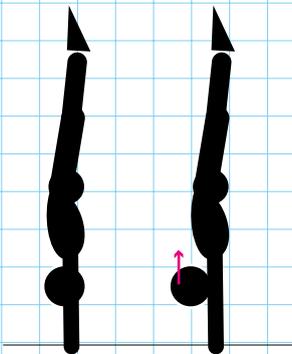
Training for balance, coordination & agility

55

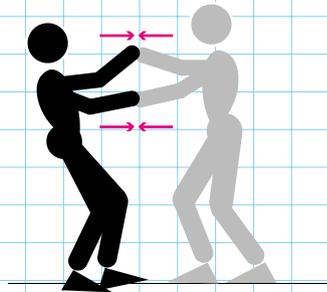
01 Pictures of person on tight wire: looking up, right, left



02 handstand looking to feet



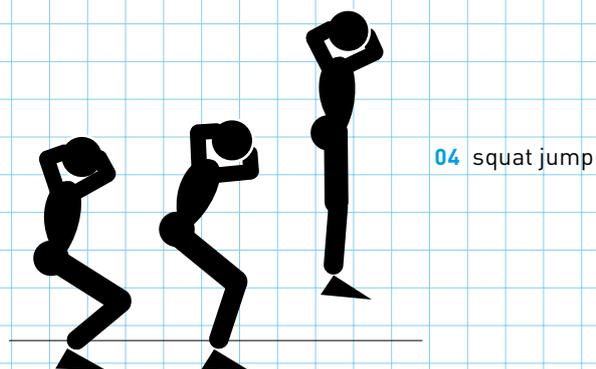
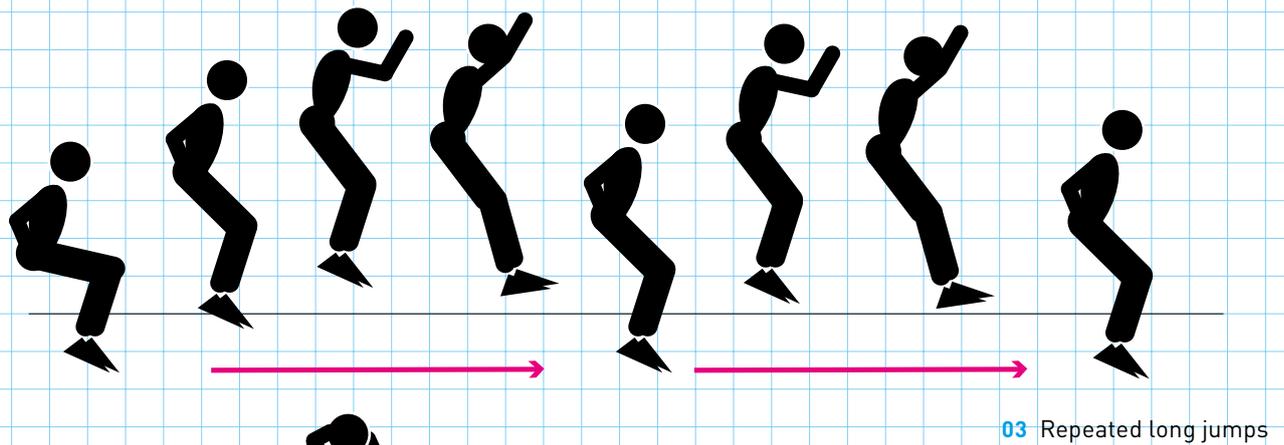
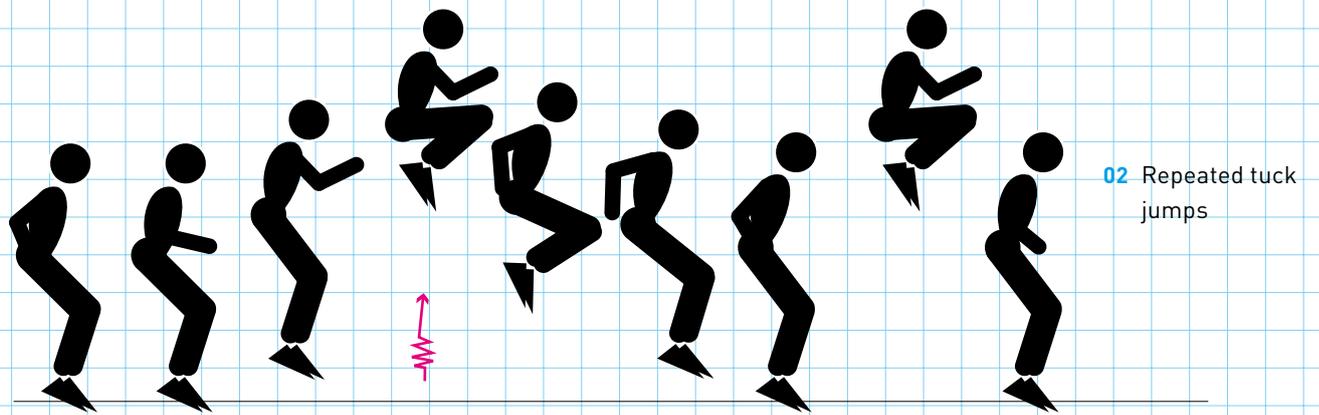
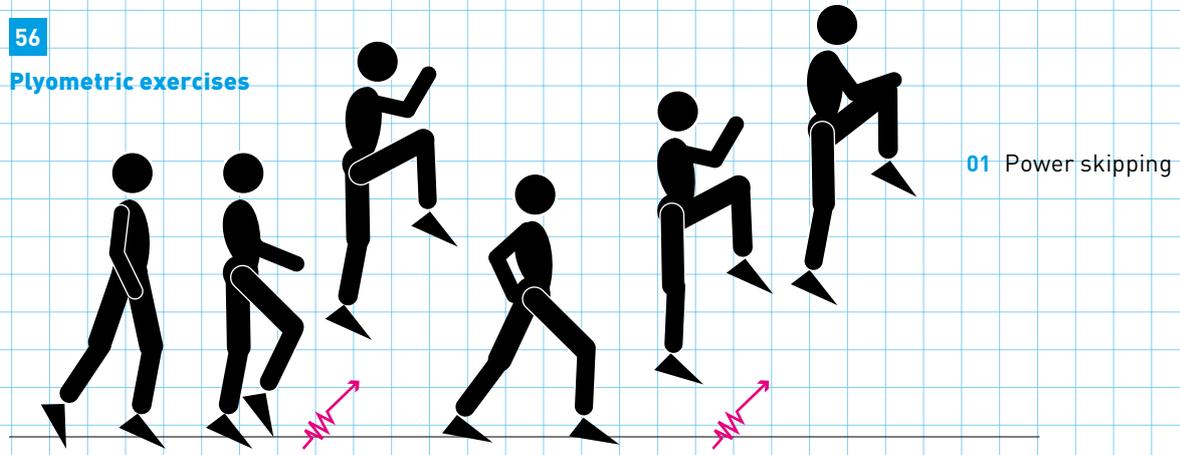
03 game of two people who try to unbalance each other by pushing hands whilst keeping feet on the ground



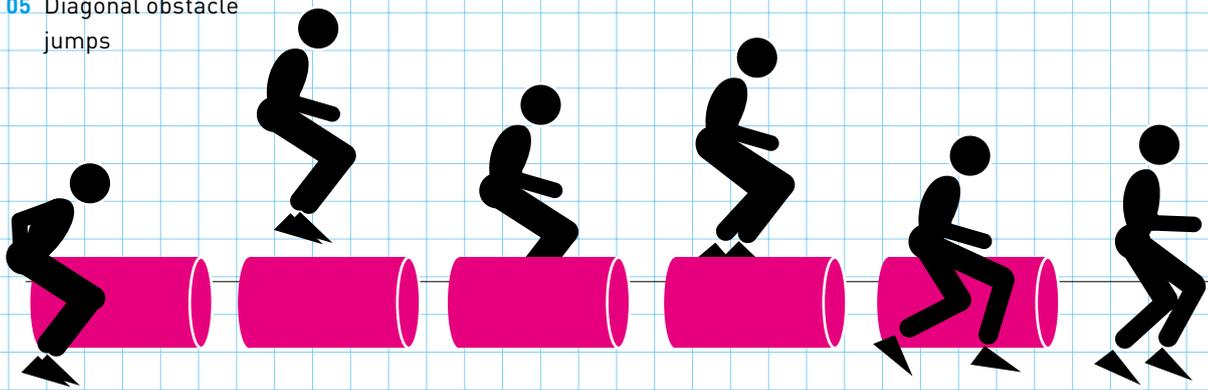
Training for Power – Plyometrics

56

Plyometric exercises



05 Diagonal obstacle jumps



06 Single leg hops



07 Alternate leg bounding

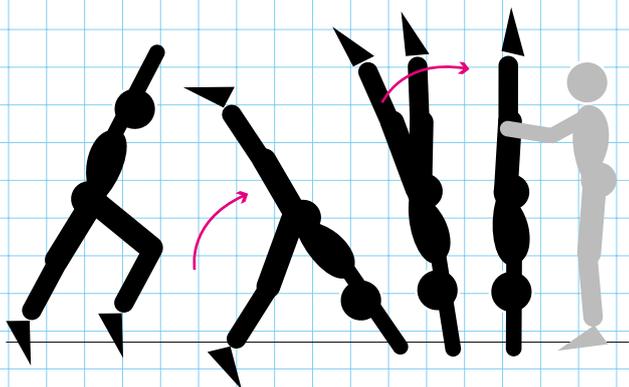


3.5

Training for Endurance

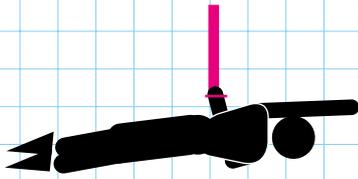
57

Holding a handstand for 2 minutes with a spot



58

One arm planche being held for 1 minute



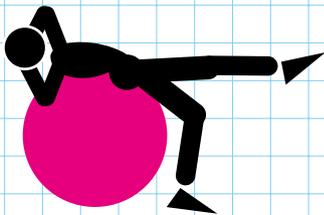
3.6

Core stability exercises for the trunk

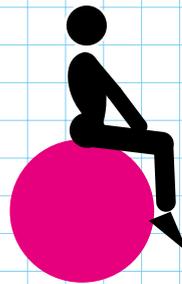
59

Core stability exercises

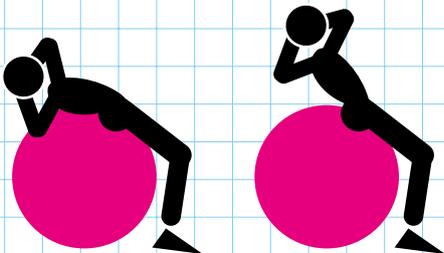
01 Balance with 1 leg for 20 – 30 seconds then change legs.



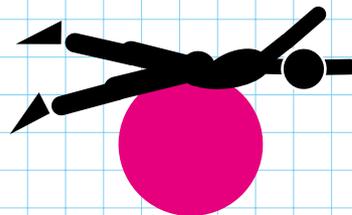
04 Balance sitting on the ball 20 – 30 seconds.



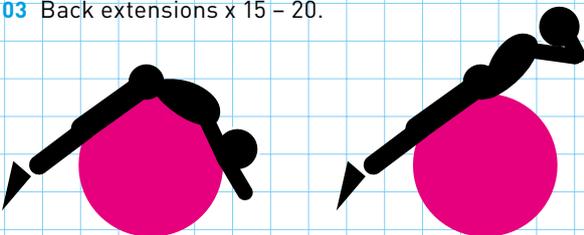
02 Sit-ups on the ball x 15 – 20.



05 Alternate arms and legs x 15 – 20.



03 Back extensions x 15 – 20.



06 Balance on knees 20 – 30 seconds.





05

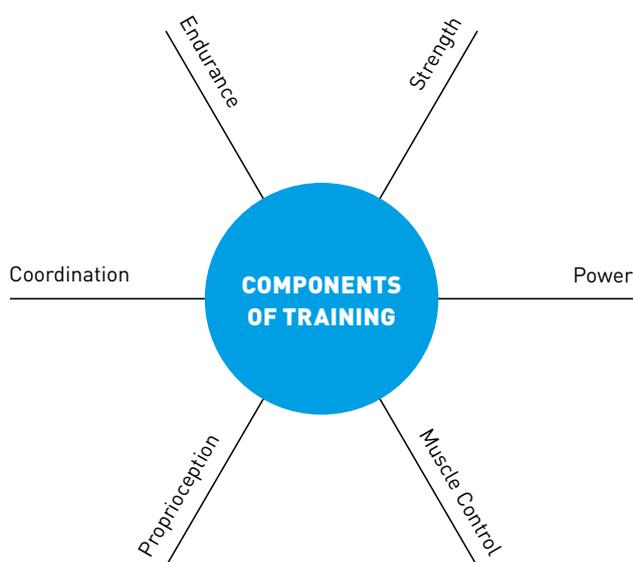
PLANNING CONDITIONING PROGRAMMES - DEVISING TRAINING PROGRAMMES

When developing training programmes it is very important to remember that the basics cannot be skipped over too quickly. This document has focused on five main components of training: flexibility; strength; balance, coordination & agility; power; and endurance. Other components include: discipline technique; core stability; muscle control; decision-making; and anticipation drills. This multiple component or “multi-lateral” approach to physical development will improve basic bio-motor abilities.

This broad base of physical development has been shown to prepare the body for more specialised training or circus-specialisation specific training. If this building block principle is initiated at an early stage, it will prepare the circus artist for better levels of technical ability and physical preparation at later stages in their career. This sequential, or building block approach is shown below in a conceptual model:

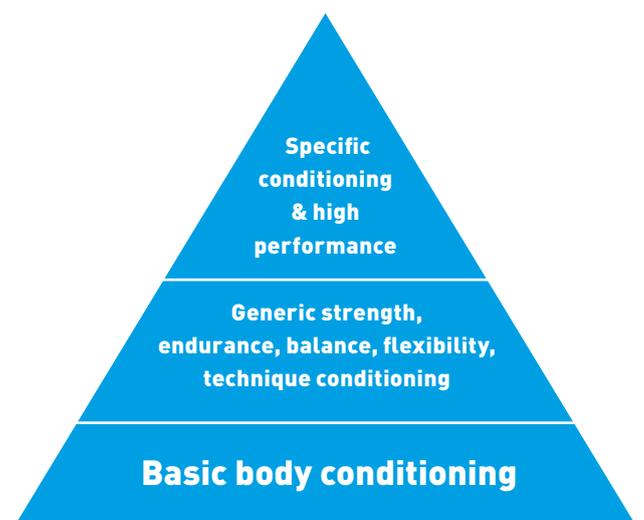
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Main components of training for multilateral physical development



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Building Block Principle



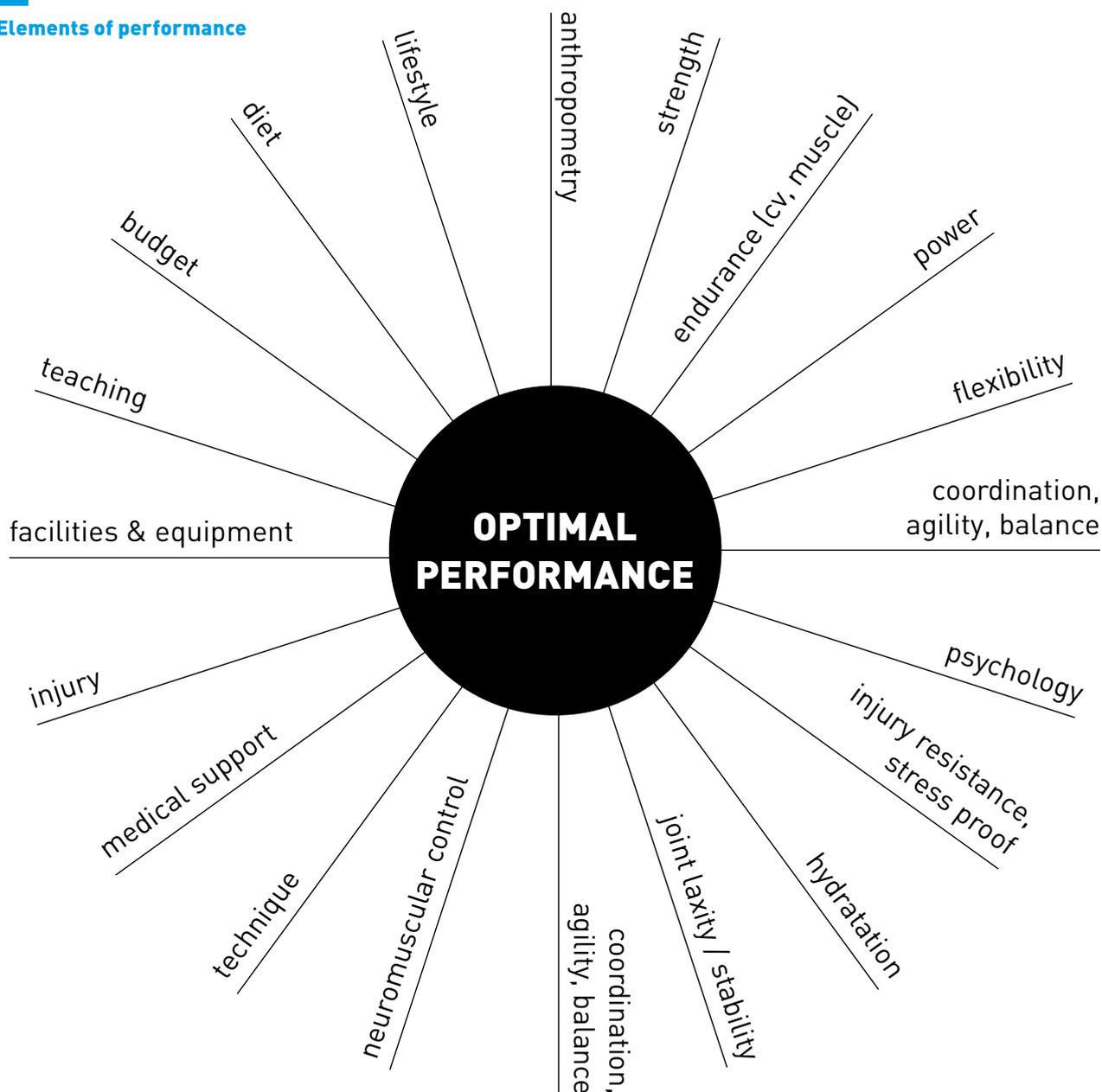
When commencing more specialised training, consideration needs to be given to the development of the physiological and fitness requirements that are specific to the circus discipline. Consideration needs to be given to the number of training sessions per week, the required training intensity and how to progress. This is always a contentious issue but each person normally finds their individual ideal training stimulus with guidance from scientific principles and practical experience. A significant challenge is how to design a training programme that facilitates muscular and neurological adaptations whilst respecting the healing rate of the body's tissues and maintaining safety of the individual.

The training of an individual should be monitored and evaluated at defined stages. Assessment can be made via teacher/trainer feedback, self-reporting and physiological testing. If the performance is not improving as expected then the training system can be re-evaluated and modified if necessary. It must be remembered that there are many different elements that contribute to successful performance, not just the physical conditioning programme as illustrated below (see Fig. 63).

Before devising a definitive conditioning programme you should also consider whether the individual has had any previous injury or illness, whether he/she has any current physical problems, and whether he/she has access to medical/physiotherapy support if needed.

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Elements of performance





APPENDIX

Basic definitions

ACCELERATION

Acceleration is a change of velocity in a given time. If we stand at the top of a building and drop a stone, within 1 second the stone's velocity will have increased by approximately 10m/s because of gravity. As the velocity increases 10m/s in 1 second, then the acceleration is said to be 10 metres per second per second. This is written as 10m/s/s or 10m/s². Of course, acceleration can also be negative, commonly known as deceleration: a braking car will exhibit negative acceleration.

ANGULAR ACCELERATION

As with linear acceleration, this describes the speed at which angular velocity is increasing or decreasing.

ANGULAR VELOCITY

Angular velocity tells us how fast an object is rotating. It expresses how fast somebody is somersaulting, or how fast a club might be rotating. It can be expressed in degrees per second.

CENTRE OF MASS (COM)

Also known as Centre of Gravity.

The point where the body is equally balanced.

The point around which all the body masses are equally distributed in all directions.

The intersection of the 3 axes.

The point around which the body turns when free in space. The position of the centre of mass varies according to the shape of the body. It may not even lie within the physical substance of the body.

FORCE

To move any object requires force. The mass (weight) of the object and how fast you want to accelerate it to a given speed will define the size of the force. The force equation is one of the most important in mechanics: $F = ma$. In other words you find the size of the force by multiplying the mass of it by the acceleration caused by the force.

For example, three men are pushing a car with a mass of 200Kg; after 4 seconds the car is traveling at 2 metres per second.

The average acceleration is 2 m/s divided by 4 seconds = 0.5m/s². This means that the men have imparted a force of $200 \times 0.5 = 100\text{kg/m/s}^2$ Or 100 Newtons.

GRAVITY

Every mass has gravity, a force which attracts other objects towards it. It is a very weak force and only becomes significant when dealing with immense bodies like planets and stars. Gravity is usually measured as an accelerating force in metres per second per second.

For instance, on Earth, if you drop a stone from a building its velocity will increase by 10 metres per second every second. Thus the Earth's gravity can be measured as a force that attracts objects at an acceleration of 10 metres per second per second, easily written as 10m/s². The gravitational force of the moon is approximately 1/6th of the Earth because of its smaller size.

INERTIA

Inertia is normally looked upon as a resistance to change. If an object is at rest it requires an outside force to move it. The mass of the object will define the amount of force required to move it. This resistance to movement is its inertia. Similarly, if another object is moving at a constant velocity then the force required to slow it or move it from its path is also a consequence of its inertia.

MASS

An amount of matter. Anything of substance is made of matter and therefore everything has a mass. It is usually measured in Kilograms (Kg).

MOMENTS

A moment is the rotational equivalent of mass. When a mass is attached to a pivot, the moments it creates are dependent upon the size of the mass and the distance from the pivot. Imagine two children playing on a see-saw. If a six year old is sitting on one end and a ten year old on the other, then the ten year old, being heavier than the six year old, will cause the see-saw to tip his way. He now starts to move his way along the seesaw towards the centre. As he moves toward the centre his body exerts a lesser moment. At a certain point they will be perfectly in balance, then as he moves closer to the pivot, the see-saw will begin to tip to the six year old's end. This is an extremely important concept for acrobatic movement because it shows that as a mass moves further from the pivot or axis of rotation then it exerts a greater moment and is therefore harder to rotate.

RM

One rep maximum (one repetition maximum or 1RM) in weight training is the maximum amount of weight one can lift in a single repetition for a given exercise. One repetition maximum can be used for determining an individual's maximum strength and is the method for determining the winner in events such as powerlifting and weightlifting competitions. One repetition maximum can also be used as an upper limit, in order to determine the desired "load" for an exercise (as a percentage of the 1RM).

ROTATIONAL MOVEMENT

All the terms we have looked at so far have been in relation to linear movement; that is, movement in a straight line. Balancing is also concerned with rotating. So now we have to consider all our linear terms in a rotational context.

SPEED

Speed is a rate of change. This can be anything from the amount of time it takes a car to travel from one place to another to the speed of a chemical reaction. Speed is what we call a "Scalar" measurement. This means that it doesn't necessarily have a direction.

VELOCITY

Velocity differs from speed in that it has a given direction. If a sprinter runs a 100m sprint along a track pointing due North in 10 secs then his average speed is 10m/s and his velocity 10m/s due North. This average velocity is what is called a "Vector" quantity, because it has speed and direction, i.e. North. As it has both of these qualities it can be represented on paper as a straight line. It is obviously not possible to do this with a chemical reaction! In mechanics velocity is usually measured in metric terms, for example metres per second (m/s).

WEIGHT

It is very important to understand the difference between mass and weight. Your weight is the effect of Earth's gravity upon your mass. Consequently, whilst you might weigh 60kg, in actual fact your mass would be roughly a tenth of this because of the effect of Earth's gravity. Whilst we normally talk of weight in terms of kilograms, in mechanical terms it should be measured in Newtons (N). This is done by multiplying your mass by the acceleration caused by gravity. So a mass of 6kg in Earth's gravity would weigh: $6\text{kg} \times 10\text{m/s}^2 = 60\text{kgm/s}^2$ (Newtons). On the moon your mass would stay the same but you would only weigh 10 Newtons because the moon's gravity is one sixth of the Earth's and 60 divided by 6 is 10.

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